

RAPID ASSESSMENT OF BLUE ECONOMY POTENTIAL IN KARNATAKA



2021

COLLEGE OF FISHERIES, MANGALURU
KARNATAKA, INDIA

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2021

**PREPARED BY
COLLEGE OF FISHERIES, MANGALURU,
KARNATAKA, INDIA**



"To me the Blue Chakra or wheel in India's National Flag represents the potential of Blue Revolution or the Ocean Economy. That is how central the Ocean Economy is to us".

Shri Narendra Modi
Prime Minister of India



Excerpts from Hon'ble Prime Minister's speech at the commissioning of the 'Barracuda' in Mauritius on 12th March 2015.

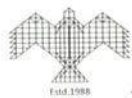
"We must focus upon developing our maritime resources and the Blue Economy. We should empower our fishermen community. Our country will have to boost its exports. Let us make every effort to reach the global market."

Shri Narendra Modi
Prime Minister of India

(73rd Independence Day Speech, August 15, 2019)



FOREWARDS



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Foreword

India has a vast coastline of 7500 km and is a region of high biological productivity and diversity as well as host ports for commerce, and sites for recreation. The ecosystem services and products provide a huge opportunity for promoting economic development which in turn will result in increased employment. Considering these opportunities the GoI has recently launched the Blue Economy programme in the country. The Ministry of Earth Sciences has brought out a draft policy on Blue Economy for the country. Considering these new areas for development World Bank has assigned College of Fisheries, Mangaluru to undertake a Rapid Assessment of Blue Economy of Karnataka.

The College of Fisheries formulated a team of experts. These experts from College of Fisheries, Mangalore have carried out detailed indepth study of each of the activities relating to the aquatic environment of Karnataka. A through indepth study of these sectors provides an insight to the opportunities that can be scaled up. As a part of the study the College of Fisheries has undertaken widespread stakeholders' consultation with all concerned parties/groups and appropriately incorporated their views. The report provides a road map to the state based on which a policy framework could be prepared for establishing a developmental plan.

Given the opportunities that are provided in each of the chapters and recommendations I sincerely hope GoK will take a pro active approach and initiate discussions with respective departments. These sectors identified are not only new but have a huge potential for the State of Karnataka to become the leader in Blue Economy implementation.

I once again thank all staff of College of Fisheries for carrying out an excellent work in bring out this report which is one of its first kind in country. It is a privilege for me to be part of this working group.

Dr. Shailesh Nayak
Director, National Institute of Advanced Studies
& Chairman, Rapid Assessment of Blue Economy of Karnataka

FOREWORD



In the state of Karnataka has around 320kms of coastline with 87000 sqkms of EEZ. Further, the state has 14 rivers, 21 lakes and 4,679 reservoirs. These aquatic systems provide a huge opportunity for promoting economic development which in turn will result in increased employment. Considering these opportunities and the initiative taken by Government of India in the area of Blue Economy the World Bank group has assigned College of Fisheries, Mangaluru to undertake a Rapid Assessment of Blue Economy of Karnataka.

The College of Fisheries formulated a team of experts which was Chaired by Dr. Shailesh Nayak, Ex-Secretary, Ministry of Earth Sciences. These experts which included the Professors from college have carried out detailed in-depth study of each of the sectors relating to the aquatic environment of Karnataka. Further, based on the draft report a widespread consultation also has been undertaken with all stake holders. The report provides a road map to the state, based on which a policy framework could be prepared for establishing a developmental plan which will be of great benefit to the youth.

The report also covers elaborately on the fisheries sector both marine and freshwater side. Some of the recommendations made are innovative and have potential for implementation specially in the integrated development of reservoirs, lakes and rivers.

I once again thank all staffs of College of Fisheries for carrying out an excellent work in bring out this report which is first of its kind in country. I am sure this report will lay a foundation for preparing a road map for implementing blue economy in the state.

A handwritten signature in black ink, consisting of a large 'X' shape with a horizontal line extending to the left and a vertical line extending upwards.

Major P Manivannan,
Secretary to Government
Department of Animal Husbandry and Fisheries

ACKNOWLEDGEMENTS

Blue Economy is the new emerging area, which provides for harnessing the vast untapped potential of our aquatic resources in a sustainable manner.

Government of India has laid high priority to development of Blue Economy in the country. Hon'ble Prime Minister Shri Narendra Modi has compared the Blue Ashoka Chakra of India's National Flag as representation of the potential of India's Blue Economy. In view of the importance given to Blue Economy in the country, the World Bank Group assigned a short-term contract titled "Rapid Assessment of the Blue Economy Potential in Karnataka" to College of Fisheries, Mangaluru, Karnataka. Based on the Terms of Reference of the study, College of Fisheries, Mangaluru formed a working group consisting of Experts, NGO's, Government Officials, Fishermen Association representatives, etc. After detailed consultations with all stakeholders the report has been prepared. The main aim of the study is creation of knowledge to the aspects of Blue Economy in Karnataka and highlight business opportunities in the state with a view to promote economic growth and generate employment.

The recommendations of the above report were presented in the business conclave organized by FICCI in Mangaluru on 21st March 2021. Based on the recommendations and the business opportunities in Coastal Karnataka, the State Government has constituted a "Coastal Development Vision Group" that shall identify developmental projects for Coastal Karnataka.

I am extremely grateful to Major P. Mannivanan, Principal Secretary, Department of Animal Husbandry and Fisheries, Government of Karnataka, for according various approvals from the Government for conducting the studies that were essential for the preparation of this report. I thank Dr. Shailesh Nayak, Director, Institute of Advanced Studies, Bengaluru, for his guidance in preparation of the report. I specifically acknowledge, Mr. Tapas Paul, Environment Specialist, World Bank Group, Delhi for assigning the study to the College of Fisheries, Mangaluru and constantly guiding College of Fisheries, Mangaluru in the completion of the report. I am grateful to the key domain experts who have contributed to this report. I profusely thank all my colleagues of College of Fisheries, Mangaluru who have provided valuable inputs in compiling this report. I thank Ms. Sharon Dsouza for her tireless work in the preparation of this report including organizing the stakeholders meeting.

I am sure the State Government of Karnataka including entrepreneurs will consider the various opportunities listed in the report for promoting development.

This report is the first of its kind for the State of Karnataka on Blue Economy that provides for a new engine for economic growth in the State.



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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
AGDP	Agricultural Gross Domestic Product
ALDFG	Abandoned, Lost or otherwise Discarded Fishing Gear
AMD	Atomic Mineral Directorate
AMPRI	Advanced Materials and Processes Research Institute
BE	Blue Economy
BOD	Biochemical Oxygen Demand
BRD	Bycatch Reduction Devices
BSNL	Bharat Sanchar Nigam Limited
BWMC	Ballast Water Management Convention
CAA	Coastal Aquaculture Authority
CAT-ESSC	Centre for Advanced Training in Earth System Sciences and Climate
CBCP	Central Pollution Control Board
CCRF	Code of Conduct for Responsible Fisheries
CEE	Centre for Environment Education
CIBA	Central Institute of Brackish Water Aquaculture
CICEF	Central Institute of Coastal Engineering for Fishery
CIFA	Central Institute of Freshwater Aquaculture
CIFE	Central Institute of Fisheries Education
CIFNET	Central Institute of Fisheries Nautical & Engineering Training
CIFRI	Central Inland Fisheries Research Institute
CIFT	Central Institute of Fisheries Technology
CIMFR	Central Institute of Mining and Fuel Research
CIMU	Coastal Infrastructure Management Unit
CMERI	Central Mechanical Engineering Research Institute
CMFRI	Central Marine Fisheries Research Institute
CMIS	Coastal Management Information System
CoFM	College of Fisheries, Mangaluru
COMAPS	Coastal Ocean Monitoring and Prediction System
CPR	Common Property Resources
CRAS	Closed Re-circulating Aquaculture System
CRZ	Coastal Regulation Zone
CSIR	Council of Scientific and Industrial Research
CSP	Coastal Security Police
CVCA	Critically Vulnerable Coastal Areas
CVI	Coastal Vulnerability Index
CWET	Centre for Wind Energy Technology
CZMP	Coastal Zone Management Plan
DGH	Directorate General of Hydrocarbons
DoF	Department of Fisheries
DPAR	Department of Personnel and Administrative Reforms
EEZ	Exclusive Economic Zone
EIA	Environment Impact Assessment

EMPRI	Environmental Management & Policy Research Institute
ENCORE	Enhancing Coastal and Ocean Resource Efficiency
ESA	Ecologically Sensitive Area
ESZ	Ecologically Sensitive Zones
ETP	Effluent Treatment Plant
EU	European Union
FADs	Fish Aggregation Devices
FAO	Food and Agriculture Organization
FCS	Fishermen Co-operative Societies
FGM	First Generation Mine
FICCI	Federation of Indian Chambers of Commerce and Industry
FISHCOPFED	The National Federation of Fishers Cooperatives Ltd.
FMFO	Fish Meal and Fish Oil
FTP	Foreign Trade Policy
FY	Financial Year
GDP	Gross Domestic Product
GoI	Government of India
GoK	Government of Karnataka
GSI	Geological Survey of India
GVA	Gross Value Added
HNS	Hazardous and Noxious Substances
HRD	Human Resource Development
HTL	High Tide Line
ICAR	Indian Council of Agricultural Research
ICD	Inland Container Depot
ICG	Indian Coast Guard
ICMBA	Important Coastal and Marine Biodiversity Areas
ICZM	Integrated Coastal Zone Management
ID, P&IWT	Infrastructure Development, Ports & Inland Water Transport
IFMFOEA	Indian Fish Meal and Fish Oil Exporters Association
IISc	Indian Institute of Sciences
IMC	Indian Major Carps
IMD	India Meteorological Department
IMO	International Maritime Organization
IORA	Indian Ocean Rim Association
IPAT	Intensive Pond Aquaculture Technology
IUCN	International Union for Conservation of Nature
IUU	Illegal, Unreported and Unregulated
KBB	Karnataka Biodiversity Board
KBITS	Karnataka Biotechnology and Information Technology Services
KFDC	Karnataka Fisheries Development Corporation
KPCL	Karnataka Power Corporation Limited
KREDL	Karnataka Renewable Energy Development Limited
KSCZMA	Karnataka State Coastal Zone Management Authority
KSNDMC	Karnataka State Natural Disaster Monitoring Centre

KSPCB	Karnataka State Pollution Control Board
KRSAC	Karnataka State Remote Sensing Applications Centre
KSTDC	Karnataka State Tourism Development Corporation
LTL	Low Tide Line
M&CSD	Marine and Coastal Survey Division
MARPOL	International Convention for the Prevention of Pollution from Ships
MBL	Minimum Beach Level
MFL	Minimum Floor Level
MNRE	Ministry of New and Renewable Energy
MoEF&CC	Ministry of Environment, Forest and Climate Change
MoES	Ministry of Earth Sciences
MoFPI	Ministry of Food Processing Industries
MPAs	Marine Protected Areas
MPEDA	Marine Products Export Development Authority
MRE	Marine Renewable Energy
MRPL	Mangalore Refinery and Petrochemicals Limited
MSP	Marine Spatial Planning
MUDRA	Micro Units Development and Refinance Agency Bank
NABARD	National Bank for Agriculture and Rural Development
NaCSA	National Centre for Sustainable Aquaculture
NBCs	Nucleus Breeding Centres
NBGR	National Bureau of Fish Genetic Resources
NCESS	National Centre for Earth Science Studies
NCSCM	National Centre for Sustainable Coastal Management
NDZ	No Development Zone
NETFISH	Network for Fish Quality Management and Sustainable Fishing
NFDB	National Fisheries Development Board
NGO	Non-Governmental Organization
NIAS	National Institute of Advanced Studies
NIFPHATT	National Institute of Fisheries Post harvest technology and Training, Kochi
NIIST	National Institute for Interdisciplinary Science and Technology
NIO	National Institute of Oceanography
NIOT	National Institute of Ocean Technology
NITK	National Institute of Technology, Karnataka
NMPT	New Mangalore Port Trust
NOS-DCP	National Oil Spill Disaster Contingency Plan
NWQMP	National Water Quality Monitoring Programme
OHI	Ocean Health Index
ONGC	Oil and Natural Gas Corporation
OTEC	Ocean Thermal Energy Conversion
PMMSY	Pradhan Mantri Matsya Sampada Yojana
PUFA	Polyunsaturated Fatty Acids

PWD	Public Works Department
R&D	Research & Development
RADAR	Radio Detection and Ranging
RAS	Re-circulatory Aquaculture System
RDPR	Rural Development and Panchayat Raj Department
RDWSD	Rural Drinking Water and Sanitation Department
RGCA	Rajiv Gandhi Centre for Aquaculture
RTC	Ready-to-Cook
RTE	Ready-to-Eat
SAC	Space Applications Centre
SCPMIP	Sustainable Coastal Protection and Management Investment Program
SDEL	Skill Development, Entrepreneurship and Livelihood
SDG	Sustainable Development Goals
SEZ	Special Economic Zone
SGDP	State Gross Domestic Product
SHG	Self Help Groups
SICOM	Society of Integrated Coastal Management
SMP	Shoreline Management Plan
SMRC	Society for Marine Research & Conservation
SPF	Specific Pathogen Free
SWQM	Seawater Quality Monitoring
TBB	Tungabhadra Board
ToR	Terms of Reference
TWSA	Total Water Spread Area
UNEP	United Nations Environment Programme
USA	United States of America
USD	United States Dollar
UV	Ultraviolet
WGEA	Western Ghats Ecology Authority
WGEEP	Western Ghats Ecology Expert Panel
WPA	Wildlife Protected Area
WQI	Water Quality Index
WSA	Water Spread Area
ZP	Zilla Panchayat

UNITS OF MEASURE

cm	centimeter
g	gram
GW	gigawatt
ha	hectare
ha ⁻¹ yr ⁻¹	per hectare per year
hp	horsepower
kg/ha	kilogram per hectare
kg/hr	kilogram per hour
kg/km	kilogram per kilometer
kg/m ³	kilogram per cubic meter
kL	kiloliter
km	kilometer
kmph	kilometer per hour
kW	kilowatt
kWh	kilowatt-hour
L	Liter
m	meter
m/s	meter per second
m ³	cubic meter
mAh	milliamp Hour
MLD	millions of liter per day
mm	millimeter
MT	metric tons
MT/ha	metric tons per hectare
MW	megawatt
NM	nautical mile
no/m ³	number per cubic meter
ppt	parts per thousand
sq. km	square kilometer
sq. m	square meter
sq. miles	square miles
tons/ha	tons per hectare
W/m ²	watts per square meter
µm	micrometer

EXECUTIVE SUMMARY

India is surrounded by oceans on three sides having a long coastline of ~7500 km. India's Exclusive Economic Zone (EEZ) extends to 2.02 million sq. km and the continental shelf area to 0.18 million sq. km. The country's coastline spans into nine maritime States and four Union Territories (UTs) with 12 major and 212 non-major ports.

India's EEZ is rich in living and non-living resources and is especially known for high biological productivity of rich fauna and flora. The economic richness of waters (oceans/seas/coasts/rivers etc.) is represented by the variety of living resources (fish and marine vegetation), material goods (hydrocarbons, minerals, bio-resources, sand and gravel), services (shipping, ports, shipbuilding, tourism) and renewable energy (wind, solar, wave, tidal, thermal and biomass). Blue economy is the sustainable use of ocean and coastal ocean-dependent resources for economic growth by taking into account the overall health of the oceans and seas while ensuring social inclusiveness, improved livelihoods and environmental sustainability.

India is the third largest fish producing and second largest aquaculture fish producing country in the world sustaining over 4 million fishermen and other coastal communities by means of food, nutritional security, foreign exchange earnings, employment generation and income. The shipping sector is one of the key livelihood providers in the blue economy. India has one of the largest merchant shipping fleets (among developing countries) and ranks 17th in the world. The number of Indian seafarers employed in Indian and foreign flag vessels has been rising steadily with an average growth rate of over 18 percent between 2017-2019. Sea ports are another large source of employment. Together, the 12 major ports and 212 non-major ports provide employment to about 34,000 people. Marine/aquatic tourism is one of the fastest growing sectors both globally and in India with coastal tourism contributing significantly to the economies and livelihood creation in coastal states and union territories.

India's blue economy currently contributes an estimated 4 percent to its Gross Domestic Product (GDP) and hence has a vital relationship with the nation's economic growth. Though endowed with a rich wealth of natural resources and the potential thereof, India's Blue Economy remains yet to be fully tapped for economic development and harnessing high value products and processes. The Government of India's Vision of New India by 2030 announced in February 2019 highlighted the Blue Economy as one of the ten core dimensions of growth. To further this zeal, the Economic Advisory Council to the Prime Minister (EAC-PM) has prepared a draft policy framework on India's Blue Economy in September 2020 to provide the strategy as well as the vision that can be adopted by the Government of India. India has also taken various steps to protect and enhance the coastal and marine ecosystems to meet its commitment to the United Nations Sustainable Development Goal 14 (SDG 14- Life below Water) that encourages conserving and sustainably using the oceans, seas and marine resources for sustainable development. The Government of India has approved the Pradhan Mantri Matsya Sampada Yojana (PMMSY) scheme in May 2020 to bring about a blue revolution through sustainable development in the fisheries sector.

One of the major consequences of the COVID-19 pandemic has been the loss of livelihoods and drying up of job opportunities. As India is home to the world's second largest workforce, it faces the challenge of ensuring adequate livelihoods and jobs. In such a scenario, the sectors of the Blue Economy have the potential to create livelihood opportunities and provide millions of jobs in the country.

Karnataka is one of India's maritime states and is located along the Arabian sea on the southwest coast of India. Karnataka has a coastline of around 320 km with 87,000 sq. km of EEZ and 27,000 sq. km of continental shelf. The state's coastline spans three coastal

districts namely Uttara Kannada, Udupi and Dakshina Kannada. The state is bestowed with 14 rivers that drain around 70 billion m³ into the Arabian sea; that form 25 estuaries with a water spread area of 7202 ha and a brackish water area of 8000 ha, which make the coastal areas rich in marine, estuarine and riparian resource. In addition, Karnataka has about 5,65,000 ha of inland water resources, with reservoirs having a water spread area of 2,72,000 ha, tanks with a water spread area of 2,93,000 ha, 5,813 km of river stretches, 9,000 ha private ponds and 22 fish sanctuaries.

Owing to the rich marine and inland resources, Karnataka has a tremendous potential for economic and social development, which is yet to be fully tapped. In line with the nation's blue economy plan, the Government of Karnataka has taken the initiative to assess the blue economy potential in the state considering the overall sustainability, potential economic growth, environmental concerns and the livelihood security of its water-dependent communities with financial assistance from the World Bank Group. The College of Fisheries, Mangaluru was entrusted with the task of undertaking the "Rapid Assessment of the Blue Economy Potential in Karnataka" on behalf of the Government of Karnataka. Under this assessment, the various established and emerging sectors of the blue economy have been examined and brief status papers as well as a Summary Outline Blue economy plan has been prepared in consultation with various stakeholders. The aim of the assessment has been to develop an all-inclusive sustainable framework to enhance the long-term economic growth, employment and sustenance of livelihoods from our blue resources.

For decades, the fisheries sector has been the mainstay of the blue economy in Karnataka. It currently provides livelihood to around 9.61 lakh fishermen (part-time/full time) of which 3.28 lakh are marine fishermen and 6.33 lakh are inland fishermen including several others along the supply and value chain while contributing to the economy of the state. While the established sectors such as fishing, shipping and port activities would continue to significantly contribute to socio-economic development, it is imperative to also augment the ecological and environmental sustainability in these sectors. On similar lines, the emerging sectors such as frontier aquaculture, offshore energy, blue-biotechnology etc. need to be well planned and implemented in a phased manner as they are also expected to provide the much-needed impetus to the Blue Economy.

The evaluation has further identified various hurdles to sustainably tap the full potential of blue resources such as lack of required skills, inadequacy of policies, adverse impacts of numerous anthropogenic activities like overexploitation, overfishing, habitat destruction, unplanned urban/industrial development, pollution etc., in addition to climate change impacts that pose a threat to these resources and livelihoods that depend on them.

Renewed/focused attention to specific areas in the blue economy is essential to bring about a turnaround in the sectors. Some of these areas include strict enforcement of legislation to prevent unsustainability in the fisheries sector, promote waste-to-useful products and strictly monitor effluent discharges etc. to minimize pollution and help restoration of ecological habitats. Moreover, use of technology and modern tools to sustainably plan activities have been suggested to conserve critical habitats such as mangroves, wetlands and protect endangered species such as turtles, dolphins, whales, sharks etc. For example, in addition to ICZM, managing the coastal/marine areas by preparing a Marine Spatial Plan (MSP) and Coastal Master plan (CMP) in consultation with various stakeholders is also essential. This would help identify critical areas needing special attention and those offering potential for development bearing in mind to safeguard areas important for non-mechanized fisherfolks to reduce/eliminate possible conflicts and protect their livelihoods.

New emerging sectors such as blue-biotechnology, integrated fish-farming, renewable ocean energy, mining of sea bed minerals etc. have been evaluated and those sectors with the ability to significantly and positively impact the economy and create jobs have been

identified and suitably recommended. For example, the preliminary evaluation has ruled out techno-economic feasibility, viability and potential of offshore wind energy, solar energy, osmotic power and ocean thermal energy in the state considering the present technologies. Whereas, recommendations have been provided for wave energy that has been experimented in the state and ocean current energy that needs to be explored.

Sustainable water-based tourism (coastal & inland), ecotourism, homestays, houseboating, water sports such as kayaking, surfing, stand-up-paddling, white water rafting etc. have been identified to have an enormous potential to spur economic growth, generate employment and improve the socio-economic conditions of communities. However, the policies to encourage these avenues need serious revamp efforts in consultation with subject matter experts to make them specific, relevant along with detailed separate methodologies for each of these avenues on obtaining licenses, prerequisite certifications etc. focusing on sustainability aspects. An extensive marketing campaign to popularize these avenues in the domestic and international fora by using public relation strategies is the need of the hour.

The recommendations for each of the several sectors of the blue economy have been assembled into a **Summary Outline Blue Economy Development Plan**. The plan addresses the potential and lacunae in each sector to holistically pursue blue economy goals along with the required institutional arrangements, skill development and capacity building that are crucial for enhancing and sustaining these goals. The recommendations are outlined giving maximum emphasis to environmental sustainability, ecological integrity and social equity.

To ensure effective implementation of the recommendations, that are prioritized under various phases for implementation (High, Medium, Low), it is suggested to form four-tier committees namely the “Blue Economy High Level Committee” headed by the Chief Minister and the cabinet members, the “Blue Economy Secretary Level Committee” headed by the Chief Secretary and Principal Secretaries/Secretaries of the key stakeholder departments, the “Blue Economy District Level Committee” headed by the Deputy Commissioners for each of the districts, and district-wise Blue Economy (Sector) Task Force Committees as applicable. The various sectors identified to further the blue economy in the state are Living Blue Resources, Tourism, Pollution Control & Management, Resource conservation & Waste Management, Conservation of priority ecological resources and Disaster Management that would be applicable to all the districts of the state whereas sectors such as Non-living Blue Resources, Maritime Transport & Development and Marine Area Management would be applicable to only the coastal districts in the state.

The sector-wise task force committees are required to convert the recommendations outlined in the **Summary Outline Blue Economy Development Plan** into specific action plans along with an institutional mechanism, clearly defined roles & responsibilities and an appropriate monitoring mechanism to ensure implementation and evaluate the progress. Implementation of recommendations would require the collated efforts of various stakeholders such as the State/Central Government departments, various research institutes, NGOs, Local Governments, local committees etc. The Blue Economy Committees constituted could meet six-monthly to review the implementation status of high priority recommendations, achievements, learnings, key outcomes etc. to facilitate cross learnings and initiate common programs.

Further, it is also recommended to establish “Blue Economy Training Institute and Research Centre/s” to carry out market analysis and engage in various skilling, up-skilling and capacity building programs recommended for every blue economy sector. This would ensure a smooth streamlined approach for maximizing the benefits from our blue economy resources effectively and efficiently with due cognizance to environmental sustainability, inclusiveness and social equity.

I. INTRODUCTION

Water covers more than two-thirds of the surface of our planet. The distribution of water on the Earth's surface is extremely uneven. Only 2.5 percent of water on the surface is fresh; the remaining 97.5 percent resides in the ocean. Of the freshwater, 69.5 percent resides frozen in ice sheets and glaciers, 30.1 percent in underground aquifers, and 0.4 percent is located in lakes, rivers, the atmosphere and as moisture in soil. Our oceans and freshwater resources sustain an enormous diversity of life and are a crucial asset to mankind, being a vital carbon sink, sustaining livelihoods, providing nutritional security and supporting several other economic activities.

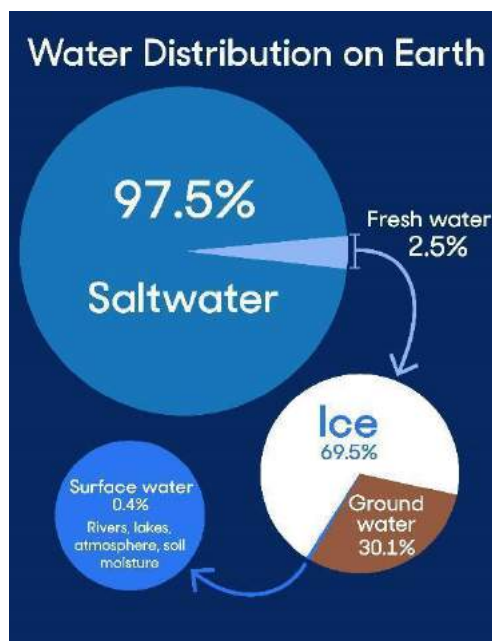


Figure A: Water distribution on Earth

The growing global population and depleting land-based resources has resulted in an increasing interest in economizing revenues from marine and coastal resources globally. However, the exorbitant human interventions and associated climate change impacts have led to disruption of natural water cycles, ocean acidification and also put water ecosystems under pressure by means of overexploitation and pollution caused by discarded solid waste, industrial and urban discharges. This has resulted in habitat destruction of critical ocean ecosystems and depletion of critical fish stocks which would pose a threat to the health, economy, and livelihoods of communities all over the world.

Blue Economy is the sustainable use of ocean resources for economic growth, improved livelihoods and jobs with due importance to the health of the ocean ecosystem. Blue Economy emphasizes on integration of ocean and freshwater economies with social inclusion, environmental sustainability combined with innovative business models to create lives and livelihoods of ocean dependent communities. This is also reflected in Sustainable Development Goal (SDG 14), which calls to conserve and sustainably use the oceans, seas and marine resources for sustainable development. The blue economy model aims for improvement of human wellbeing and social equity, while significantly reducing environmental risks and ecological scarcities.



Figure B: Blue Economy Concept

I. A. Blue Economy potential of India

India today faces an urgent situation on account of its finite and fragile water resources that are stressed and depleting while various sectoral demands are growing rapidly. Plentiful water resources have been primarily used for irrigated agriculture but with growth of Indian economy and industrial activities, the water demand has increased further. Apart from the traditional uses of the freshwater, several new areas are emerging that have tremendous employment and revenue generation opportunities like tourism, aquatic sports, green energy generation, floating agriculture, etc.

Apart from the freshwater reserves, India has a long coastline of ~7500 km. Its marine resources are spread over the Indian Ocean, Arabian Sea and Bay of Bengal. The Exclusive Economic Zone (EEZ) of the country has an area of 2.02 million sq. km comprising 0.86 million sq. km on the west coast, 0.56 million sq. km on the east coast and 0.6 million sq. km around the Andaman and Nicobar Islands. The continental shelf area is around 3,72,424 sq. km and a territorial water area of 1,93,834 sq. km spreading across nine maritime states and four Union Territories. In addition to marine areas, the country has numerous estuaries, backwaters and saline areas which have a potential for development. The coastal areas of the country support agriculture, aquaculture, fishing, industries, ports, tourism and other such activities. The freshwater, brackish water and marine areas have vast potential for generating employment, economic growth, providing alternative livelihood to traditional and other marginalized communities. As India is home to the world's second largest workforce, it faces the challenge of ensuring adequate livelihoods and jobs. Moreover, the COVID-19 pandemic has resulted in loss of livelihoods and drying up of job opportunities. In such a scenario, the sectors in the Blue Economy such as fisheries, aquaculture, shipping, tourism, deep sea mining, offshore energy, marine research, blue biotechnology, ocean conservation, and ocean sciences collectively have the potential to provide millions of jobs. The established and emerging components of Blue Economy are as tabulated in **Table A** below:

Aquatic Economy Sector	Aquatic Economy Industry/Service
Living resources	Capture fisheries (sea, rivers, lakes, ponds, estuaries) - Finfish - Shellfish/mollusks - Plants (lotus, lilly, ornamental plants, grass, mangroves)
	Marine aquaculture - Finfish - Shellfish - Sea Plants (seaweeds and other macro & micro algae) - Mollusks (mussels, clams and pearl oysters) - Other (e.g., sea cucumber and sea urchin)
	Brackish Water - Fin fish - Shellfish - Sea plants/ algae/ mangroves/ seagrass/ seaweeds - Mollusks
	Processing and retailing - Marine/fresh water aquatic product preparation and packaging - Marine/fresh water aquatic product canning - Fresh and frozen seafood/ fish processing - Fish and food markets - Fish and food merchant wholesalers
Minerals	Aggregate's mining - Sand and gravel mining - Other minerals - Support activities for non-metallic minerals mining
	Marine (including deep sea) minerals mining
	Sea salt production
Energy	Offshore oil and gas - Crude petroleum and natural gas exploration - Crude petroleum and natural gas field development - Crude petroleum extraction - Natural gas (liquid) extraction - Oil and gas pipeline and related structures
	Coastal electric power generation (when ocean/estuary waters are used for cooling)

	Renewable energy sources - Wind (onshore in coastal locations and offshore) - Wave - Tidal - Ocean thermal energy conversion - Osmotic energy
Coastal and maritime research and education	Research and training institutions and projects Secondary and higher education institutions
Ocean support services	Insurance and financial services
Desalination	Desalination plants and construction of related water supply systems
Maritime safety and security	Navy, Indian Coast Guard, State Coastal Security Police, and other public safety organizations; private security
Other raw materials (e.g., for marine biotechnology)	Pharmaceuticals, chemicals, bio-fuels, bio-fertilizers, bio-polymers
Transport and trade	Transport - Maritime freight transportation - Coastal freight transportation - Maritime passenger transportation - Inland navigation - Coastal passenger transportation - Navigational services to shipping - Port and harbor operations - Marine cargo handling - Production of navigational products - Other support activities to water transportation
	Ship and boat building - Ship building and repair - Ship breaking - Boat building and repair - Boat sales, workshops
Tourism and recreation	Tourism - Scenic and sightseeing transportation, water, and other - Recreational activity or sporting goods (sale or rental) e.g., recreational fishing equipment - Sports and recreation instruction, sports fishing - Zoos, aquaria and oceanarium

	- Nature parks and other similar institutions - Marinas, sea cruises, house boats, rafting, kayaking, stand up paddling - Hotels and motels - Island tourism - Lighthouse tourism - Museums in ships/submarine
Coastal development	Marine-related construction (infrastructure development)
Carbon sequestration	Blue carbon (i.e., coastal vegetated habitats) like Mangroves, salt marsh
Coastal protection	Habitat protection, restoration
Waste disposal	Assimilation of nutrients, solid waste
Existence of biodiversity	Protection of endangered marine species, protection and restoration of habitats
Western Ghats biosphere reserve	Protection and Conservation of endangered species and endemic species
Island Development	Construction, protection and Integrated Island Development
Cultural, religious, spiritual, and emblematic services	Value attributed to ecosystems, e.g., to an estuary or river / lake / temple ponds

Table A: Blue Economy Sectors

I. B. Blue Economy Potential of Karnataka

Karnataka is one of India's maritime states and is located along the Arabian sea on the southwest coast of India. It has a coastline of around 320 km spanning three coastal districts namely Uttara Kannada, Udupi and Dakshina Kannada with an Exclusive Economic Zone (EEZ) of 87,000 sq. km and a continental shelf of 27,000 sq. km. The state is bestowed with 14 rivers that drain around 70 billion m³ into the Arabian sea, forming 25 estuaries with a water spread area of 7202 ha and a brackish water area of 8000 ha. These make the coastal areas rich in marine, estuarine and riparian resources. In addition, Karnataka has about 5,65,000 ha of inland water resources, with 5,813 km of river stretches, 22 fish sanctuaries, reservoirs with a water spread area of 2,72,000 ha, tanks with a water spread area of 2,93,000 ha, and private ponds with a water spread area of 9,000 ha. The district wise water resources of Karnataka are provided as Annexure i.

For the purpose of this report, the Blue Economy of Karnataka encompasses all sectoral and cross sectoral economic activities related to the Arabian Sea, marine and coastal waters, brackish water systems including estuaries and fresh water bodies including rivers, lakes, reservoirs, ponds and tanks.

Owing to these rich resources, Karnataka has tremendous blue economy potential to drive socio-economic development. However, it has not made serious inroads into these sectors. Additionally, over the years, Karnataka's coastal, marine, estuarine and Ghats ecosystems are subject to tremendous pressure from various anthropogenic activities and climate change impacts that pose a threat to these resources. The overexploitation,

overfishing, habitat destruction, unplanned urban/industrial development and pollution have resulted in unsustainable management of Karnataka's precious resources that would hinder the long-term sustainable development if not curtailed or addressed effectively.

In view of these resources, the Government of Karnataka has initiated several programs to sustainably tap the full potential of its marine resources in line with the United Nations Sustainable Development Goal 14 (SDG 14- Life below Water) that encourages conserving and sustainably using the oceans, seas and marine resources for sustainable development. As one such initiative, College of Fisheries, Mangaluru has been assigned to conduct a rapid assessment of the blue economy potential in the state with financial assistance from the World Bank Group. Furthermore, the Government of Karnataka has constituted a Coastal Vision Group to prepare a Coastline Development Vision Report 2030 in areas such as development of Maritime, Fisheries, Marine asset creation, Banking, Education and Tourism with more focus on wellness, dharmic, cruise and aqua tourism. The copy of the Government order in this regard has been provided as Annexure ii.

The College of Fisheries has carried out an extensive evaluation on the blue economy potential of the state based on primary data, secondary data and inputs from various stakeholders giving due cognizance to environmental sustainability and social equity. The assessment has been organized into seven chapters, as below;

Chapter 1: Sustainable harvesting and conservation strategies for living resources

This chapter discusses in detail the current status, historical trends, potentials, constraints and strategies to be adopted for conserving and sustainably harvesting living blue resources in the well-established marine, inland and estuarine capture fisheries. The coastal and brackish water aquaculture which are still in their nascent stages of development are examined and the approaches to address the barriers for growth and equitable distribution of benefits are outlined. The potential of various emerging sectors such as ocean surface seaweed farming and submerged food production, energy plantation in the salinity intruded areas, development of pharmaceutical products based on various aquatic life forms as well as integrated fish farming and aquaponics have been evaluated and recommendations for sustainably exploring these sectors have been suggested. Moreover, ways to promote traditional practices such as Gazanis (integrated rice-shrimp farming) are also recommended.

Chapter 2: Scientific extraction and potential for utilization of non-living resources

The viability and techno-economic feasibility of existing renewable energy technologies such as offshore wind energy, offshore solar energy, osmotic power, tidal energy, wave energy, ocean current energy and ocean thermal energy have been evaluated for conditions in Karnataka. The presence of sand deposits, shell and lime deposits, rare earth minerals in the offshore and nearshore regions of Karnataka have been reviewed. The current status of existing salt pans in Karnataka and scope for further expansion has been reviewed. The current status and constraints in the Inland waterways, ports and port related sectors have been assessed and suitable recommendations to enhance socio-economic development from ports and inland waterways have been provided. Current status of hydrocarbon discovery in the offshore region of Karnataka has been reviewed. Actions to ensure environmentally sustainable and scientific extraction of non-living resources have been advised.

Chapter 3: Alternative efforts to maximize social benefits from blue economy resources

The potential for socio-economic development in the 101 mostly uninhabited islands along the coast of Karnataka have been discussed. The coastline of Karnataka faces erosion and accretion and various coastal sites have been selected for protection by various soft and

hard measures depending upon the severity of erosion under the SCPMIP sub projects. The potential of these coastal sites to be converted into generators of recurrent income in addition to providing security against erosion and coastal flooding has been assessed. The tourism potential of beaches, coastal waters, fast flowing rivers, mangrove areas etc. of Karnataka including promotion of various water sports, angling activities etc. has been evaluated in order to achieve higher employment opportunities and socio-economic development of coastal communities. To increase the tourist footfall for the beaches in the state, strategies such as blue flag certification have been assessed.

Chapter 4: Strategies for pollution management, improved resources efficiencies, recycling and waste to useful products

The various strategies to convert aquaculture sludge, fish and shellfish processing wastes into useful products such as organic fertilizers, animal feed/fish feed have been evaluated. Ways to improve water resource efficiencies such as rainwater harvesting, desalination powered by OTEC as a source of water has been assessed. Recommendations for reuse of decommissioned ships for providing tourism services and shore erosion protection services and as a water storage facility to supply potable water in areas of water stress have been suggested. Strategic interventions to reduce the flow of plastics into the oceans and control and management of ship generated wastes are provided. A generic conceptual strategy for a resource-efficient integrated zoning has been proposed for the upcoming preparation of ICZM plan for the state.

Chapter 5: Rehabilitation and conservation and protection of priority ecological resources

The various approaches for rehabilitation, conservation and protection of ecological sensitive areas such as mangroves, coastal wetlands and parts of Western Ghats have been outlined. Specific conservation and protection measures for various endangered species such as turtles, dolphins, whales, sharks, migratory birds, and fishes are provided.

Chapter 6: Strategy for augmentation of institutional capacity and human resources development in a blue economy context

The institutional arrangements, human resource and skill development that needs to be augmented for conservation & protection of priority ecological resources, sustainable harvesting & extraction of potential blue economy resources, coastal & marine area management and disaster management have been charted out. A robust skill development program to strengthen the established sectors and explore new frontiers of the blue economy has been outlined with emphasis on women and other historically disadvantaged groups/communities.

Chapter 7: Stakeholder Consultations

Due to the wide-ranging activities within the sphere of the Blue Economy, a very large number of stakeholders were identified and consultations were held at multiple levels through e-mail, telephone and online. This allowed each stakeholder group to openly discuss and provide candid feedback, important information and interventions/ solutions/ approaches that they believe would be robust and practicable. This chapter provides the minutes of the consultations held with Academicians, Government Institutions & Departments, NGOs, Industry leaders, heads of SHG's & Co-operative societies and individuals associated with 'Blue' livelihoods such as fishermen, prawn farmers, tourist-related etc.

Based on the analysis of available data/information and inputs from various stakeholders, the recommendations and suggestions have been collated into a **"Summary**

Outline Blue Economy Development Plan” and is accompanied with an effective implementation strategy. This plan has aimed to achieve a sustainable inland, ocean and coastal economy by strengthening the established sectors and exploring the economic benefit potential of the underutilized/unexplored sectors of the blue economy for generating employment, promoting socio-economic development and conserving the aquatic environment. It has also highlighted the interventions that would be required to rectify, rehabilitate and rejuvenate aquatic systems that have been damaged due to unscientific exploitation/unplanned developmental activities. Further, establishment of a “Blue Economy Training Institute and Research Centre/s” to carry out market analysis and engage in various skilling, up-skilling and capacity building programs in every blue economy sector is recommended.

An effective implementation of this all-inclusive sustainable blue economy framework in true spirit would promote and enhance environmentally sustainable and socially equitable long term economic growth, employment and livelihood sustenance in the state of Karnataka.



CHAPTER 1

Sustainable Harvesting and Conservation Strategies for Living Resources

Chapter 1: Sustainable Harvesting and Conservation Strategies for Living Resources

1.1 Introduction

Aquatic living resources include all the living “renewable” resources ranging from microscopic bacteria, arthropods, mollusks, corals, aquatic plants, diverse fishes and mammals present in aquatic ecosystems such as oceans, seas, coastal areas, estuaries, rivers, lakes, reservoirs and other water bodies.

In the blue economy context, these living resources are recognized as key components for economic gains. The majority of the aquatic living organisms are harvested for human consumption as a source of animal protein and some others are used to produce various products and materials such as nutritional supplements, cosmetics and pharmaceuticals. Many people use living marine resources for sport fishing, recreational diving, or for home aquariums. Processing of the marine living resources also yields useful by-products such as fertilizers, animal feed and fish feed.

As the global population is on the rise, the demand for healthy food and nutrition, employment opportunities to the people, demand for animal/fish feed etc. has driven unsustainable harvesting of marine living resources eventually leading to reduced fish stocks.

1.2 The Need for Sustainable Harvesting of Living Resources

Marine life was once thought to be so dynamic that it was under no threat of extinction. However, contemporary research has shown that the varied biodiversity and population of life in aquatic ecosystems in coastal and marine tracts, in streams, rivers and lakes have eroded. This erosion may be traced to four significant causes, namely,

- (a) Unsustainable harvesting of living resources
- (b) Habitat destruction and fragmentation
- (c) Impacts of pollutants and adverse impacts of Climate Change
- (d) Competition with colonizing, often exotic, invasive species

Associated impacts of rapid urbanization, industrialization, maritime transport, marine fishing, tourism, aquaculture and the recent setting up of special economic zones have led to a very significant increase in demand for infrastructure, resulting in pollution and overexploitation of water resources. A considerably large number of fish die every year due to the pollution caused by the disposal of municipal/industrial effluents, accidental oil spills etc. Moreover, overfishing the oceans, catching juvenile fish and limiting the growth of other fish populations negatively impacts aquatic food chains and webs that are extremely complex and fragile. Overfishing or killing of any species can be devastating to an entire ecosystem as every aquatic organism is an important component of their own healthy and biologically diverse ecosystem.

Such depletion and degradation, unless arrested, will impact the livelihood, health and well-being of communities dependent on these resources; in turn affecting prospects of sustainable economic growth. The need to balance the economic, social, and environmental dimensions of sustainable development in relation to water resources is a key component of the blue economy. It is a difficult balance to achieve in practice, given that the fundamental nature of the oceans often renders the use of these resources open to all who can access them, eventually resulting in overexploitation and degradation. In view of this, it is necessary

to pay immediate attention to unsustainable management of living resources and try to re-establish equilibrium between development and conservation through an effective management strategy to profitably extract the immense value the aquatic living resources provide. Conservation of aquatic ecosystems and protecting them from environmental degradation is crucial and central to sustainable harvesting of aquatic living resources. This in turn will meet the growing demand of healthy and safe food as well as a host of other value-added byproducts for an increasing population while ensuring long-term economic benefit that propagates sustainable and inclusive growth.

The vast water resources in Karnataka offer enormous sustainable development opportunities in its marine and inland waters to harness the ever-growing demand for various forms of living resources in them.

The Fisheries sector is well-established and forms one of the cores of the blue economy in the state. It contributes to the national income, national food and nutritional security, trade, foreign exchange earnings, employment generation, community income and various kinds of non-traditional economic benefits. This chapter provides an overview of the ongoing trends, status, broad gaps and future potential in the state's fisheries sector to harness the aquatic living resources sustainably.

The emerging economic activities derived from living aquatic resources such as advanced aquaculture and the associated supply-value chains, marine biotechnology, ocean farming, energy plantation etc. have the potential to create enormous job opportunities and promote socio-economic development in the state. These sectors are the subject of promising experimentation and pilot projects for use in medicine, cosmetics, water treatment, food industry and production of biofuels. The state has not yet made serious inroads into these emerging sectors. This chapter provides an outline on how each of these economic activities can provide vast opportunities in boosting the state's economy. For example, the proposed Marine Biotech Park in Mangaluru and Karwar for promoting research in areas such as structural and functional genomics and bio prospecting from marine organisms (seaweeds and microbes) will boost the economic growth as well as provide jobs in the state. Creating awareness to local communities and funding research on emerging technologies such as cultivation of seaweeds, energy plantation, vertical ocean farming, integrated fish farming, aquaponics can open new avenues to provide food security and sustain livelihoods in the state. Growing ocean forests with native species is an ocean of opportunity because the low-trophic species such as algae, mussels and bottom fauna can exploit the excess nutrients from agriculture, aquaculture and human activity, and convert these to harvestable biomass. It will reduce the footprint caused by production of fish while generating significant volumes of raw materials for human consumption, for feed and clean energy and at the same time representing a substantial absorption of CO₂. This will ensure safer and healthier food with reduced impact on the environment and climate. However, a planned and scientific approach is extremely vital to ensure that new avenues such as mariculture are not carried out in areas that are important for capture fisheries (nursery areas, fisheries reserve, spill over zones etc.) to allow sustenance of traditional fisheries and safeguard current fish stocks.

This position paper aims to consider all potential water bodies in the state that can offer sustainable development opportunities in sectors such as fisheries, aquaculture, marine biotechnology, ocean farming, energy plantation, developing pharmaceutical products from aquatic life forms etc. It evaluates the potential economic opportunities in harnessing living aquatic resources sustainably that would in turn support economic advancement, present and future food security and sustain livelihoods of coastal communities without negatively impacting the aquatic ecosystems. The aquatic living resources if managed efficiently can enhance the sector's impact in supporting sustainable economic growth in the state that leads to improved human wellbeing and social equity without significantly enhancing environmental risks and ecological scarcities.

1.3 Fisheries Sector– Marine and Inland

Fishing as an occupation of subsistence has evolved gradually and emerged to play a strategic role in food security, international trade and employment. Globalization has made a major contribution to the expansion of demand for fisheries in the domestic as well as international markets. For over 60 years, global apparent fish consumption as food has increased at a rate significantly above that of world population growth. The global per capita fish intake has increased from 6 kg/year in 1950 to 21 kg/year in 2018. The expansion in consumption has been driven not only by increase in production but also by a combination of many other factors that include increased awareness of the health benefits of fish among consumers, technological developments in processing, cold chain, shipping and distribution and rising incomes, which strongly correlate with increased demand for fish and fish products worldwide. Figure 1.1 shows the trend in worldwide capture fisheries and aquaculture. Marine capture fisheries have stagnated since the mid-1980's and the increasing trend in fish harvest is mainly driven by aquaculture in marine and inland waters.

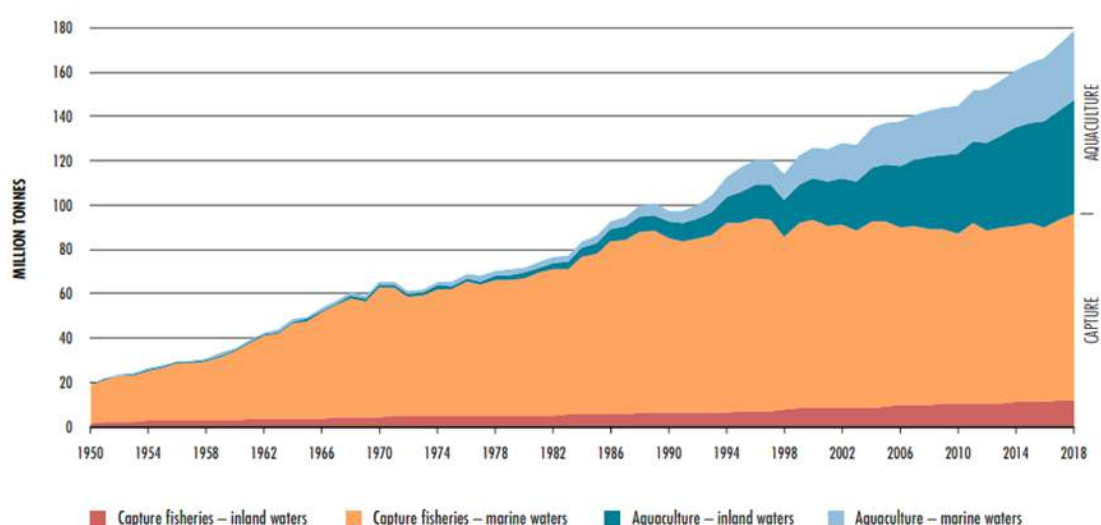


Figure 1. 1: World Capture Fisheries and Aquaculture Production
(Source: FAO)

Stagnancy in marine fish production is mainly due to reduction in global marine fish stocks as a result of overfishing and environmental degradation.

At present, one of the main challenges encountered globally is global food loss and waste which is also the focus of Sustainable Development Goal (SDG) Target 12.3, which aims at halving wastage at the retail and consumer levels and to reduce food losses along production and supply chains, including post-harvest losses by 2030. In fisheries and aquaculture, it is estimated that 35 percent of the global harvest is either lost or wasted every year. In most regions of the world, total fish loss and waste lies between 30 percent and 35 percent. Fish losses, in quantity and quality, are driven by inefficiencies in value chains such as inadequate infrastructure, services and practices for adequate onboard and on-shore handling of catch to preserve fish quality. Some of the key deficiencies relate to access to electricity, potable water, roads, ice, cold storage and refrigerated transport. Proper handling, hygiene and cold chain from harvest to consumption are crucial to prevent losses, wastes and preserve quality.

Fisheries and aquaculture remain an important source of food, nutrition, employment and income for millions, especially the rural populations. In fact, the sector provides livelihood

to about 25 million fishers and fish farmers at the primary level and twice the number along the value chain. Fish being an affordable and rich source of animal protein, is one of the healthiest options to mitigate hunger and nutrient deficiency. It has immense potential to enhance incomes and usher in economic prosperity to stakeholders. Hence it is essential that sustained and focused attention is given to the fisheries sector through policy and financial support to accelerate its development in a sustainable, responsible, inclusive and equitable manner.

Majority of fisher folk directly depend on the sector, especially the small-scale and artisanal fishers and since they continue to fall behind the national indices of socio-economic development, it is essential to provide requisite impetus towards amelioration of poverty and backwardness among these marginalized and vulnerable communities and promote their holistic development and welfare.

India has rich and diverse fisheries resources ranging from deep seas to lakes, ponds, rivers and more than 10 percent of the global biodiversity in terms of fish and shellfish species. The marine fisheries resources are spread along the country's vast coastline and 2.02 million sq. km Exclusive Economic Zone (EEZ) and 0.53 million sq.km continental shelf area. The inland resources are in the form of rivers and canals (1.95 lakh km), floodplain lakes (8.12 lakh ha), ponds and tanks (24.1 lakh ha), reservoirs (31.5 lakh ha), brackish water (12.4 lakh ha) and saline/alkaline affected areas (12 lakh ha) etc. The unutilized and underutilized vast and varied inland resources offer great opportunities for livelihood development and ushering economic prosperity.

The total fisheries potential of India has been estimated at 22.31 million MT (in 2018), of this, the marine fisheries potential stands at an estimated 5.31 million MT and the inland fisheries potential has been estimated at 17 million MT. In recent years, the fish production in India has registered an average annual growth rate of more than 7 percent. The fish production in the country has shown continuous and sustained increments since independence. The total fish production in the country rose from 0.752 million MT in 1950-51 to 13.42 million MT (provisional) during FY 2018-19. Of this, the marine fisheries contributed 3.71 million MT and the inland fisheries contributed 9.71 million MT. During FY 2018-19, 71 percent of marine fisheries potential and 58 percent of the inland fisheries potential has been harnessed. Trends show that over the years there has been a significant shift in terms of increasing contribution from the inland fisheries sector propelled by freshwater aquaculture and fluctuations in brackish water aquaculture. Aquaculture production has increased to 6.2 million MT in FY 2017-18 from 1.9 million MT in 2000-01. About 88 percent of the farmed fish comes from freshwater aquaculture. In spite of its rapid growth, aquaculture today is beset with several issues impacting production and productivity such as disease, absence of species diversification and genetic improvement, poor brood and seed, high input cost, lack of access to institutional credit, credit guarantee and insurance, environmental sustainability etc.

The marine fisheries sector is dominated by the socio-economically backward artisanal and small-scale fishers whose lives are closely intertwined with the oceans and seas. However, 75 percent of the total marine fish production comes from the mechanized sector, 23 percent from the motorized sector and only 2 percent from the artisanal sector.

In spite of stagnation in the growth of marine capture fish production over the years, the dependency of traditional marine fisheries on marine capture fisheries for livelihoods has been increasing and it is only imperative that sustainable alternative livelihood opportunities are developed and promoted. Mariculture is the fastest growing subsector of aquaculture and the success of the development of inland and brackish water aquaculture in India also corroborates with the prospects of the emergence of the mariculture sector. The projected annual mariculture production potential based on area available in the Indian region ranges from 4 to 8 million MT, whereas the current mariculture production is negligible. The rapid

growth of culture fisheries has enhanced the sector's vulnerability to aquatic diseases which are trans boundary in nature along with the threats posed by invasive species. The mitigation and control of aquatic diseases necessitates a coordinated and concerted effort between the center and states.

The regional dimensions also need adequate attention to ensure coordinated and cooperative management of shared fisheries resources and their long-term sustainability. Since the sector is extremely diverse and dynamic, a national policy that encompasses development, management and regulation of inland and marine fishery resources including aquaculture in marine, freshwater, brackish water and saline/alkaline areas and their post-harvest management, strengthening and modernization of the value chain is required.

Marine fish landings in India for the year 2019 were estimated as 3.71 million MT. Marine fish catches declined in Gujarat, Maharashtra, Goa, Kerala and Puducherry and increased in Daman and Diu, Karnataka, Tamil Nadu, Andhra Pradesh, Odisha and Bengal. A notable feature of fisheries in 2019, is the popping up of *Odonus niger*, a commercially less important marine fish at national level as the major resource in the harvests with 2.74 lakh MT landings from only 0.72 lakh MT in 2018.

In India, the annual post-harvest losses for Marine Fisheries are over INR 15,000 crores and the combined losses for Marine and Inland Fisheries Sector stands at INR 61,000 crores. This results in enormous loss of income for the fishermen community. Effective reduction in fish loss and waste requires appropriate policies, regulatory frameworks, capacity building as well as services and infrastructure. It should be emphasized that reducing fish loss and waste can lead to a reduction in pressure on fish stocks and contribute to improving resource sustainability as well as food security.

The State of Karnataka located along the Arabian Sea on the southwest coast of India has abundant fishery resources. The state has a coastline of around 320 km with 27,000 sq. km of continental shelf and 87,000 sq. km of Exclusive Economic Zone (approx. 4 percent of India's EEZ of 2.02 million sq. km). The resources are spread out mainly in 3 coastal districts viz. Dakshina Kannada, Udupi and Uttara Kannada with a coastline of approximately 62 km, 98 km and 160 km respectively. In addition, Karnataka has about 5,65,000 ha of inland water resources that includes 3,906 departmental tanks with water spread area of 1,79,000 ha; 22,414 Gram Panchayat tanks with water spread area of 1,24,000 ha; 82 reservoirs with water spread area of 2,72,000 ha, 5,813 km of river stretches, 9,000 ha private ponds and 22 fish sanctuaries. The inland resources also include fourteen rivers that drain around 70 billion m³ into the Arabian sea; and form 25 estuaries with water spread area of 7202 ha and brackish water area of 8000 ha, which make the coastal areas rich in marine, estuarine and riparian resources. The other marine resources in the state are Mangroves (23.81sq. km), Coral reefs (0.87 sq. km), Sand dunes (1.09 sq. km), mud flats (11.76 sq. km), and Salt Marshes (3.20 sq. km).

For the purpose of this report, the fishery resources are divided into Marine waters (Coastal) and Inland waters (major tanks, minor tanks, reservoirs, rivers, canals, brackish waters and estuarine areas) in line with the approach of the Department of Fisheries, Government of Karnataka.

1.3.1 Fish Production in Karnataka

Karnataka stood 4th in India contributing 4.52 lakh MT (Dept. of Fisheries, Karnataka) to India's total fish production of 3.49 million MT in the year 2018. As shown in Figure 1.2, the average fish production in the last 5 years (2014-15 to 2018-19) is about 5.87 lakh MT with the marine and inland sectors contributing 66 percent and 34 percent respectively. The year-wise fish production in Karnataka is provided in Chapter 1 Annexure 1.

In 2019 (calendar year), marine fish landings in Karnataka increased to 5,01,331 MT (11 percent) (CMFRI) from 2018 mainly due to the unusually large landings (1,20,527 MT) of the red toothed triggerfish (*Odonus niger*) by almost three-fold by the multi-day trawl nets and purse seines with simultaneous reduction in landings of commercially important species such as Indian oil sardine and mackerel. Once known for mackerel and sardine landings along with other commercially important species such as pink perch, pomfrets, seer fish, lactarius and anchovies, fishermen have been getting loads of trigger fish or *Odonus niger* (Kargil fish). While trawl landing of Kargil fish was about 300-500 MT in 2008-2009, it rose substantially to 2.74 lakh MT in 2019. The red-toothed Kargil fish is normally found in the bottom region of the seas, occurring in enormous shoals and is caught in large quantities in trawl nets during the monsoon season and other months. These fish were found in areas where there are rocks, at depths of 40- 60 fathom. At present, these fish are found even in shallow regions.

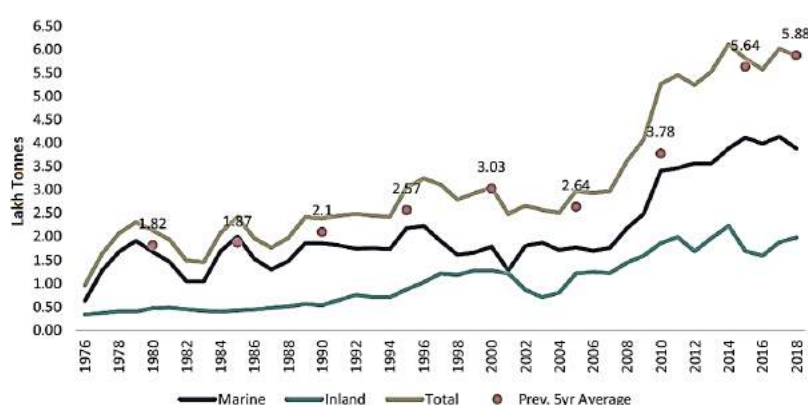


Figure 1. 2: Fish Production trend of Karnataka

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

1.3.2 The contribution of Fisheries Sector to SGDP & AGDP (at current prices)

India is one of the largest fish producing countries in the world and contributes 7.58 percent to the global production. The fisheries sector in India has shown impressive growth over the past few years with an average annual growth rate of 10.88 percent from 2014-15 to 2018-19. The fish production in India has registered an average annual growth of 7.53 percent from 2014-15 to 2018-19 and stood at an all-time high of 137.58 lakh MT during 2018-19 (provisional). The export of marine products stood at 13.93 lakh MT during 2018-19 valued at INR 46,589 crores (USD 6.73 billion) with an impressive average annual growth rate of about 10 percent in recent years.

The share of the fisheries sector to the total GDP (at current prices) increased from 0.40 percent in 1950-51 to 1.03 percent in 2017-18, recording an increase of 157 percent. The sector contributed INR 1,75,573 crores to the GDP (at current prices) during FY 2017-18 (Ministry of Statistics and Program Implementation, 2020). The sector has been showing a steady growth in the total Gross Value Added and accounts for about 6.58 percent share of Agricultural GDP. The sector has been one of the major contributors of foreign exchange earnings with India being one of the leading seafood exporting nations in the world. The marine exports stood at about 5 percent of total exports of India and constituted 19.23 percent of Agri-exports (2017-18). During 2018-19, export of marine products stood at 13,92,559 MT and valued at INR 46,589 crore (USD 6.73 billion). The rapid increase in the growth of seafood exports has been mainly due to boom in brackish water aquaculture¹.

¹National Fisheries Policy, 2020

Contributing 1.24 percent to India's Gross Value Added (GVA) and 7.28 percent (2018-19) to the agricultural GVA, fisheries and aquaculture continue to be an important source of food, nutrition, income and livelihood to millions of people. The contribution of the fisheries sector to State Gross Domestic Product (SGDP) & Agricultural Gross Domestic Product (AGDP) (at current prices) for the State of Karnataka is provided in Table 1.1.

Sector	2014-15	2015-16	2016-17	2017-18	2018-19
Agriculture	78620	79749	81343	98403	93396
Animal husbandry	18717	19763	22870	25344	27378
Forestry	6618	8401	8263	8360	8646
Fisheries	5004	4501	4380	6195	6996
Total Agriculture sector	108959	112414	116856	138302	136416
SGDP	831316	942681	1034512	1185035	1348889
Contribution (within Agriculture)	4.59 %	4.00 %	3.75 %	4.48 %	5.13 %
Contribution (to Total SGDP)	0.60 %	0.48 %	0.42 %	0.52 %	0.52 %

Table 1. 1: Contribution of Fisheries Sector to SGDP & AGDP (at current prices)

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

The State Gross Domestic Product (SGDP) at current prices during 2014-15 was INR 5004 crores and has increased to INR 6,996 crores in 2018-19 witnessing an increase of 40 percent. The average contribution of the fisheries sector during the five years was INR 5415 crores. The average contribution of the sector to SGDP is about 0.51 percent and to state agriculture GDP 4.39 percent². Small scale fisheries contribute around 15 percent to the fisheries GDP and provide 45 percent of employment (Bhatta, 2019). The sector has great potential for higher GDP growth and is important as a source of revenue contributing to the growth of the region.

1.3.3 Environmental Degradation and its Impact on Fisheries

The great majority of fishery production occurs within 200 miles off land; hence marine fishery resources are highly susceptible to impacts of human activities. Pollution from atmospheric and land-based sources has taken a toll on the marine environment. The cumulative release of various pollutants in rivers, lakes and oceans from several point and nonpoint sources such as untreated sewage, agricultural run-off, contamination from ships, untreated industrial effluents etc. have resulted in severe deterioration of the water quality and disruption in the balance of the ecosystem, killing fish and other aquatic life.

Moreover, the ever-increasing number of boats that use diesel engines are also contributing to the increase in greenhouse gases fueling climate change and its associated impacts as well as acidifying the oceans. Additionally, climate change is also modifying fish distribution and productivity of marine and freshwater species. The effect of sea level rise means that coastal fishing communities are significantly impacted by climate change, while changing rainfall patterns and water use impacts the inland freshwater fisheries and aquaculture.

²Department of Economics and Statistics, Government of Karnataka

Vulnerable coastal communities face the brunt of this unethical management of waste, discharges and climate change impacts severely threatening their livelihood opportunities. It is therefore evident that if these devastating impacts continue, it will substantially hamper the state's potential to harness the blue resources sustainably and endangering the very resources that these coastal communities depend on.

Hence there is an urgent need to regulate the number of fishing fleets, combat the impact of land-based waste, wastewater & plastics pollution on marine ecosystems in coastal areas and high seas. UNEP's Global Program of Action for the Protection of the Marine Environment from Land-Based Activities is one of the few intergovernmental mechanisms addressing land-based pollution directly to meet SDG 14.1. The World Bank's PROBLUE program also identifies marine pollution from land-based sources as one of its pillars for implementation.

Reflecting on the importance of water bodies as an essential resource, it is crucial for the state to highly prioritize protecting marine ecosystems, preventing pollution from various sources, sustainably managing marine resources and also increasing awareness by means of policy interventions and strict enforcement mechanisms.

1.3.4 Impacts of Climate Change on Fisheries and Adaptation Strategies

The impacts of Climate change on our oceans include shifts in temperature, acidification, deoxygenation and changes in ocean currents which in turn modify fish distribution and the productivity of marine and freshwater species. The effect of sea level rise means that coastal fishing communities are in the front line of climate change, while changing rainfall patterns and water use impact inland (freshwater) fisheries and aquaculture. The uncertainties of climate change exacerbate the vulnerabilities of ecosystems and people who depend on it. Many aquatic ecosystems and allied livelihoods in Karnataka are susceptible to the combined climate change impacts such as effects of sea level rise, increasing sea surface temperature, ocean acidification and the intensification of intense weather events.

Oceans are both the greatest victims of climate change and its greatest mitigators. Oceans play a major role in climate dynamics, absorbing 93 percent of heat that accumulates in the Earth's atmosphere, and a quarter of the carbon dioxide (CO₂) released from fossil fuels. The coastal ecosystems of mangroves, tidal marshes and seagrass meadows contain large stores of carbon deposited by vegetation and various natural processes over centuries. These ecosystems sequester and store more carbon – often referred to as 'blue carbon' – per unit area than terrestrial forests. The ability of these vegetated ecosystems to remove carbon dioxide (CO₂) from the atmosphere makes them significant net carbon sinks, and they are now being recognized for their role in mitigating climate change. However, if the ecosystems are degraded or damaged directly or indirectly by human activities, their carbon sink capacity is lost or adversely affected, and the carbon stored in the soil is released, resulting in CO₂ emissions that contribute to climate change³.

In the past 30 years, marine heat waves are estimated to have increased by more than 50 percent⁴. Globally, ocean temperatures are predicted to increase by 1-4 degrees Celsius by 2100. The Arabian Sea has registered the fastest warming rate among the tropical oceans. Its surface temperature has increased by 1.2-1.4 degrees Celsius between 1982 and 2018. Hence, it is extremely important to have long-term mitigation strategies in place to combat the impacts of climate change and focus on climate resilient sustainable fishing practices and

³<https://www.iucn.org/resources/issues-briefs/blue-carbon>

⁴https://www.msc.org/what-we-are-doing/oceans-at-risk/climate-change-and-fishing#_

coastal area management that are conducive and environment friendly. Efforts in this direction have to be given high importance since these factors could become the most significant drivers of fish populations, coastal stability, and coastal biosecurity over the next few decades. Any blue economy policy that does not account for the uncertainties associated with climate change could catastrophically overestimate what the coast is capable of safely contributing to the economy.

Hence, there is a need to tap into the blue carbon economy that is rapidly growing in importance by strengthening the role of Blue Carbon (BC) through conservation strategies, implement Nature-based Solutions (NbS) to protect coastal ecosystems from pollution and enhance climate adaptation strategies through Ecosystem-based Adaptation (EbA).

An effective tool would be to bring together vulnerable coastal communities, civil society groups and the government to collectively conserve, protect, and manage critical coastal ecosystems. This engagement at multiple levels – from people at the grassroots to key decision-makers at the policy level – is underpinned by targeted initiatives that support policy reforms, institutional strengthening, and safeguarding livelihoods and incomes for the poorest and most vulnerable. The objective is to create an enabling environment for sustainable communities and ecosystems, by improving capacity to co-manage natural resources, adapt to climate variability and change, and safeguard livelihoods of local communities that depend on it.

We are fortunate to have a small-scale fishery along the coastline which has very little carbon footprint. The road to climate change friendly fisheries policy is through safeguarding and incentivizing small scale fisheries. There is a need to support and build climate-resilient local fishing institutions that are able to respond, adapt, learn and feel empowered to make decisions about their own self-governance. This needs to be part of a larger climate-resilient institutional framework that builds meaningful partnership between fisheries departments, coastal fishers, markets and scientific research institutions.

1.3.5 Women and vulnerable communities in the Fisheries sector

Women play an important role in the Fisheries Sector all over the world. In India, fish trade is a traditional occupation that has been a livelihood for the majority of fisherwomen. It is estimated that out of 5.4 million people fully engaged in fisheries activities, 3.8 million are fishermen and 1.6 million are fisherwomen i.e., about 30 percent. Around 25 percent of women labor forces are involved in pre-harvest activities, 35 percent in export marketing and 40 percent in internal marketing⁵.

Though fishing is carried out mainly by men, women are active mainly in secondary and allied activities either in their own cottage-level industries or as wage laborers in the large-scale processing industries for their livelihood. The activities in which women are actively involved are categorization, icing, internal marketing, cleaning, vending, salting, prawn peeling, fish packing, curing, net making, smoking, sun-drying, fish seed collection, collection of mussels, edible oysters, sea weeds etc. Women in coastal Karnataka are actively involved in the retail marketing of fish to the general population by direct marketing, either personally by going to the individual customers or in fish markets. Many women have undertaken the manufacture of value-added products such as fish & prawn pickles, and chutney-powder and become successful fish entrepreneurs. Among the important species utilized for such products are: tuna, seer fish, mackerel, squid, sardines, jewfish, silver bellies and prawns. The value-added products are prepared in Malpe and Mangaluru and sold in retail markets. Community based enterprises were established in recent years for the production and marketing of improved dry fish which is being sold through an organized marketing system. These products

⁵Shyam. S. Salim, R. Geetha, *Indian J. Fish.*, 60(3): 73-80, 2013

have also been successfully introduced into super markets.

Participation of women in these activities generates supplemental income to support their families. However, women are vulnerable and fisher folk women are no different. They have always remained small players in the fisheries economy, in that their scale of operation and market have been limited. Women borrow at high rates of interest and sell fish, travelling to and from distant markets or harbors. They have to compete with men in order to earn and sustain their families. Though women are as efficient as men, they earn, on average, 50 percent less than their male counterparts.

A study found that the socio-economic condition of all the fisher women was invariably equal. Health vulnerability was prominent⁶, wherein the tedious nature of work had led to the deterioration of their health. Concomitantly they also failed to spend quality time with their family members, which led to other serious social problems like school dropouts and low attention on adolescent girls.

Changes in the fisheries sector poses several challenges and substantially affects the livelihood of women fisher folk in the form of non-availability of fish in adequate quantity, decline in coastal space for fish processing activities, competition from men traders and growing number of fish retailing shops. Schemes like Matsya Mahila Swavalambana Yojane, Savings Cum-Relief Scheme are not big enough to meet or compensate the needs of the fisherwomen. Ignorance of information on welfare programs has become a major handicap. In one study⁷, nearly 67 percent of the respondents had a medium level of awareness on beneficiary programs of the State Fisheries Department, and half of them had a low level of participation in those beneficiary programs.

Many of the programs designed by the government have not been fully utilized by women because of their poor literacy. In one study⁸, most of the respondents were illiterate or fell below the basic literacy level. Among the respondents, 58 percent were illiterate. Furthermore, superstitions abound in both men and women, but the latter suffer more from these beliefs. Fisherwomen involved in fish marketing are charged an extremely high interest rate by money lenders (81.66 percent). No proper allotment of space for fish retailers in the marketplace, and lack of cooperation on the part of fisheries officials were yet other major constraints as opined by more than 70 percent of the respondents. In the past, the government reserved (notified) some of the coastal land for fish curing purposes, but presently such land is diverted for non-fishing activities. In most of the landing centers, processing & storage areas and fish markets there is no adequate/suitable basic infrastructure, amenities and services to meet their business and personal needs. The recommendations to empower women and vulnerable communities in the Fisheries sector is provided in the **Summary Outline Blue Economy Development Plan**.

1.4 Marine Capture Fisheries in Karnataka

Marine fisheries sector is one of the major industries in coastal Karnataka and is the most recognized part of the state's Blue Economy. Historically, the Karnataka coast is known as "Mackerel Coast". The contribution of the marine fisheries sector to the state and national economy is widely acknowledged. The state has a 320 km coastline that runs along three districts viz. Dakshina Kannada, Udupi, and Uttara Kannada and has an Exclusive Economic

⁶International Journal of Scientific & Technology Research Volume 8, Issue 12, December 2019

⁷V Sagar, Mahesh & Sundaram, Swathi & Shivaprakash, S & Naik, Kumar & Khavi, Muttappa & Jagadeesh, T D. (2016). Study on Awareness and Participation of Fisherwomen in Beneficiary Programs of State Fisheries Department in Coastal Karnataka, India. J. Exp. Zool. India. 19. 1437-1441.

⁸Ashalatha, Saravanan (2020). The study on Socio-economic Status of Fisherwomen in Udupi District, J. Xi'an Univ. of Arch. & Tech. Volume XII, Issue V. 481-496.

Zone of 87,000 sq. km. About 3,28,000 coastal and marine fishers live in 156 marine fishing villages across 3 coastal districts (86 in Uttara Kannada, 41 in Udupi and 17 in Dakshina Kannada districts). A further 6,33,000 fish workers in other villages are directly or indirectly connected to the marine/coastal fisheries. The sector serves as a significant source of animal protein for human consumption, employment generation and foreign exchange earnings. A drive to export shrimp and a state sponsored modernization program through co-operatives and banks influenced the growth of marine fishing in Karnataka since the early 1960s. However, the development of modern marine fisheries has been traced to the launching of the Indo-Norwegian project for the mechanization of the fishing craft in 1966. The number of motorized boats has increased from 974 in 1990 to 4,298 in 2009 and 8,949 in 2019 showing a 27.3 percent year on year increase since 1990. Thus, introduction of large mechanized vessels and high-speed engines to facilitate better exploitation of fishes from different niches, increased number of hauls/day in case of multi day trawlers was focused to enhance fish catch. The state sponsored modernization program through financial support and incentives of co-operatives and banks, and this has greatly influenced the growth of fleet size. In recent years, the trend is towards deep-sea fishing and improvements observed are in use of imported speed engines reducing the fishing from 15-20 days to 3-5 days (Bhatta, 2019). To reduce the pressure on inshore coastal waters and support the sustainable development of marine capture fisheries, the state under the Indo-Danish project, implemented a pilot project during 1990's to harvest high-value untapped fishery resources with export demand present in deeper parts of sea (up to 100m depth) such as Tunas, Bill fishes, pelagic sharks, deep sea shrimp, cephalopods, lobsters etc. This led to enhancing the total marine fish production, improving the economic status of traditional fishers and reducing the negative impacts of unsustainable fishing practices. Owing to the success of the pilot project, deep sea fishing is being promoted by extending Government support with focused attention on mainstreaming traditional fishers and their societies for fishing in offshore and deep-sea oceanic regions.

The State-wise Marine fish landings in lakh MT for the calendar year 2019 are shown in Figure 1.3.

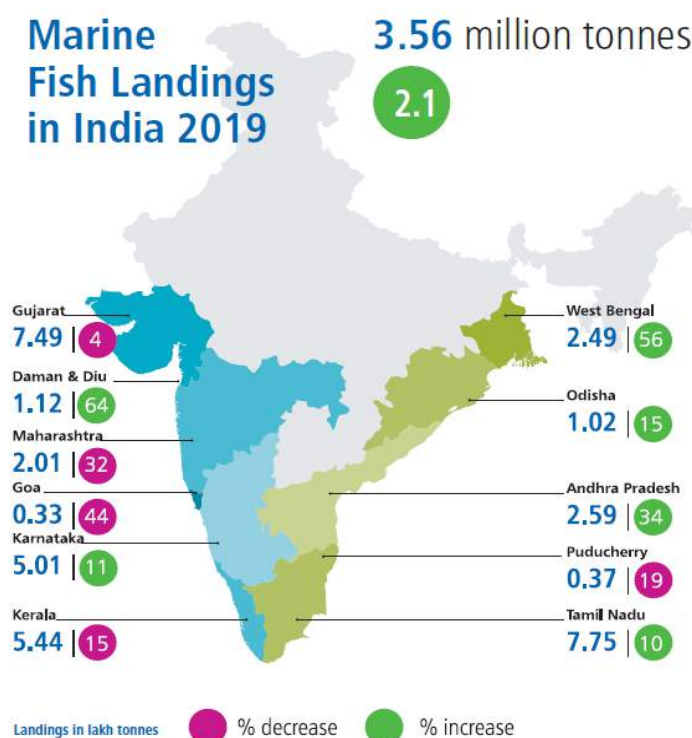


Figure 1. 3: State-wise marine fish landings in India for calendar year 2019
(Source: CMFRI)

The sector is contributing to poverty reduction through revenue generation and wealth creation, facilitating a socio-economic 'lift' at community level while providing a sustainable stream of economic benefits to the community. This rising trend in aquaculture production is due to the negative impacts of overfishing and environmental degradation wherein marine capture fisheries are no longer considered a reliable source of food security for a growing population due to unsustainability concerns.

1.4.1 Marine Fishery Resources and Infrastructure

Over the years, the fishery sector has moved from a subsistence level activity to a cash intensive sector. With the process of commercialization in fishing operations, successive governments have taken up development activities in infrastructure and physical marketing systems to support efficient production and marketing. The state witnessed unprecedented development in infrastructure facilities during the mid-70's. and supported the sector development by way of establishing a wide range of supportive infrastructure across the activities at various levels of supply-value chain. The key infrastructure established are mainly major Fishing harbors (8 nos.) located in Mangaluru, Malpe, Honnavar, Tadri, Karwar, Gangolli, Bhatkal and Amadall. In terms of general facilities, Malpe, Mangaluru and Honnavar harbors are well established with slightly better facilities compared to others. However, in terms of sanitation facilities, all fisher stakeholders consulted for the purpose of this report expressed displeasure on the severe inadequacy of drinking water facilities, toilets, and a complete lack/negligence of their maintenance. The 3 coastal districts have 16 Fish landing centers (Udupi (4 nos.), Kundapura (4 nos.), Bhatkal (2nos.), Kumta (3 Nos.), Ankola (2 Nos.) and Karwar (1 no.) and 96 beach landing centers of which the district of Uttara Kannada has the maximum number (51 nos.) followed by Udupi (31 nos.) and Dakshina Kannada (14 nos.).

In support of craft and fabrication of nets the state has supported the establishment of 27 boat building yards and 3 net making plants in different coastal districts. For better postharvest handling, processing, value addition and improved marketing chains infrastructure such as ice plants (260 nos.), cold storages (54 nos.), freezing plants (14 nos.), frozen storages (11 nos.), canning plants (8 nos.), fish meal plants (21 nos.) and fish markets (280 nos.) are established in different coastal districts. The other infra supports are fish jetties, fish auction halls, mechanical workshops, slipways, diesel bunks, fish handling sheds, fish gear sheds, fish drying yards, access roads, freshwater supply, electricity and other amenities. These infrastructure developments supplemented sector growth and led to a change in the utilization pattern of fish.

The Marine fishery resources and infrastructure in Karnataka are provided in Table 1.2

A GLANCE AT THE MARINE FISHERIES SECTOR IN KARNATAKA	
Resource Type	Area/Length
Coastline	320 km
Continental Shelf	27,000 sq.km
EEZ	87,000 sq.km
Fishing harbors: 8	
Fish landing centers: 16	
Beach landing centers: 91	
Fish Markets: 280 Nos.	
Boat building yards: 27	

Net making plants: 3	
Shrimp Hatcheries: 5	
Potential: 6.02 lakh MT (Earlier proposed 4.25 lakh MT)	
Production: 3.89 lakh MT (2018-19)	
Total Fishermen: 3.28 lakh	
Active Fishermen: 1.57 lakh	
Fishermen Villages: 156	
Total Fisheries Co-operatives: 13	
Fishery Co-op. Apex Federations: 2	
Mechanized	Motorized
4542	8949
Traditional	Total Boats
9044	22535

Table 1. 2: Marine fishery resources and Infrastructure in Karnataka

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

1.4.2 Historical trends in Marine fish landings

The marine fish landing trends in Karnataka are shown in Figure 1.4 and the year-wise marine fish catch, percent growth quantity and percent growth value are given in Chapter 1 Annexure 2.

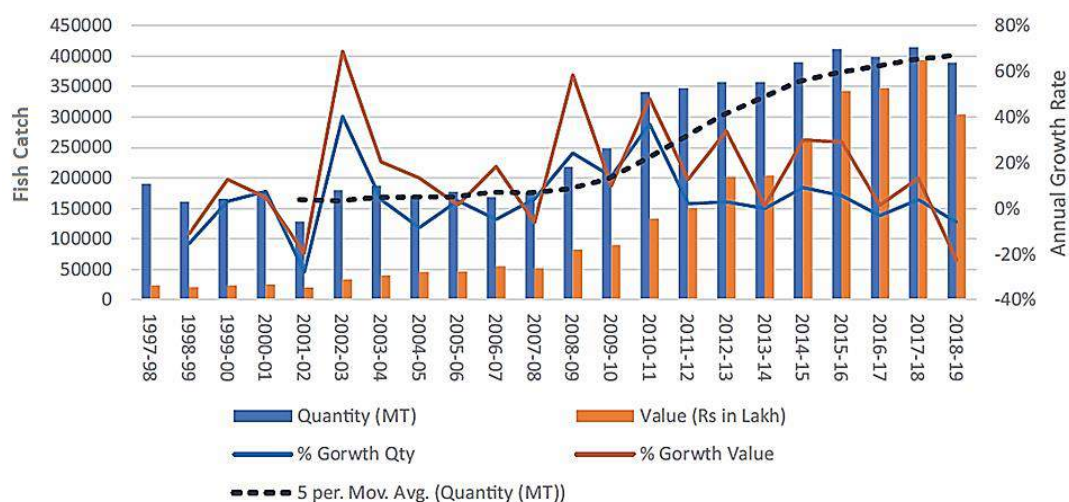


Figure 1. 4: Marine Fish Landing trends in Karnataka

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

A review of marine fish production in the state during the past two decades indicated a steady increase despite fluctuations. The lowest landings were recorded in 2001-02 and the highest during 2017-18. Mechanization, motorization, improved crafts and gears, expansion

of fishing grounds, multi day fishing, improved marketing and processing facilities contributed to increase in landings over the years. The five-year moving average of the fish production has an increasing trend since 2008-09 and is seen to be likely approaching stagnation (2018-19 onwards). The percent growth value has a decreasing trend since 2008-09 and is the likely factor towards the observed stagnation in fish production.

It is noteworthy that though the quantity of fish produced is on the rise since 2008-09 and is approaching stagnation, the value of percentage growth in quantity and value are on a decreasing trend. In addition, the percentage growth in value has dropped significantly as compared to a moderate drop in percentage growth in value during 2018-19. This indicates that the increased fishing effort is not yielding commensurate increase in value. It is also important to note that trash fish and low-value-bycatch are increasingly being landed.

Status of major fish species as abundant, less abundant, declining, depleted and collapsed has been reported based on Rapid Stock Assessment (RSA) study (CMFRI-2016). The present status of commercial fish stock exploitation viz., fish stocks overfished, stock depletion, unexploited or underexploited, trends against time line have been assessed and impacting factors are documented by CMFRI. The sector is experiencing a crisis of marine fish stock decline.

1.4.3 Species-wise Marine fish landings

The district and species-wise marine fish landings and its value for the year 2016-17, 2017-18 and 2018-19 is given in Chapter 1 Annexure 3. The composition of species of the marine fish catches for the year 2018-19 is depicted in Figure 1.5.

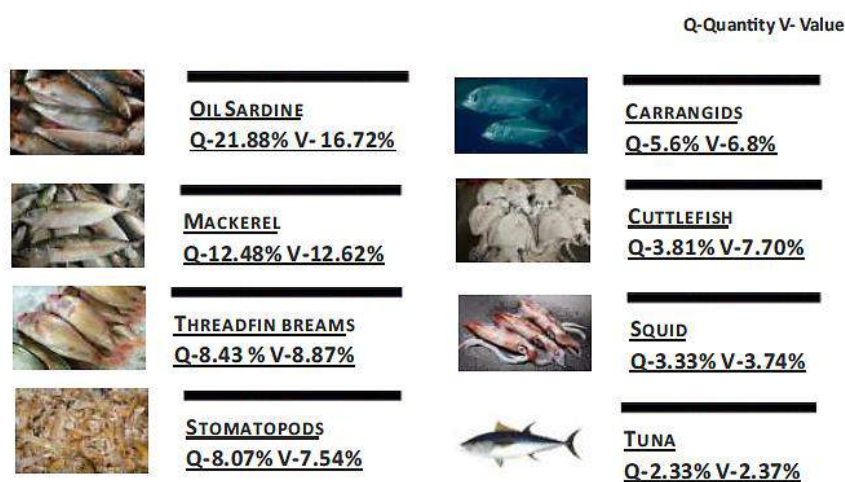


Figure 1. 5: Species composition of marine fish catches (2018-19)

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

The Indian Oil Sardine ranks highest in the marine fish landings followed by Mackerel.

1.4.4 District wise contribution to Marine fish landings

The district-wise contribution to Marine fish catches (2017-18 and 2018-19) is shown in Figure 1.6.

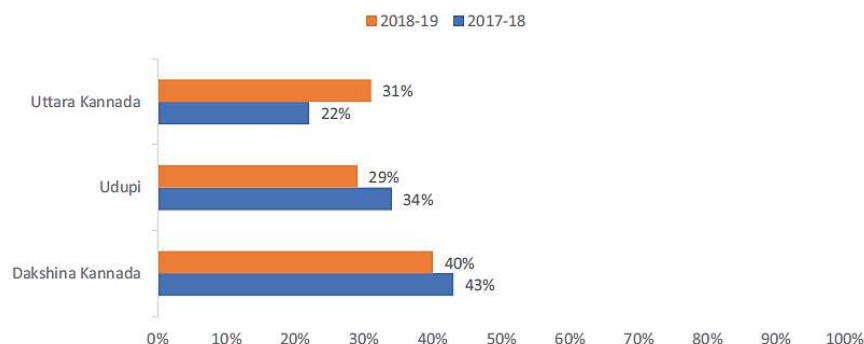


Figure 1. 6: District-wise contribution to Marine fish catches (2017-18 and 2018-19)

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

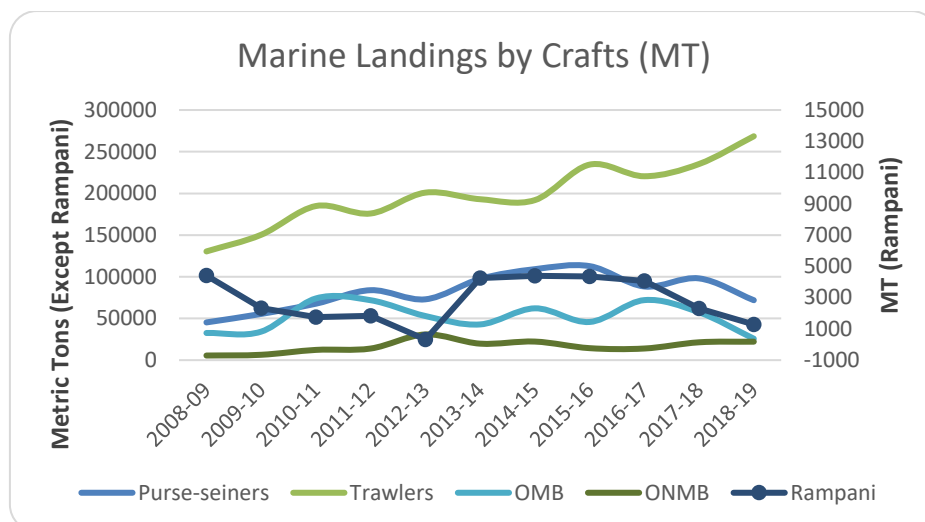
Export of fish and fish products from Karnataka is mainly limited to the marine sector. The export of fish from the state has increased from 1.16 lakh MT during 2014-15 to 1.42 lakh MT in 2018-19. About 30 percent of the marine fish production is being exported annually. The average export during the past five years was 1.23 lakh MT valued at INR 1539.73 crores (USD 243.5 million). The export increased from INR 1375 crores (USD 225.11 million) to INR 1891 crores (USD 269.9 million) during the five-year period. The contribution of the state to the Country's total exports in terms of quantity varied between 8.88 percent to 11.16 percent (av. 10.4 percent) and in value terms 3.45 percent to 4.2 percent (av. 3.96 percent) during the five years' period. The export is being made mainly through the ports of Mangaluru (nearly 99.8 percent) followed by other ports.

1.4.5 Marine fish landings by different crafts

Fishing boats are mainly Mechanized, Motorized (OBM) and Non-motorized (Traditional) types. Fishing operations are dominated by mechanized fishing gears mainly trawlers, seines and gill netters. During 2018-19, the number of non-motorized boats was high (9044) and the share is maximum (40 percent) followed by motorized boats (8949) with a share of 39.7 percent and mechanized boats as trawlers, purse seiners, gill nets and others (4542) with share of about 20 percent. The number of mechanized boats is high (46 percent) in Udupi district followed by DK district (38 percent). Motorized boats fitted with outboard Motor is high in Udupi district (51 percent) followed by Uttara Kannada district (32 percent). The use of traditional boats in fishing is high in Uttara Kannada district (71 percent) followed by Udupi district (23 percent) and least in DK district (6 percent).

The year-wise marine fish landings by different crafts are provided in Chapter 1 Annexure 4. The Figure 1.7 depicts the marine fish landings by different crafts from 2008-09 to 2018-19. The comparison of marine fish landings by different crafts for the year 2008-09 and 2018-19 is shown in Figure 1.8.

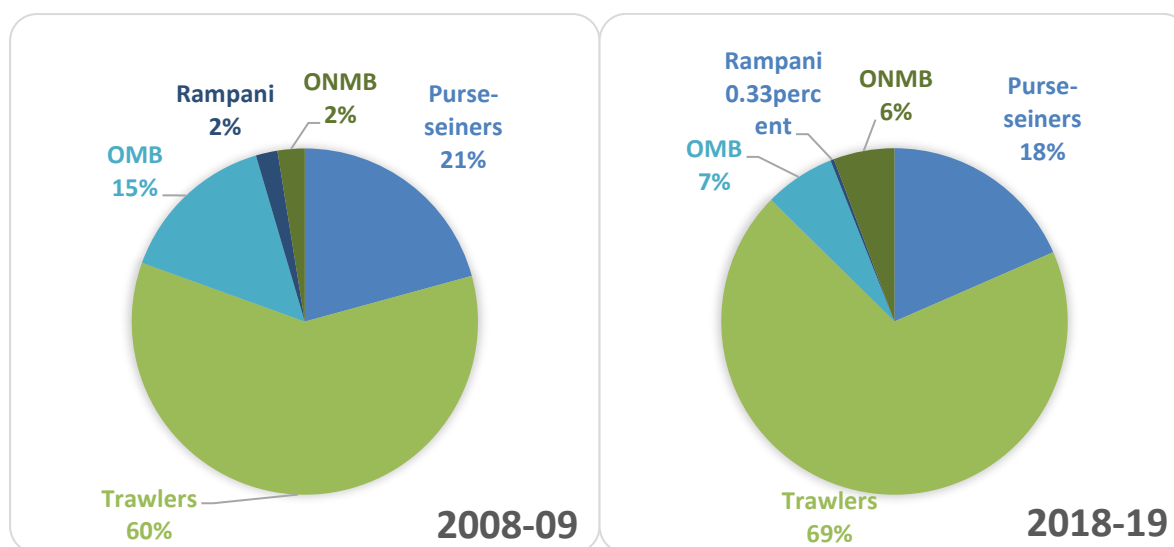
The overall increase in the number of fishing boats registered 3.06 percent growth compared to previous year and the trend indicated higher gains (6.1 percent) for motorized boats followed by mechanized boats (2.44 percent) and least (0.52 percent) for non-mechanized boats. The overall share of registered vessels to the country's total is 8.48 percent (motorized non-mechanized 6.7 percent, motorized mechanized 6.9 percent and non-mechanized 13.76 percent). The computed optimum fleet size suggested for mechanized crafts is 1312 Nos. for mid-day trawlers, 739 Nos. for single day trawlers, 182 Nos. for purse seiners and 2330 Nos. for motorized craft (CMFRI, 2016). Some of the fishing vessels of coastal Karnataka also carry out fishing in waters of Goa, Maharashtra, Kerala and Lakshadweep.



(Note: OMB- Other Mechanized boats, ONMB- Other Non-Mechanized boats)

Figure 1. 7: Marine Fish landings by different crafts from 2008-09 to 2018-19

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)



(Note: OMB- Other Mechanized boats, ONMB- Other Non-Mechanized boats)

Figure 1. 8: Comparison of Marine Fish landings by crafts 2008-09 and 2018-19

As can be seen in Figure 1.8, over the last decade, the marine fish landings from trawlers have been on an increasing trend and have doubled in a period of ten years while the share of other crafts have decreased, especially those from traditional fishing crafts (rampani). The introduction of trawlers has adversely affected other shore seines and their own catches.

The traditional 'rampani' nets, which once accounted for 50-60 percent of the annual catch, have almost disappeared (landings from rampani accounted for only 0.33 percent of the total fish landings in 2018-19). The increased mechanized and motorized boats are alleged to have interfered with the fishing rights of traditional, small-scale fishers in the near-shore areas leaving them with hardly any catch threatening their livelihood and sustenance. It would

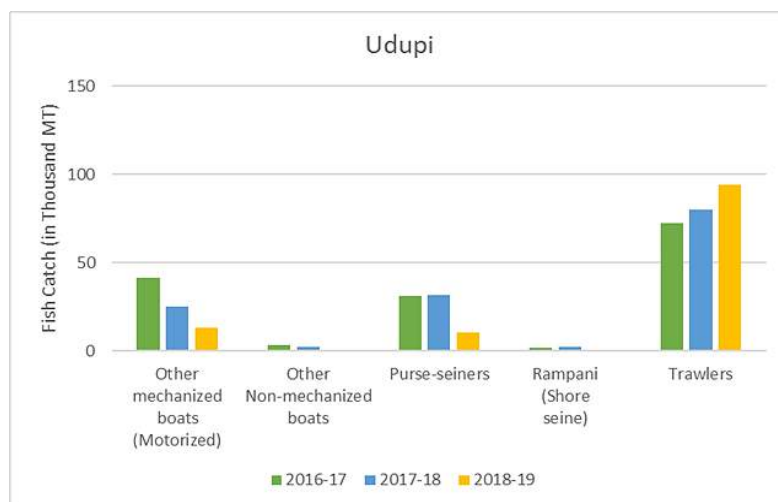
be of no surprise that in the future the traditional fishers would be forced out of business.

According to a report⁹ Karnataka operates with 39 percent excess trawl capacity. Trawlers equipped with advanced technologies in fishing and high storage capacity are diligently trawling to fish as much as possible with no concern over the size or the species of fish or the future concerns about the fishery sector. This practice has resulted in substantial exploitation of commercially important fish juveniles and ecologically important biota¹⁰. Fishing with excess trawl capacity has led to increased competition between fishers, reduced yield per boat and increased low-value bycatch (LVB) or "trash fish". These Low-value bycatches (LVB) or "trash fish" are utilized by FMFO plants located at various locations along the 320-kilometre Karnataka coastline. Among the estimated 50-72 FMFO concerns in India, around 21 fish meal plants are in Karnataka. At the FMFO plants the Low-value bycatches or "trash fish" are used as raw material to produce fish meal, fish oil and in some cases fish soluble. These products are sold in domestic and international markets.

The buyers at these markets are various companies, such as pharmaceutical companies, paint producers and mainly animal feed producers (feed for poultry, pigs and aquaculture). An augmented demand from these fish meal plants has resulted in the sharp increase in trash fish catch in Karnataka. For example, the trash fish landing at Mangaluru was around 3 percent in 2008 and increased to 26 percent by 2011. Trade and industry are playing a key role in the quantity of LVB (Low value by catch) landed and discarded. Today, far from being a value addition, the FMFOs are the only source of stable income for trawlers and hence to meet the increasing demand from the industry, more and more trawlers are sweeping the ocean floor. Unfortunately, the utilization of trash fish that was once considered as a boon by converting them to fish meal and subsequent value added by products has led to indiscriminate fishing practices, decreasing fish stocks and severe environmental pollution.

1.4.6 District wise landings by crafts

The district-wise marine fish landings by different crafts are given as Chapter 1 Annexure 5. The Gear-wise Marine Fish Catch by district and year is shown in Figure 1.9.



⁹Report of the Expert Committee constituted for Comprehensive Review of the Deep-Sea fishing Policy and Guidelines, Bharathiamma, Meenakumari, ICAR, August 2014.

¹⁰Mahesh Et Al.: Characterization of LVB and its impact on Juvenile Fishes, Indian J. Mar. Sci., Vol. 48, No. 11, November 2019.

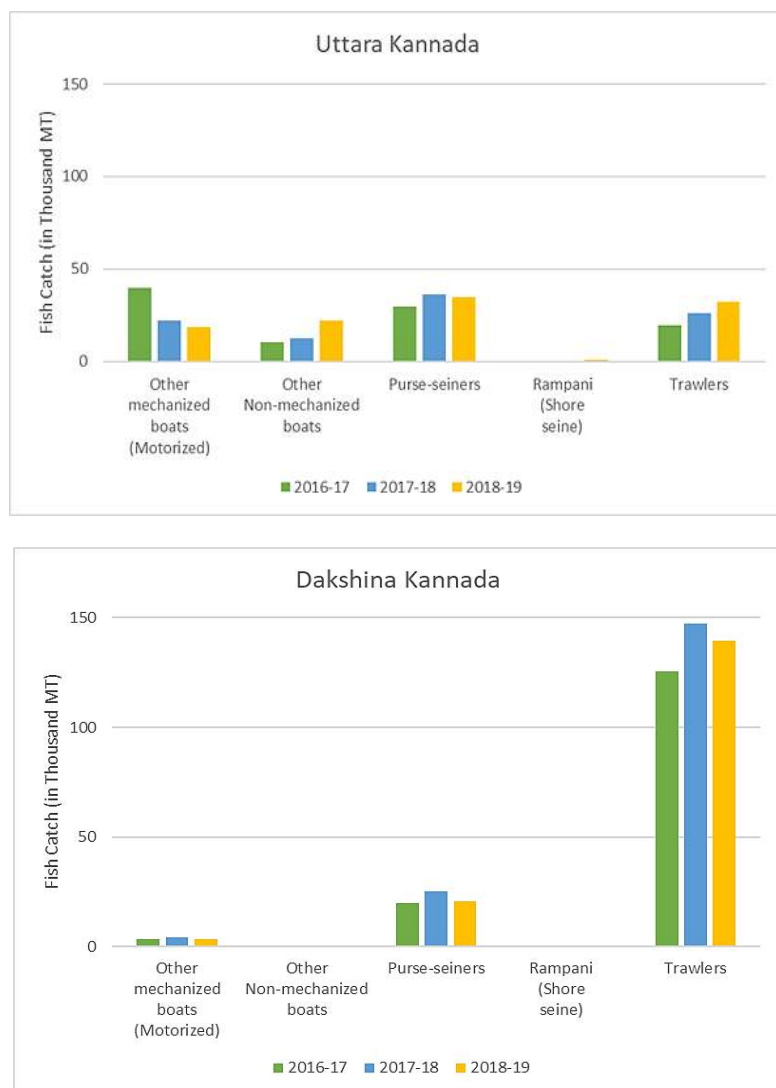


Figure 1. 9: Gear-wise Marine Fish Catch by district and year

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

As seen from Figure 1.9, the fish landings from trawlers are the highest in Dakshina Kannada as compared to Udupi and Uttara Kannada. Fish landings from Dakshina Kannada are almost double that of Udupi and almost 4 times that of Uttara Kannada.

1.4.7 Fishing Nets/Gears

Wide variety of gears are in use for fishing operations. The common traditional/motorized gears are Drag net, Gill net, cast net, Shore-seines, Disco net and others, and the mechanized gears are mainly trawl net and Purse-seine.

As on 31-03-2019, the nets/gears owned by marine fishermen was maximum for gill nets (9033) followed by traditional nets (7360), trawl nets (4420) and purse seines (274). In Uttara Kannada district, the share of traditional nets was high (over 56 percent), followed by gill nets (28 percent), trawl nets (8.6 percent and purse seine nets (<1 percent) to the total number of nets/gears owned in the district. Whereas, in Udupi and Dakshina Kannada districts the share of gillnets was high (60 percent and 46 percent respectively) followed by trawl nets (28 percent and 44 percent respectively), traditional nets (10 percent and 4 percent respectively) and purse seines (<2 percent).

Over the period, the number gears and gear size used for fishing operations witnessed significant changes. Use of synthetic gear material for making nets has become common. In the mechanized sector, gill-nets, trawl nets, and dragnet numbers increased considerably, while the number of purse-seine nets increased marginally. In the traditional sector, the number of shore-seine nets declined. Though, number of traditional gears increased compared to mechanized gears, there is no corresponding increase in fish harvested by the traditional gears.

1.4.8 Export of Marine products

India is the tenth largest seafood exporter in the world. As per the Marine Products Export Development Authority (MPEDA), during the financial year 2019-20, India has exported 12,89,651 MT of seafood worth US\$ 6.68 billion as against 13,92,559 MT of seafood worth US\$ 6.73 billion in 2018-19. USA, China and the European Union are the major import markets of Indian seafood. Frozen shrimp continues to be the major item of export followed by frozen fish, frozen fish, frozen squid and frozen cuttlefish. In 2019-20, Shrimp accounted for a share of 50.58 percent in quantity and 73.21 percent of the total USD earnings among exports. USA is the largest market for frozen shrimp followed by China, European Union, Japan, South East Asia, Middle East countries besides others. During 2019-20, Shrimp exports rose by 6.2 percent in quantity and 6.04 percent in USD value.

The export of fish and fish products from Karnataka for the year 2019-20 was 95,941 MT worth US\$ 195 million translating to 7.44 percent of India's total exports in terms of quantity and only 2.92 percent in terms of value. For the year 2018-19, the export of fish and fish products from Karnataka was 1,42,048 MT worth US\$ 270 million, which constituted 10.2 percent of India's total exports in terms of quantity and 4.1 percent in terms of value. The year-wise trend of export of fish & fish products from Karnataka is given in Figure 1.10. The exports of Marine products, port wise and year wise is attached as Chapter 1 Annexure 6.

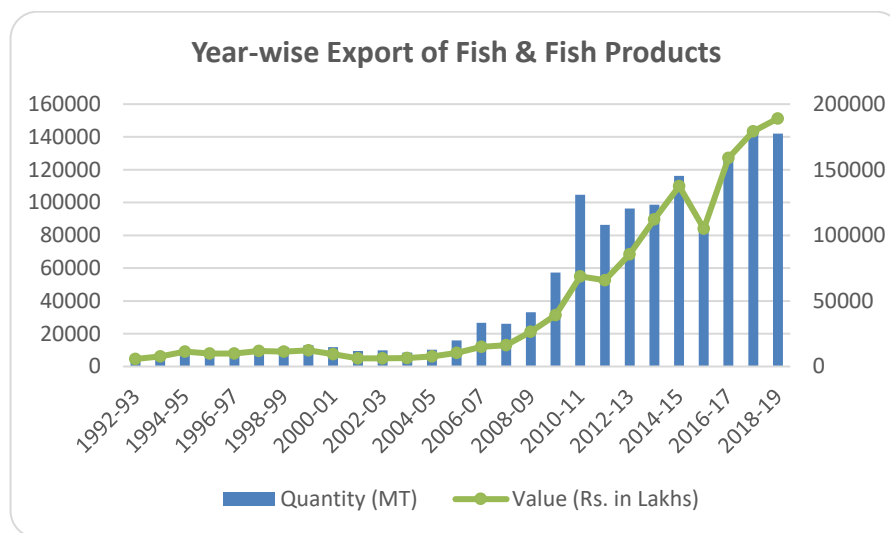


Figure 1. 10: Year-wise Export of Fish & Fish Products

Exports of marine products have increased from 0.98 lakh MT during 2013-14 to 1.42 lakh MT during 2018-19. The quantity of fish exported and the value of exports have both seen an exponential rise since 2008-09. The trend of Karnataka's share in India's Exports is given in Figure 1.11. Karnataka's share in India's exports have remained fairly steady between 2014-15 and 2018-19, both in terms of quantity (9-11 percent) as well as in value (3-4 percent).

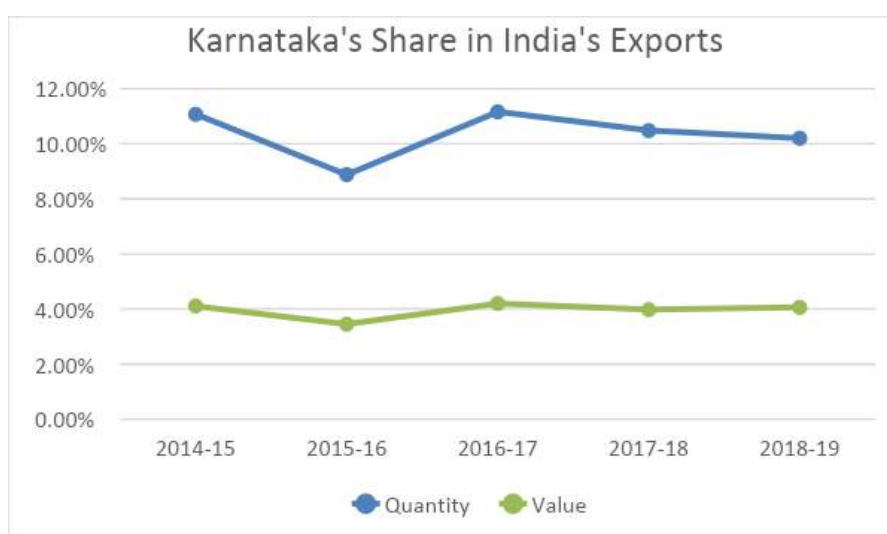


Figure 1. 11: Karnataka's share in India's Exports

The trend of exports from ports in Karnataka is given in Figure 1.12. Mangaluru port continues to be the major seafood export hub of Karnataka. Mangaluru accounts for more than 99 percent of the exports and currently contributes 99.95 percent of the total exports from Karnataka. The trend of exports from Mangaluru/ICD Port is given in Figure 1.13.

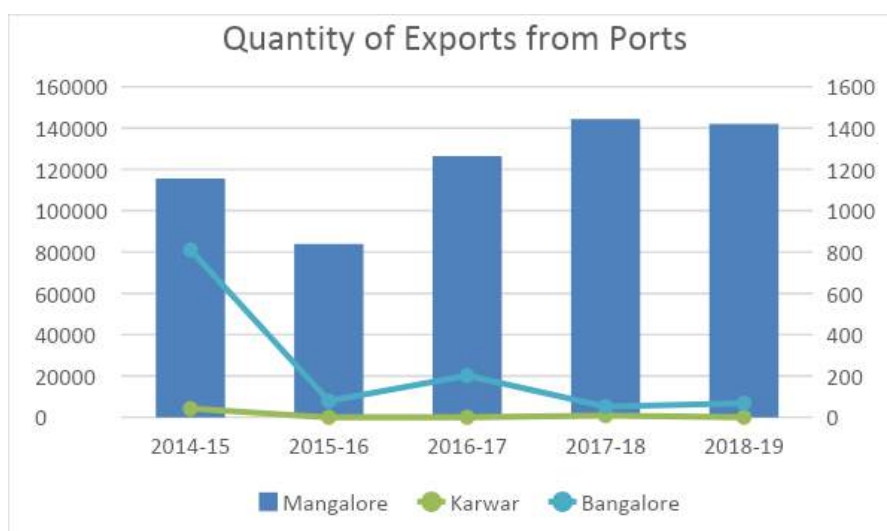


Figure 1. 12: Trend of Exports from Ports in Karnataka

As per MPEDA, in 2017-18 Mangaluru/ICD port accounted for 10.47 percent of India's exports in terms of quantity and 3.98 percent in terms of value (USD).

The majority of frozen seafood that is exported to China and South-East Asia is further processed into value added products and re-exported to the USA and Europe. In view of this, there is significant potential for Karnataka in the value-added seafood market and Karnataka needs to shift from exporting only frozen seafood to upgrading seafood into higher-priced value-added seafood products and exporting it directly to USA and Europe to earn higher foreign exchange returns. Some of the various products that Karnataka can focus on is the production and export of Ready to Eat (RTE) and Ready to Cook (RTC) sea food products such as sauces, noodles, fillets/flaps, fingers, sticks, bites, burger fillets, cutlets, breaded and

battered seafood, sausages, nuggets, kababs, salami, steaks etc. Products with Indian taste, flavored with Indian spices have a distinct demand in the domestic as well as export market. A detailed market analysis, feasibility and branding cum marketing campaign would need to be carried out.

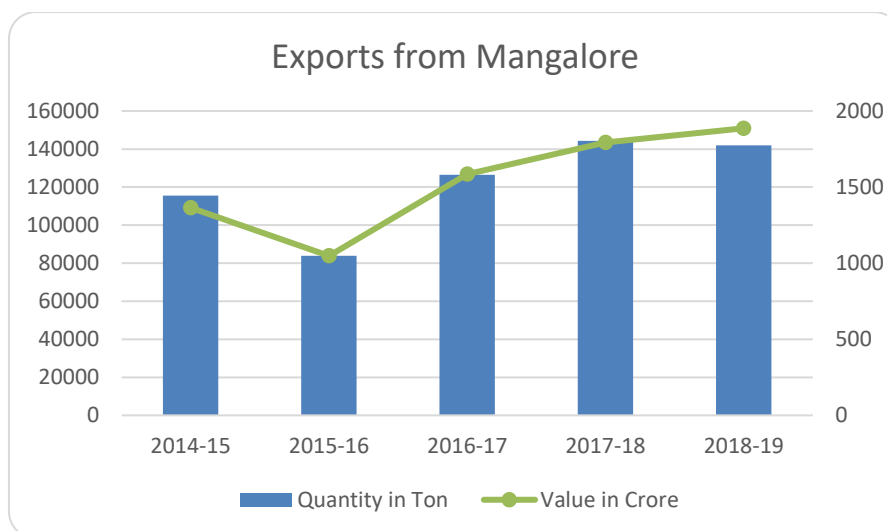


Figure 1. 13: Trend of Exports from Mangaluru/ICD Port

Currently, India's export is dominated by shrimp. However, there is a significant export demand and potential for mud crab and fishes like sea bass, pangasius and tilapia. Hence, it is essential to urgently enhance the production of these export-oriented fin and shell fishes. To this end, there is a need for area expansion, intensification and species diversification in a cluster/area approach coupled with good farm management practices. Further species diversification of shrimps needs to be promoted to limit dependence upon only one species. Quality shrimp farming needs to be supported to ensure sustained income transfers to the marginalized small farmers and fuel growth of exports.

Exports of fish and fish products from India are in high demand as is evident from the increasing trend of exports over the years. In line with the trend, India's overall share of the global seafood market is expected to go from 4.1 percent to 6.7 percent by 2030. India also has set a marine products export target of US\$10 billion by 2022. If India is to achieve both these targets, it has to put in place robust policies, address key concerns, chart out actionable roadmaps, embrace new technologies and adopt innovative strategies.

In order to ensure that the exports continue to show a sustained double-digit growth, concerns regarding microbiological and chemical residues need to be effectively addressed. Seed and feed certification and accreditation needs to be set up. Concurrently, a system of end-to-end traceability needs to be urgently put in place. It is equally important to create awareness among fishers on the issues of export rejection, the causes leading to rejection and ways to minimize/eliminate them. Export policies, procedures, inspection and testing protocols need to be strengthened to further reduce the rejection rates and improve the confidence level in Indian seafood exports.

1.4.9 Supply and Value Chain in Marine Fisheries

The supply and value chain in the fisheries sector plays a vital role in the socio-economic development of the state by sustaining livelihoods and generating foreign exchange earnings. Since the quality of seafood starts deteriorating immediately after the catch, the

supply and value chain aims to ensure the sea food and its value-added products reach consumers in the freshest form possible in an efficient manner.

A fisheries supply chain includes a network of retailers, distributors, transporters, storage facilities and suppliers that participate in the production, delivery and sale of catches to the consumer. The supply chain is typically made up of multiple individuals/companies who coordinate activities to achieve the above goals.

A supply chain comprises of 3 main parts i.e., supply, manufacturing and distribution. The Supply part focuses on the providing auxiliary goods required for fisheries such as supply of boats, nets, seed etc. and inbound logistics that ensures how, when and from which location the raw materials are to be supplied to manufacturing units. Karnataka has 27 boat building yards, 3 net making plants and 5 Shrimp hatcheries. The Manufacturing part focuses on converting these raw materials into semi-finished or finished products such as ice plants, cold storages, freezing plants etc. There are 195 ice plants, 32 cold storages, 14 freezing plants and 11 frozen storages across the state. The distribution part focuses on ensuring these products reach the consumers through an organized network of distributors, warehouses and retailers-such as logistics, marketing and sales.

While the focus of the supply chain is on upstream activities i.e., integrating the supplier and producer and improving efficiency, the value chain comprises downstream activities such as value addition to the harvested fish through innovative product development and marketing that strives to achieve consumer satisfaction. Since fish is a highly perishable commodity, the quality of fish is to be retained by preservation techniques such as chilling, freezing, canning, smoking, salting, drying and processing into various products. Karnataka has 8 canning plants, 21 fishmeal plants and 2 surimi plants.

The value-added products in the state meet the domestic as well as export demand. The exports command a larger share and are composed of frozen seafood, fish meal and fish oil. Currently value-added seafood products in the domestic market are seafood-based pickles, crackers, chips, curry pastes, wafers, chutney powder, canned sea food etc. Except seafood pickles, other value-added seafood products are recent entrants that are yet to gain adoption and popularity in the domestic market.

There is immense potential for the state to produce and market other high value-added Ready to Eat (RTE) and Ready to Cook (RTC) sea food products such as sauces, noodles, fillets/flaps, fingers, sticks, bites, burger fillets, cutlets, breaded and battered seafood, sausages, nuggets, kababs, salami, steaks etc. Products with Indian taste, flavored with Indian spices have a distinct demand in the domestic as well as export market. A detailed market analysis, feasibility and branding cum marketing campaign would be needed to be carried out.

Organizing food festivals across the state would lead to an increased awareness among fish consumers about different varieties of seafood value-added products available and their nutritional values. This will also help to gauge the demand of RTE and RTC sea food products. Launching of mobile food trucks and mobile sale units with cold storage facility will not only take the seafood value added products to the doorsteps of the consumers but also help to boost demand, preserve the fish for a longer duration while also ensuring a better livelihood for retailers and also offer much higher quality fish to end consumers. There is also ample scope to earn foreign exchange through the marketing and export of higher quality products.

There is a need to strengthen and modernize the value chain including creation of fisheries infrastructure to increase shelf life, reduction of post-harvest losses and production of value-added products. Existing fisheries infrastructure will have to be modernized/upgraded. Fisheries infrastructure include processing plants, cold storages, ice plants, freezing and packing plants, value addition, fish and fisheries products, transportation vehicles including

refrigerated and insulated vehicles, ice flaking and ice crushing units, ice/fish holding boxes, warehouses etc. A robust mechanism to reduce costs and increase the efficiency in fresh fish marketing, freezing facilities and canning industries to enable the fishers to harvest fishery resources and to meet the inimitable consumer needs is required. Efforts need to be made towards innovations in packaging for increased shelf life and product differentiation. It is equally important to generate gainful employment and entrepreneurship opportunities along the value chain leading to higher income of fishers and fish farmers, improve their living standards and usher in economic prosperity.

1.4.10 Sustainability assessment and concerns in the Marine Fisheries sector

Fishery resources are a renewable natural resource but are liable to become depleted (as witnessed in many cases across the globe) if continuous and indiscriminate harvest is adopted resulting in a rate of harvest or exploitation higher than the rate of regeneration or reproduction. The size of the fish stock mainly depends on the biological, economic and social considerations. Since fisheries resources fall under common property resources, their management becomes a complex issue and various management intervention options need to be adopted to ensure sustainable harvest as well as to maintain inter and intra generational equity. Being a natural resource with the capacity to rebuild, harvest of marine fishery resources needs to be managed based on periodic assessment of status of the fish stocks for maintaining sustained production from the sea.

Overcapacity or overcapitalization in a fishery occurs when the size of the fishing fleet, its harvesting ability or fishing power exceeds what is necessary to harvest an optimum yield. Since most fisheries are fully exploited or overexploited, existing fishing capacity exceeds what is necessary to harvest the maximum sustainable yield (MSY) and/or maximum economic yield (MEY).

Fish stock assessment and projections often aid in evaluating responses of fishery to different management plans. In a study, the maximum sustainable yield of trawl fishery along the south-west coast of India (in the states of Kerala, Karnataka and Goa) was estimated¹¹. In the study, forecasts of biomass and fish catch were made for years up to 2025 for five different levels of fishing effort and the expected dynamic changes in biomass as well as fish catch when fishing effort levels are altered were examined. The study showed that the biomass sequences for future years (up to 2025) had a steady declining trend when exploitation levels were maintained or increased and an increasing trend when exploitation levels were reduced. The expected catch in the future years was found to be highly fluctuating over years for all levels of fishing effort. From the model predictions, it was also found that the impact of changing fishing effort would be higher on biomass than on marine landings of the study region. The study concluded that any increase in fishing effort would only lead to further unsustainability of fishery in the region.

The study attributed the major reason to unsustainable fishing was the overcapacity in the fishing fleet of the region. The optimum fleet size proposed by the revalidation committee¹² for Karnataka was 1312 for multi day trawlers and 729 for single day trawlers. However, the number of trawlers including both single day and multi day, operating in Karnataka were 2847 (CMFRI, 2012), representing a 39 percent excess trawl capacity.

The expected average annual harvest by trawlers in the south-west region (Kerala, Karnataka and Goa) corresponding to the fleet size recommended by the revalidation

¹¹Sathianandan, T. V., Kuriakose, Somy, Mini, K. G., Safeena, P. K., *Maximum sustainable yield of trawl fishery along the south-west coast of India: Bayesian estimation approach*, *Indian J. Fish.*, 67(1): 23-29, 2020.

¹²Report of the working group for revalidating the potential of fishery resources in the Indian EEZ. Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Govt. of India, New Delhi, 69 pp.

committee is 5,75,600 MT which is 74,000 MT higher than the estimate of MSY obtained in the study. The average landings by trawlers in the south-west region for the three years preceding the study were 5,26,900 MT of which 89 percent was contributed by approximately 4250 multi day trawlers and the remaining 11 percent by 820 single day trawlers. This was in excess of 5 percent to the estimated MSY and hence, to bring down the exploitation level to MSY, the study recommended that the numbers of multi day and single day trawlers in the south-west region should be reduced by 207 and 36 respectively.

The study also recommended that, the fisheries managers of the south west region (Kerala, Karnataka and Goa) need to jointly chalk out a fleet reduction strategy for the region to ensure that the fishery operates within the MSY level. Since there are no state-wise boundaries in the sea as in land, ensuring stakeholder participation in the decision-making process will ensure that fleet reduction can be a success and that the trawl fishery of the south-west coast of India remains sustainable in the coming years. There is also a need for regular species wise fish stock assessment due to the change in stock of different species. For example, in recent years, landings of the Indian oil sardine have come down drastically and the landings of a demersal fish i.e., *Odonus niger* catch is high. It is therefore essential to carry out detailed investigations of the biology and population parameters of important species periodically (Stock/resource assessment) to estimate the Maximum Extractable Catch using information from population vulnerabilities (Using modern genetic tools such as “genetic population structures” and “effective population size using allele frequencies”) and life history parameters using ecosystem-based fisheries management tools like ECOPATH and ECOSIM.

Fishing regulations such as ban period for mechanized boats during peak spawning period, curtailing destructive fishing practices etc need to be made uniform for the entire west coast of India. The uniform regulations need to be pursued by the Central Government in consensus with state fisheries departments (Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu) and National governmental and Non-governmental Scientific Research bodies.

1.4.10.1 Sustainability concerns in the Marine Fisheries sector in Karnataka

Several study analyses were carried out on the impact of mechanization and increased fishing fleet size by many institutions/organizations which has indicated that there are several factors that have led to the biological and socio-economic un-sustainability, threatening the livelihood of traditional fishers and the very future of coastal fisheries. The following are some of the reasons for overcapacity and decline in the capture of marine fisheries that requires immediate attention:

1. **Oversized fishing fleet:** Over the years, the number of crafts operating in Karnataka has multiplied many-folds. As a result, the returns per boat have dwindled putting a lot of pressure on the exploited resources. Amidst all this, the traditional, small-scale, artisanal fisher folk suffer the greatest while most catch is harvested by capitalists causing a rise in social rifts among traditional, small fishers in the near shore and mechanized craft owners.
2. **Overcapitalization:** The steep increase in the cost of vessel construction, net materials, diesel prices, ice, labor, overhead charges for post-harvesting, etc., has made the fishing activity expensive. It has resulted in unhealthy competition among boat owners resulting in intensified targeted fishing operations using larger vessels with higher fish hold capacity, high speed engines, reduced mesh size at the bunt / cod end, increased fishing effort (units and fishing hours) and use of modern fish finding devices.
3. **Increased landings of trash/ discards:** Increased competition among fishermen

has led to the use of several destructive fishing methods in order to maximize the harvest from fishing grounds. In spite of the ban in the state, bull trawling and light fishing has been carried out rampantly in coastal Karnataka, threatening the marine ecology and killing juvenile fish, thereby jeopardizing the livelihood of traditional fishermen. Additionally, use of fish aggregation devices (FADs), extensive use of small-sized meshes (<20 mm) in cod-end of trawls etc. are being practiced leading to high landings of juveniles/trash fish/low value bycatches (LVB).

4. **Decline in fish stocks:** Indiscriminate targeted exploitation of some resources has resulted in over-exploitation, resulting in poor recruitment and growth of stocks. This has thrown the state's marine ecosystem out of balance. If nothing changes, this could lead to further depletion of fish stocks and thereby decline in fish production in the future.

CMFRI data reveals a 9 percent decline in overall fish catch in 2018 as compared to the previous year. The 2018 annual fish landing data also showed a 54 percent decline since 2017 of the Indian oil sardines (*Sardinella longiceps*), a pelagic fish found abundantly in the Arabian Sea, particularly the coastal waters that cover Karnataka. Fishermen have also revealed that they have seen a major decline in the Indian Oil sardine since 2016, as for a long time it formed 30-40 percent of fish catch which then reduced to 15 percent and now barely makes it to 5 percent.

5. **Impact of climate change:** Climate change has a direct impact on the marine fishery of the region. The frequent occurrence of cyclones and storms has resulted in regime shifts and change in species composition and disappearance of certain species from its natural habitats. For example, in recent years, there has been a sudden substantial increase in landings of a non-dietary and commercially unimportant species known as *Odonus niger* (Kargil fish) in India. In Karnataka, the landings of *O.niger* have risen from around 300-500 MT in 2008-2009 to around 2.74 lakh MT in 2019.
6. **Impact of anthropogenic activities:** Changes brought about in the environment due to anthropogenic activities other than fishing (sewage discharge, industrial effluents, oil spills etc.) also have adversely impacted the fishery of the region.
7. **Impact of activities from neighboring states:** Ocean ecosystems are dynamic ecosystems and the natural or biological boundaries will not necessarily align with political boundaries and hence Karnataka does share fish populations with its neighboring states such as Tamil Nadu and Kerala in the south as well as Goa and Maharashtra in the north. All these neighboring states with which Karnataka shares its fishery resources have different fishing regulations which often leads to conflict. For E.g., Karnataka has strict legislations when it comes to destructive fishing practices like Bull trawling and Light fishing (KMFRA notifications 2016, 2017). However, the neighboring states of Kerala and Maharashtra do not have any explicit legislation against these practices. In such a scenario, even with relevant regulations, fisheries in Karnataka would still suffer from these differences in management in neighboring states.

The fishermen in Karnataka have also expressed that the fishers from Kerala and Tamil Nadu are often spotted using destructive and banned fishing methods for cuttlefish catches in the state affecting the livelihoods of small-scale fishers. Moreover, there are instances where states of Kerala and Maharashtra have fined Karnataka fishers up to INR 5 lakhs for having entered territorial waters of their state for fishing, whereas, the state does not have any norms for action to be taken on other state fishers fishing in Karnataka's territorial waters. Hence, an active dialogue

with neighboring states needs to be pursued to ensure coordinated fishing bans & practices and common regulatory mechanisms.

1.4.11 Constraints faced by Marine fisheries sector

Some of the hurdles and constraints faced by Marine fisheries sector are as follows:

1. **Inconsistent Quality Control and Product Quality Assurance:** Although there is great demand for marine products caught from this region in the export market, the products are rejected due to lack of strict quality measures leading to great monetary loss to the sector. Though certain measures are in practice, there is a need for better handling and preservation of the catch onboard so as to fetch better returns.
2. **Insufficient infrastructure facilities:** The lack of sufficient infrastructure facilities such as hygienic landing facilities, hygienic auction ward, water supply, drainage, electricity, lack of sufficient cold stores at the landing centers, cold transport chain and absence of value addition through fish processing is affecting the sales and value of the high-quality fishes landed.
3. **Lack of support prices and inequity of returns:** Fishery products are highly perishable and whenever there is a good catch, the middlemen involved in marketing generally control the price. The primary stakeholders are exploited by middlemen and this hinders the fishers to get their due.
4. **Lack of enforcement mechanism:** Due to scarcity of manpower, enforcement mechanism is lacking in the Fisheries department. The coastal police are also given charge to look into the illegal fishing practices operated in the sea. However, due to their limited knowledge on the fishing operations, the enforcement mechanisms are lagging behind.
5. **Lack of Awareness:** Some of the fishermen may be unaware of the consequences of the illegal fishing practices. Apart from this many of the fishermen are commercialized and do not care about sustainability.

1.4.12 Conclusion – Marine Fisheries in Karnataka

In the past decade, the marine fisheries sector has witnessed acute unsustainability. Unrestrained increase in fishing vessels, rampant use of destructive fishing methods and unwavering demand from the fish meal industry have together led to a decline in commercially important fish stocks and adverse impacts on the livelihoods of fishermen, especially the traditional fishers who are totally dependent on marine resources for their daily bread.

An explosive, unrestrained increase in fishing vessels is one of the primary reasons for the unsustainability in fisheries being witnessed today. This coupled with Illegal, unreported and unregulated fishing has led to inefficient and wasteful exploitation of marine resources. Overfishing by destructive fishing methods and fishing gears such as bottom trawlers, long lines and drift nets have resulted in an abundance of bycatch and discards. High input costs (fuel etc.) and a sustained demand for trash fish compel fishermen to fish anyhow using any means to at least recover the input costs. Rise in landings of bycatch and discards in turn damage ocean ecosystems and reduce the diversity of life in the oceans. Unsustainability is further fueled by non-uniform policies (fishing ban duration, penalties, enforcement etc.) between adjoining states adding to the woes of the fishermen. The increased number of mechanized and motorized boats are alleged to have interfered with the fishing rights of traditional, small-scale fishers in the near-shore areas leaving them with hardly any catch thereby threatening their livelihood and sustenance.

Another threat to marine fisheries is the effect of marine pollution occurring in the continental shelf and upwelling areas of the nearshore zone, in which over 90 percent of world's marine fish are harvested. The marine life face extreme threats from pollution and other anthropogenic activities in a number of ways such as destruction of their habitat, acute poisoning from toxic wastes, adverse alteration of water quality, sub-lethal effects of pollutants causing impairment of feeding, growth, migration, resistance to disease and parasites, interference with reproduction, bacteriological and viral contamination; bioaccumulation of toxic metals and organic substances etc. Unless the environmental degradation of coastal waters is curtailed it will continue to impact marine life as well as the livelihood, health and well-being of communities dependent on these resources; in turn affecting prospects of sustainable economic growth.

Marine fisheries today are marred by unsustainability, rapid decline in fish stocks, unprofitability, decimation of traditional fisheries, loss of livelihoods etc. Unless appropriate remedial measures are taken, the marine fisheries in Karnataka are staring at a grim and bleak future.

To reverse the damage, focused actions that are streamlined to cease the unsustainable management of marine fishery resources are required to be taken up on high priority. It is the need of the hour to address the multitude of issues plaguing coastal fisheries and take appropriate restorative actions. This will ensure that an equilibrium is maintained between development and conservation through effective management strategies. The turnaround needs to be driven primarily by appropriate policy support, policy enforcement coupled with adequate institutional arrangements and capacity building. Fisheries production needs to be boosted by the help of technology including new farming technologies (vertical ocean farming) and data-driven satellite-aided fisheries. A paradigm shift to a co-operative mode of fisheries is required in order to be sustainably augmented. Further, fishery resources can only be managed sustainably when they are co-managed at a decentralized level along with the fishermen communities. Diversification in fisheries, value-added-products and quality control will go a long way in sustaining long-term growth in the sector. Finally, no sustained growth is possible without adequate capacity building and institutional arrangements.

The recommendations for sustainable harvesting of marine fisheries, sustaining economic growth as well as supporting the well-being of coastal communities are provided in the **Summary Outline Blue Economy Development Plan**.

1.5 Inland Fisheries in Karnataka

Karnataka is blessed with varied types of inland water resources and accounts for a share of about 9.3 percent of the total national inland fisheries resources. The state has two main drainages, viz., east flowing large rivers such as Krishna and Cauvery with their tributaries and the west flowing rivers having a short run. The State is endowed with a rich and wide variety of water bodies both seasonal and perennial. The resources are vast and diverse, and are in the form of tanks, ponds, brackish water, reservoirs, rivers, canals, water harvesting structures, waterlogged and saline/alkaline lands in watershed/river basins and non-conventional water bodies.

The State has a total of 5.65 lakh ha of inland water resources, which provide immense scope for development of inland fisheries in Karnataka. The annual estimated fish production potential of inland resources of the state is around 4.02 lakh MT taking into account the full utilization of all inland water resources for fisheries. The sector comprises numerous water bodies (rivers, lakes, reservoirs and tanks, wetlands etc.), ecosystem functions, inhabited by a wide range of species and stakeholders apart from the fisher community with diversified livelihood and business strategies. The Inland fisheries sector is making valuable contributions to the economic development of the state and both livelihood and nutritional security of most

of the traditional fishermen in catchment areas of tanks and reservoirs is inseparably linked to fishing and related activities. The sector is witnessing a changed scenario from its traditional role as subsistence supplementary activity wherein most fishers were carrying out fishing operation on a day-to-day basis to meet the requirement of own consumption and surplus for sale to market, to viable economic activity.

The overview of the Inland fishery resources in the state is shown in Table 1.3.

INLAND RESOURCES IN KARNATAKA	
Resource Type	Water spread Area (WSA)/Length
Major Tanks (Departmental Tanks)	1.79 lakh ha (3906 Nos.)
Minor Tanks (Gram Panchayath Tanks)	1.24 lakh ha (22414 Nos)
Reservoirs	2.72 lakh ha (82 Nos)
Rivers	5813 km
Canals	3187 km
Private Ponds	9000 ha
Fish Sanctuaries	22 Nos
Estuarine areas	7202 ha
Brackish water areas	8000 ha
Aquaria	13
Potential: 4.02 lakh MT	
Production: 1.98 MT (2018-19) 2.29 MT (2019-20)	
Total Fishermen: 6.33 lakh Active Fishermen: 1.39 lakh	
Total Fisheries Co-operatives: 524 Fishermen Co-operative Apex Federation: 1	
Fish markets: 610	
Fishermen training Centers: 4	
Ice Plants: 75	
Cold Storages: 22	
Freezing plants: 1	
Frozen storages: 1	

Table 1. 3: Overview of the Inland fishery resources and infrastructure in the state
(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

The Inland fish production of the state for the period 2014-15 to 2018-19 is provided in Table 1.4.

Year	Inland Fish Production (MT)	Value (INR. In Lakh)	Growth trends*		Total fish Production (MT)	Value (INR in lakhs)
			Prod. (%)	Value (%)		
2014-15	223419	193205			613241	458298
2015-16	168828	148217	-24.4	-23.3	580590	490650
2016-17	158566	143779	-29	-25.6	557494	491049
2017-18	188174	169356	-15.8	-12.3	602522	562656
2018-19	197921	178129	-11.4	-7.8	587412	482489

Table 1. 4: Inland fish production for the period 2014-15 to 2018-19

The production trend shows that during the past five years, inland fish production varied between 1.58 to 2.23 lakh MT (average 1.93 lakh MT) depending on rainfall and related weather aberrations. Its share of total fish production was 29 percent to 36.4 percent (average 34 percent) and in value terms INR 1438-1932 crores. Analysis of production data of the past five years indicated a negative growth both in production (-11.4 to -29 percent) and value (-7.8 to -25.6 percent) against the base year (2014-15).

The state is in 11th position in inland fish production. During the decade, inland fisheries witnessed an increase in fish production of 130 percent (from 0.86 lakh MT to 1.98 lakh MT) and witnessed constant increase in fish production from 2008-09 onwards. During 2015-16 the total inland fish production was nearly 1.69 lakh MT valued at INR 1482 crores (at current market price) compared to previous year that recorded the highest production of 2.23 lakh MT valued at INR 1932 crores. The production during 2018-19 was 1.98 lakh MT valued at INR 1781 crores accounting for 33 percent of total fish production and nearly 37 percent value share as against the estimated potential of 4.02 lakh MT taking into account the full utilization of all inland water resources for fisheries. The contribution of inland fish production of the state to the national inland fish production is only 1.8-2.9 percent (average 2.25 percent) during the past five-year period. The share of the state to the country's Inland fish production during 2018-19 is only about 2.04 percent. Table 1.5 below shows a glance of the Inland water resources in the state, the production potential and current production level.

Sl. No.	Resource Type	Extent	Max Expected Yield	Estimated Production Potential (MT)	Current Status
1	Reservoirs	272258 ha	150kg/ha	20058	25-90kg/ha
2	Department Tanks (Major & Minor Tanks)	239195 ha	2500 kg/ha	214644	1130 kg/ha
3	Gram Panchayat Tanks	52432 ha	1000 kg/ha	60309	220 kg/ha
4	Rivers	5813 km	1000 kg/km	2907	150 kg/ha
5	Brackish Water	8000 ha	3500 kg/ha	14000	2420 kg/ha
6	Private Ponds (current)	9000 ha	10000Kg/ha	90000	3000 kg/ha

Table 1. 5: Inland water resources in Karnataka, potential and current status

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

The resource-wise contribution to Inland Fish Production in 2018-19 is provided in Chapter 1 Annexure 7 and the same is depicted in Figure 1.14.

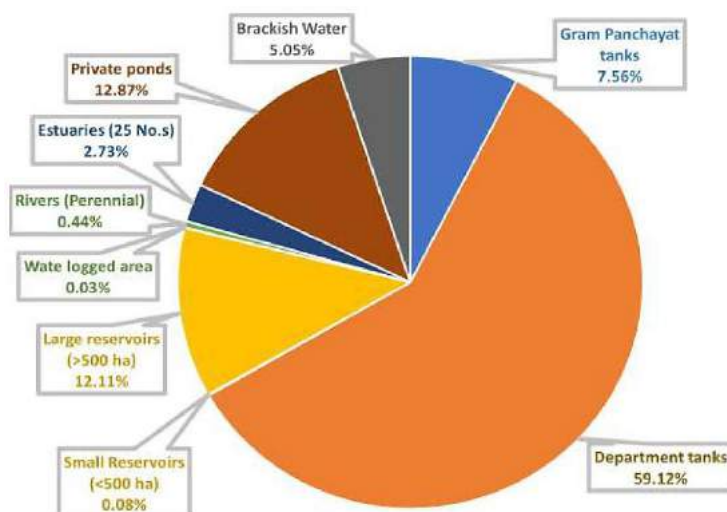


Figure 1. 14: Resource-wise contribution to Inland Fish Production in 2018-19

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

The above chart shows the contribution of different resources to inland fish production in 2018-19. The major share of total inland fish production is mainly from natural resources (tanks, ponds and reservoirs) which are multipurpose, common property resources. The contribution of aquaculture is less¹³. The estimated contribution of different resources to total Inland fish production indicated the highest share by department tanks/ponds (>62 percent) followed by reservoirs (13 percent) and private tanks (13.5 percent). In spite of huge tank resources under Gram panchayat, the contribution to production is low (<8 percent). Rivers and canals contributed only 0.5 percent and the rest by other water bodies. In most instances inland fisheries harvest data are undervalued due to lack of scientific data collection, analysis and documentation.

The district wise Inland fish production for the period 2013-14 to 2018-19 is provided in Chapter 1 Annexure 8 which shows the status of potential districts in the state to inland fish production. For the purpose of development of the fisheries sector, the state is divided into 5 inland fisheries zones comprising 27 districts and one coastal zone comprising 3 coastal districts. The top five districts contributing maximum (>10,000 MT annually) to inland fish productions are Shivamogga, Mandya, Raichur, Tumakuru, and Ballari. The second category of districts contributing fish production of 8000-10000 MT Annually are Mysuru, Hassan, Davanagere, and Vijayapura and the third category of districts contributing fish production of 5000-8000 MT are Uttara Kannada, Koppala, Chikkamagaluru, Ramanagara, Kalaburagi and Belagavi districts. Both resource utilization and development vary between districts within the state. The share of inland capture fisheries is limited and over the years, culture-based capture fisheries in natural water bodies (tanks/ponds and reservoirs) has replaced traditional practices of mere harvesting natural productivity for fish production.

The district wise Inland Fisheries Resources of Karnataka is given in Chapter 1 Annexure 9. The district-wise and taluk-wise reservoirs and water spread area are provided

¹³Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020

in Chapter 1 Annexure 10 and Chapter 1 Annexure 11 respectively.

The inland fisher population is higher (over 6.33 lakh) in the state compared to the marine sector (3.28 lakh). Nearly 66 percent of state fishers represent inland fisheries sector, of which only about 1.39 lakh inland fisheries are actively involved in the fisheries activities viz., fishing and related supportive activities, net fabrication, transportation and distribution, marketing and supply chain management, fish culture in tanks and own ponds, fish seed production and rearing. Vast majority of the households that depend on inland fisheries are fishers or farmers who have traditionally engaged in seasonal farming and fishing. Great majority of inland fisher folk are engaged in the 'small-scale' sector, which ranges from family based artisanal units operating with or without dugout canoes in small ponds or lakes, or along tributaries or larger river channels, to commercial enterprises with well-equipped boats fishing in larger lakes and reservoirs.

The major programs initiated under inland fisheries development include assistance for construction of fish ponds, stocking of grass carp seeds, construction of ponds in water logged areas, development of fish sanctuaries and intensive fish culture with Central Government assistance from 2009-10 onwards. A new scheme on providing 50 percent subsidy for purchase of fish seed and supply of fishery requisite kits was introduced. In 2013-14 the subsidy was enhanced to INR 10,000 under free distribution of fisheries kits.

1.5.1 Fish processing and value addition

Fish processing and value addition of freshwater fishes in the state is low key due to limited production of freshwater fish. The domestic demand for fresh fish is more than the internal production and at present, almost all the inland fish produced (>95 percent) is either consumed fresh locally or transported to other places in iced condition. Only in a few pockets and during summer seasons, forage fish like minnows, other weed fishes, small fishes of less market demand are sun-dried and marketed both within state and to neighboring states. Intensive activity of dry fish preparation in the state is witnessed in Tungabhadra dam. Although fish like pangasius, tilapia are pond cultured and are suitable for value addition, the activity has not catch-up attention of entrepreneurs. However, intensification and diversification of aquaculture activities in years to come is expected to result in surplus fish production and flow to the market. Processing and value addition will bring better benefits to producers, traders and also consumers in terms of getting better produce. The number of families involved in fishing and number of fish markets in the State as on 31-03-2019 is provided in Chapter 1 Annexure 12. Strategies to support fish processing are provided in the **Summary Outline Blue Economy Development Plan**.

1.5.2 Fishermen Cooperative Societies (FCS) in Inland fisheries

The Department of Fisheries is constantly pursuing a vigorous mission of enhancing resource productivity and optimal use of available vast water bodies by organizing activities at different resource levels through community involvement and participation. The fishers were mobilized and organized under the local institutional framework of Fishermen Cooperative Societies (FCS) and provided access to public water bodies for fishing and fisheries development, support for procurement of key inputs viz., quality fish seed, fishing nets, boats; bicycle/ mopeds, fish transport vehicles; provide training, facilitation for marketing of produce, support for house construction and such other benefits on a continued basis. Over the years, these FCS are serving as effective grass root level institutions for fisheries development, contributing to the uplift of living standards and socio-economic status of fishermen communities. The state has 524 inland Fishermen Co-operative Societies of which 442 are active and One State Level Co-operative Fisheries Federation functioning at Mysuru. There are 90300 members in all FCS (average of 200 members/ society). The fishermen use society as a common platform for getting access to water bodies for fishing and several fisheries

related activities like growing fish, marketing of fish and other services. Each FCS is eligible to have leases for a maximum of three water bodies or 300 ha WSA for a period of 5 years on annual renewal basis. The state's entire fish production activities in common property resources are dominated by the Fishermen Cooperative Societies by virtue of the government policy of leasing the water bodies only to the societies. Although this system of leasing is conducive from the point of equitable distribution of wealth and welfare, over time it has led to monopoly with no accountability of FCS to scientific management of water bodies and harnessing potential productivity of resources. This may result in negative impact on the comprehensive sector growth

The district-wise fishermen population and active fishermen population during 2018-19 is given in Chapter 1 Annexure 13 and the district-wise Fishermen Co-operative Societies as on 31-3-2019 is provided in Chapter 1 Annexure 14.

1.5.2.1 Strategies to support Fishermen Cooperative Societies (FCS)

Some of the strategies to promote Fishermen Cooperative Societies (FCS) are:

1. Encourage diversification and shift to better and new activities
2. Enhance functional efficiency of FCS through key drivers of technologies, management and participatory process
3. Incentivize and encourage achievers of the society/members through recognition, awards and honoring
4. Organizational powers to members in the societies to be provided
5. Financial accountability and monitoring to be improved
6. Entrepreneurial leadership to be encouraged

1.5.3 Fish Seed production and Rearing

Production of quality seed of cultivable fish species and its availability throughout the year in support of fisheries and aquaculture development is the key for the success of the sector. State is witnessing increased demand for quality fish seed and requires about 56 crores fingerlings (80-100 mm) annually to develop all water resources that are suitable for fish culture as against present production of only 25 to 30 crore fish fingerlings. The State is in seed deficit and is meeting only about 50 percent of its requirement, and the rest is being outsourced from neighboring states mainly Andhra Pradesh and West Bengal to bridge the existing gap. Ensuring availability of quality fish seed of the right choice and required quantities at the right time at affordable cost is the responsibility of the state Govt. for sustained growth of fisheries in the state.

Hence, fish seed production and rearing farms and taluk-level nurseries were set up by the Department of Fisheries in order to develop the inland fisheries sector and the much-needed infrastructure for producing required quantities of fish seed for stocking. The seed chain in the state is simple and comprises mainly government and private hatcheries, seed nursery at taluk level of Govt. fish seed farms, private seed growers, seed traders and fish farmers. Fish seed production is being pursued by both the public sector (hatcheries of Department of Fisheries, Zilla Panchayat and Tungabhadra Board) and private sector. Fish seed production by the public sector is four times greater than the private sector. The share of the private sector is only 20 percent and the rest is by the Department of Fisheries (72.6 percent) followed by Zilla Panchayat (3.8 percent) and TB board (3.6 percent). At present,

there are 17 fish seed production and 30 rearing farms under the control of the Department of Fisheries, Zilla Panchayat and 60 Taluk level nurseries in the State. Figure 1.15 depicts the resource-wise share of fish seed stocked in the state.

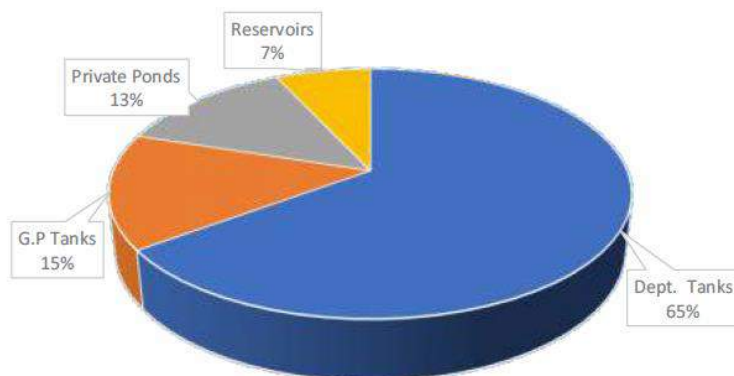


Figure 1. 15: Resource-wise share of Fish seed stocked

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

During 2018-19, a total of 6298.01 lakh fish seed (fry) have been produced. Stockings of 1768 (70.83 percent) lakh fingerlings were developed in 2791 departmental tanks. Similarly, 1734 Gram Panchayat tanks were developed by stocking 410 (16.43 percent) lakh fingerlings, 318 lakh fingerlings (12.74 percent) stocked in Private Ponds and 94.99 lakh fingerling stocking in Reservoirs, by stocking 2590.81 lakh fingerlings and achieved total inland fish production of 1.97 lakh MT. There is still considerable scope to increase inland fish production by undertaking regular and periodical stocking of the suitable water bodies with quality fingerlings. During the year 2018-19 the fish seed production of the State was 6298 lakh fry which played a strategic role not only in increasing fish production but also in providing employment to rural folk. The fish produced by them provides livelihood or additional income to them. Due to stocking of fish seed in tanks and reservoirs under 'Reservoir Fisheries Development' and 'Mathsya Krishi Asha kirana schemes marginal increase in inland fish production of the state has been witnessed¹⁴.

The details of fish seed stocked from the year 2017-2019 is provided in Chapter 1 Annexure 15. The district-wise fish seed production during 2017-19 is provided in Chapter 1 Annexure 16 and the fish seed produced at different fish farms of the state in Chapter 1 Annexure 17. Chapter 1 Annexure 18 provides the district wise details of fish farms in Karnataka. The year-wise details of fish seed stocked in lakh fingerlings are given in Chapter 1 Annexure 19. The fish seed production for the period 2013-14 to 2018-19 is tabulated in Chapter 1 Annexure 20. The fish seed production (Spawn, Fry, and Fingerlings in lakhs) in Karnataka is presented in Chapter 1 Annexure 21.

¹⁴Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020

1.5.3.1 Species share to seed production

The species-wise composition of fish seed production during the year 2018-19 is depicted in Figure 1.16.

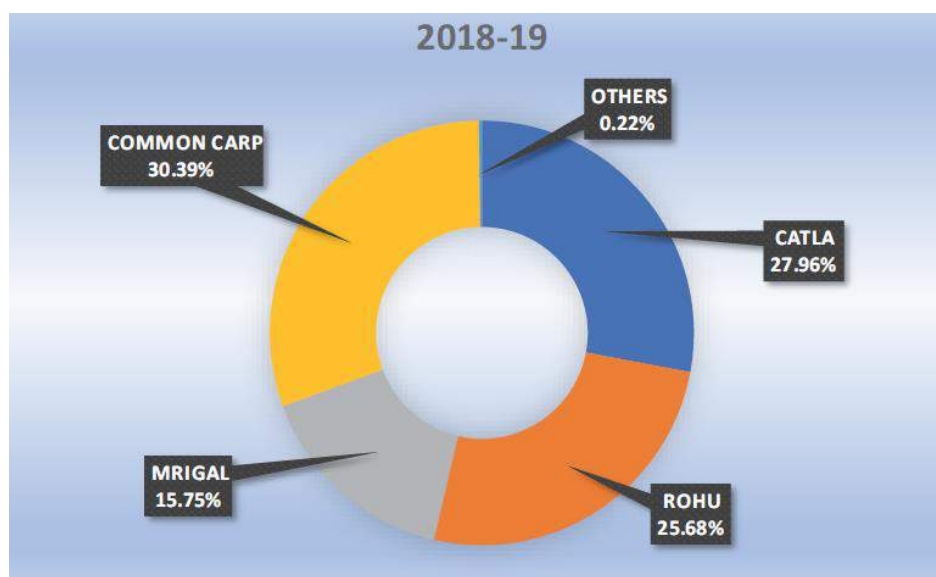


Figure 1. 16: Fish seed production species composition during 2018-19
(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

Species diversity in seed production is limited and the activities are more focused on Indian major carps and common carp. The average survival rate of spawn to fry (12-15 mm) and fry to fingerlings (35-40 mm) in most of the state farms is around 40-50 percent and 50-60 percent respectively and the survival from spawn to fingerlings (35-40 mm size) is around 25 percent while in private sector farms survival from spawn to fingerlings (35-40mm size) is better (30-40 percent).

1.5.3.2 Districts share to seed production

Although seed production is being carried out in 16 districts, the major contributions are only from three districts Shivamogga (55.6 percent), Ballari (23.6 percent) and Mysuru (12.7 percent) collectively contributing nearly 92 percent to the total seed production. Seed rearing is being taken up in 19 districts and nursery rearing of seeds in 22 districts.

1.5.3.3 Constraints faced in fish seed production

Commercial seed production and rearing of other species of cultivable prospects are not available in the state. There is growing demand for quality seed to meet the requirement of both enhanced fisheries (stocking reservoirs and tanks) and aquaculture. Thus, meeting the demand is one of the major challenges for growth of fisheries and aquaculture sector in the state. Further, fish seed cost is the single most cost component of high significance. The amount needs to be invested in the very beginning of the fish culture activity itself with many unforeseen uncertainties and risk factors ahead. The poor performance of stocked fish is likely to reduce growth and survival of fish which can cause considerable economic loss to the fishers and decides the very profitability of the activity.

Some of the other constraints faced in fish seed production are as follows:

1. Lack of quality fish seed in the required quantity and timely supply
2. Lack of diversity in seed production
3. Lack of knowledge, technical know-how, standards and guidelines on seed production (brood stock management, breeding practices), hatchery production and seed rearing
4. Absence of mechanism for registration of breeding centers, multiplication centers, seed growers and seed suppliers
5. Lack of fish seed networks in support of production and distribution of seed
6. Absence of fish seed policy to address availability of quality seeds, regulation of their sale, interstate movement, procurement & supply, quality control and documentation

1.5.4 Tanks and Pond Production systems

Tanks and ponds are regarded as the lifeline of the State and core of the rural ecosystem with a significant contribution to both agricultural production and total fish production. Tank fishery development plays a strategic role in providing employment to the rural folk. The tanks in the state are primarily for irrigation purposes, public utilities and other multiple uses. In exceptional cases, tanks are allowed to be used exclusively for fisheries. These water bodies receive nutrients from the agricultural run-off and hence are productive from a biological point of view and fish production. Tanks and ponds are regarded as key resources to enhance fish production and to meet the growing demand.

The inland water bodies of the state are mainly Common Property Resources (CPR), spread out in all 30 districts of the state. The fishery rights of public water bodies are disposed for the purpose of fisheries development, harvesting and resource conservation.

Tanks are categorized based on achcut¹⁵, as Department tanks (> 40 ha. achcut) and Gram Panchayat tanks (< 40 ha achcut). The Departmental tanks (>40 ha achcut) constitute 3906 in number and 1.72 lakh ha in area and mainly represent large tanks while Gram Panchayat tanks (<40 ha achcut) are 22414 in numbers and 1.21 lakh ha in area. The fishery rights of the tanks with achcut of more than 40 ha. are vested with the Fisheries department and are disposed to Fishermen Co-operative societies (FCS) and to fish conservation societies through lease. If there are no claims from FCS, they are disposed to individuals through a process of tender cum auction/issue of licenses. Tanks up to 40 ha Achcut area have been transferred to the respective Gram Panchayats for disposal of fishery rights and development of fisheries. Currently, the Inland Fisheries Leasing Policy 2014 is in force to allocate resources for development through the stakeholders.

Minor/small tank resources catering <40 ha achcut land are under the administrative and management control of Gram panchayat. These small tank resources generate internal revenue, incremental employment and increased availability of fish in the region addressing rural nutrition. These resources are smaller in size (average 5.4 ha TWSA) and most of them are seasonal, holding water for 4-5 months. Due to systemic problems, only about 10 percent of the resources are being presently utilized for the sector activities. The estimated average productivity is about 285 kg/ha as against the potential of one Ton/ha and is contributing about 0.15 lakh MT to total inland fish production.

Major tanks (>40 ha achcut) are under the administrative jurisdiction of the State department of fisheries. Major tanks are generally larger in size (average 44 ha. TWSA) and perennial. The present resource utilization is about 60-65 percent and the estimated

¹⁵Govt. Order No/RDPR/165/ZPS/2002 dated 01-03-2004

productivity is 550 kg/ha as against a potential of 2.5 MT/ha. The contribution of Department tanks to fish production is over 60 percent mainly due to timely disposal of resources for fisheries activities, additional support for seed stocking, fishing accessories, feed input, technology etc. Most of the tank resources are rain dependent and receive water at different points of time during the rainy season (pre monsoon and post monsoon June- October). The resources are apt to dry up if normal rain fails and their storage levels are determined according to the rains within the small or big catchments. Depending on nutrient influx, productivity varies. Most rural tanks are oligotrophic and least productive. Urban lakes with sewage influx are eutrophic, and though highly productive, they are at high risk due to threat of pollution from other sources and sedimentation.

1.5.4.1 Production practices in tanks and pond production systems

Fish production practices in adoption are diverse, in accordance to the resource typology, characteristics, and as per empirical experiences of FCS/ individuals. Community based fisheries/culture-based capture fisheries with low input farming approaches are predominant. Due to the traditional nature of activities, excluding fish seed stocking with selected cultivable fish species no other inputs are used to support better fish production and fish are allowed to grow on natural productivity. Over the years there is no change in fisheries practices in the state.

1.5.4.2 Craft and gears in tanks and pond production systems

Coracle is the most commonly used craft and both gill nets and cast nets are used for fishing. In most of the long seasonal and seasonal tanks, shore seine/ drag nets are used for the final harvest of fish during summer when water level recedes to the low points. In small seasonal water bodies, all activities of stocking, watch and ward, harvesting and marketing on an end-to-end basis are carried out primarily by family labor.

1.5.4.3 Present scenario of tanks and pond production systems

Of late, the resources are witnessing a changed scenario in terms of seasonality, water availability, water nutrient status, enhanced resource productivity due to filling of tanks with treated sewage water under lift irrigation program. This has changed the resource use pattern and its long-term sustainability. Several drivers both internal (fisheries management practices) and external from outside the fishery (land-use practices and demand for water, climate change etc.), social and economic framework within which the activities are pursued determine the success of activities CIFRI has generated a wealth of data on the limnology and fish and fisheries of tanks of Karnataka. Data on seasonality, biological characteristics of tank resources and economic analysis of fisheries activities are lacking.

1.5.4.4 Constraints faced by tanks and pond production systems

Tank resources are confronted with diverse problems related to resource limitations, biophysical and socio-economic parameters. The predominant economic features of the fishers are its limited access/ownership to resources. In general, constant decline of natural resource base, common property nature of resources, rainfall (intensity and timely), recurring drought and related climatic aberrations, several anthropogenic activities, loose ends in policy and governance, low income and poorly adapted nature of the communities to the changed technological innovations and development process have constrained the growth.

There are a large number of small water bodies in the state. Factors such as seasonality and presence of multiple user groups make them common property resources and multiple institutions claim ownership on these resources. For example, the State DoF, Gram Panchayat, Dept. of Forest, Lake development Authority claim ownership for urban tanks.

Anthropogenic activities in and around lakes/tanks are leading to water diversions, changed resource use pattern, extensive habitat alteration/destruction through unsustainable and unmanaged activities, threat of pollution from filling of treated sewage water, overexploitation and overfishing of natural fishery resources, biodiversity loss caused by invasive alien species etc. act as growth inhibitors in the sector.

Other constraints include weak legal, policy, regulatory frameworks that are responsible for poor governance; poorly planned and unregulated resource development, weak inclusion in decision-making processes and limited participatory approaches. Further, poor adoption of good management practices in development – technology, input usage, system health, harvesting practices have also contributed to stunted growth in the sector. The social related concerns of poaching, poisoning, lack of shared prosperity, livelihood insecurity among traditional fishers are also major concerns that need to be addressed to promote growth in the sector. The recommendations to enhance sustainable productivity and resource governance in Tanks and Ponds as well as support the well-being of fisher communities are provided in the **Summary Outline Blue Economy Development Plan**.

1.5.5 Reservoir production systems

Reservoirs in the state are the key inland water resources represented by both large, medium and small reservoirs meeting multiple requirements of irrigation, power generation, navigation, domestic and industrial use, fishing etc., and also contributing to the fish production and growth of the fisheries sector. Large numbers of fishers living in the catchment of reservoirs are exclusively dependent on reservoir fisheries to earn their livelihood. The state in all has 82 reservoirs of varied size spread across in 24 districts with an area share of nearly 48 percent (over 2.72 lakh ha) to the total inland water resource area. The small reservoirs (<1000 ha) accounted for nearly 60 percent (49 nos.) in numbers followed by 20 nos. of medium (1000-5000 ha) and 13 nos. of large reservoirs (>5000 ha). In area share, the large reservoirs comprise 78 percent of total reservoir area of the state followed by medium reservoirs (12.5 percent) and small reservoirs (10 percent). The average size of a large reservoir is 17610 ha, medium 1693 ha and small reservoir 540 ha. Though the reservoir resource is vast and has great potential, the present utilization of this resource is estimated to be <40 percent and its share to total fish production of the state as 13 percent annually (about 0.30 to 0.40 lakh MT). Most reservoirs are located in high rainfall zones and only a few are in the rain shadow region. The resource has its own distinct eco-morphological characteristics.

Water management of reservoirs is under the control of the irrigation department except a few where it is under the control of Power Development Corporation of Karnataka and other departments. The fishery development and management of all reservoirs are under the control of the Fisheries Department. During the initial period of resource development for fisheries activities, the reservoirs gained importance as one of the alternative livelihood sources for the fishers living in the reservoir catchment and dependent on the riverine sector. The resource gains advantages from environmental and social perspectives as benefits of the activities increased yield and income generated is more equitably distributed within fishing communities of reservoirs. The resource provided new opportunities for the fishers, and complemented the income, employment, food security and other social benefits to the community. Hydrographic changes have a direct bearing on productivity, as sudden changes in water level, inflow and outflow directly affect the biotic communities. It has been observed that plankton, benthos, and periphyton pulses coincide with the months of least level fluctuations and all these communities are at their ebb during the months of maximum level fluctuations and water discharge.

1.5.5.1 Resource Access for Reservoir fisheries

Fishers are being provided access for fishing on the license system. The state

department authorities determine the number of fishers and fishing units to be operated in a reservoir. The fishing rights are disposed of in accordance with Government order No. AHF 125 SFE 2013 dated: 21-02-2014 (issue of license, leasing etc.) by local office of DoF.

1.5.5.2 Fish seed stocking in Reservoirs

Indigenous fishes of Cauvery and Krishna River systems are not adequate to realize the yield potential of reservoirs. In general, tributaries (being seasonal) harbor few species of commercial importance. Slow growth rate of endemic carps, lesser stock of endemic medium carps, poor/no auto-stocking of endemic and Indian major carps warrants stocking of reservoirs on continued basis to improve the species diversity and maximize production at a sustainable level. The initial development was limited to DoF stocking selected reservoirs on a sporadic basis and the productivity was mainly dependent on anthropogenic activities in the catchment and availability of native fish fauna. In later years, reservoir fishing activity received boost on account of introduction of regular stocking program by DoF with better sized fingerlings of cultivable carps predominantly Indian major carps and exotic carps (common carp and grass carp) at the rate of approximately 500/ha for large reservoir, 1000/ha for medium and 2000/ha for small reservoirs (considering 60 percent of the full reservoir area as effective water spread area) under various development programs of the State Department of Fisheries and supportive initiatives of the National Fisheries Development Board, Hyderabad. Stocking of major carp and common carp is being done to varying degrees in the reservoirs, predominantly of common carp followed by rohu and catla. Normally, the department of fisheries stocks fish fingerlings free of charge and also supports fishers in purchase of nets and boats, transport vehicles, marketing facilities and such other supports through various schemes / subsidy programs. Although fishers were brought under an organized system with the formation of Fishermen Cooperative Societies (FCS) and involved in regular seed stocking, their involvement in development of resources is limited due to open access for fishing.

1.5.5.3 Crafts and Gears for fishing in Reservoirs

The crafts and gears used in reservoir fisheries include coracles, wooden boats, country craft and small meshed monofilament gillnets (surface gillnets of different mesh sizes 20-150 mm bar size) and are operated extensively during peak fishing season. Generally, shore seines (alivi) are used during January to March for harvesting small sized fishes. Dragnets of various dimensions and mesh sizes are employed in many small reservoirs for harvesting fishes. The other fishing gears in use are cast nets, scoop nets, long lines and traps but the catches are insignificant. The presence of underwater obstacles restricts the use of active gear in reservoirs. Mechanized boats are not in use in reservoir fishing.

1.5.5.4 Fishing activities in Reservoirs

The peak fishing activities are in the months of September to February (6 months) and the lean fishing activities during March to May. Generally fishing in reservoirs is not carried out during the months of June-August to facilitate breeding of local fish species. Fishing activity is generally low during monsoon and post-monsoon months. Peak fishing appears to be during February-April. The fishing effort varies from reservoir to reservoir and is mainly dependent on the availability of local indigenous fish fauna and stocked fish seed. Catches are assembled in fish landing centers and are disposed of to the middlemen. Catches are pooled and iced at pooling centers by the merchants and dispatched to markets/ different destinations

1.5.5.5 Species composition in Reservoir fisheries

The catch composition varies with season and characteristics of reservoirs. The predominant species in catch composition generally includes stocked species such as catla,

rohu, mrigal, common carp; indigenous fish consisted of minor carps and minor catfishes. The species include *Labeo pangusia*, Mahaseer, *Puntius carnaticus*, *Gonoproktopterus dubius*, indigenous catfishes viz., *Wallago attu*, *Ompok bimaculatus*, *Mystus seenghala*, *Mystus cavasius*, Featherbacks (*Notopterus notopterus*), eels (*Mastacembelus armatus*) and Murrells, *Channa marulius*, Tilapia (*Oreochromis mossambicus*); weed fishes especially, *Puntius* spp., *Puntius mahecola*, *Devario aequipinnatus*, *Oxygaster* spp., *Salmostoma* spp., *Chela* spp. and *Chanda* spp.

Performance of stocked species varies with productivity of the reservoir and depends on the nature of the food chain. The vast stretches of aquatic vegetation in many reservoirs seem to be favourable for the growth of *L. rohita* as it offers a good substrate for periphyton. The macrophytes of reservoirs include submerged, emergent and floating types and include *Potamogeton*, *Hydrilla*, *Vallisneria*, *Ceratophyllum* and *Najas* depending on resource characteristics. Occurrence of macrophytes will be in peak during summer and low during the monsoon season. These macrophytes provide substrata to many insects, mollusks and other invertebrates, and pose serious problems in the operation of fishing gear.

1.5.5.6 Productivity in Reservoirs

Reservoirs have high potential in respect of productivity and there is greater scope to exploit and enhance productivity. The present average annual fish productivity realized is low (small: 49.9, medium: 12.3 and large: 11.4 kg ha⁻¹yr⁻¹) against the annual potential yield of 100, 75, and 50 kg ha⁻¹yr⁻¹ (Sarkar et al., 2018). Nearly 27,000 ha of small reservoirs is available in the state for promoting culture-based fisheries and to enhance both resource productivity and production. The ecology and fish yield potential of a large number of reservoirs of the state has been studied and potential yield has been predicted for selected reservoirs by the Reservoir Division of CIFRI, Bengaluru (CIFRI, 2000). As per different models, the potential yield varied from 25 to 85 kg/ha and reported production potential of 100, 200, and 500 kg ha⁻¹yr⁻¹ from large, medium and small reservoirs, respectively as achievable targets with proper management.

1.5.5.7 Constraints in reservoir fisheries

Reservoirs of the state are underutilized and less exploited at present due to a number of constraints. They include the open access nature of fisheries exploitation as well as common property nature of resources with multiple ownership.

Other constraints are as follows:

1. Increasing threat of environmental degradation due to catchment activities and pollution
2. Lack of supply of quality fingerlings of carps and indigenous species
3. Impediments to fishing such as submerged tree stumps, rocks, etc.
4. Lack of stock enhancement interventions, inadequacy in stocking – stocking density, species, size, etc. in accordance to reservoir characteristics
5. Lack of regulatory measures like mesh size and ban on fishing during closed season, ban on destructive fishing practices like dynamiting and Alivinet operation,
6. Non-functional nature of co-operative societies in development of reservoir resource
7. Poor economic status of fishers and social conflicts
8. Absence of exclusive arrangement to monitor and document reservoir wise catch and

catch composition.

9. Lack of database on aspects like fish catch composition, size structure, fishing effort and fish yield, which are essential for proper reservoir management

1.5.5.8 Strategies for developing reservoir resources

Considering the resource base and potential opportunities, there is wider scope for developing reservoir resources through effective and sustainable strategies for further enhancing the fish yield. Mainstreaming of fisheries management models developed for reservoirs addressing issues of ownership and development rights, leasing system, technological options, management practices, investments, community and stakeholder involvement in participatory planning, implementation, decision making, monitoring of progress, community benefits and other impacts related to the activity etc. are the key for development. The specific strategies for developing reservoir systems are provided in the **Summary Outline Blue Economy Development Plan**.

1.5.6 Status of Riverine production systems

The state has over 5813 km of river resources and the major river systems are river Cauvery and its tributaries in the southern parts, river Krishna and tributaries traversing in northern and central parts of the state, Godavari, North Pennar, South Pennar, Palar rivers Mahadayi/Mandavi, Kali, Gangavalli (Bedthi), Aghanashini (Tadri), Sharavathi, Chakra, Varahi (Haladi), Netravathy and Barapole (Valapattanam) are west flowing rivers in Karnataka. The tributaries of Krishna (Tungabhadra, Ghataprabha, Malaprabha, Bhima and Vedavati), Cauvery (Harangi, Hemavathy, Lakshmana Tirtha, Kabini, Shimsha, Arkavathi and Suvarnavathy) and Godavari (Pravara, Purna, Manjira, Pranahita, Indravathy and Sabari) form east flowing rivers (Directorate of Fisheries, GoK, 2015). More than one dozen rivers originating from the Western Ghats open into the Arabian Sea along the Karnataka coast, rendering the inshore waters rich in nutrients and plankton. Netravati, Gurupur, Gangolli, Sitanadi, Aghanasini, Kali and Sharavati are the important rivers.

1.5.6.1 Resource access in Rivers

These riverine resources are under open access fisheries, supporting the livelihood of the traditional fisherman community. Degree of deforestation and agriculture practices in the vicinity determines the productivity of the river. Parts of the river stretches (25 km long stretch to fish community for fishing and < 25 km long stretch in taluk border) are leased out by the Department of Fisheries to the Fishermen Cooperatives, fishing community, local institutions, non-governmental organizations for fishing, fishery development, and biodiversity conservation. Fishers of the catchment are mainly fishing local varieties of fishes and also carps on a regular basis for their livelihood.

1.5.6.2 Resource Utilization and production share of Riverine fisheries

In general, the utilization of these resources for fisheries is negligible. No regular fish stock enhancement of rivers/canals through ranching activities by the Government is in practice. Occasionally river stretches are stocked with IMC seed by DoF without required technical knowhow of the production and biodiversity parameters. Over the years, the fishery of this resource has witnessed structural changes and fish stock in most of the rivers has declined rapidly both qualitatively and quantitatively. The share of commercially important Indian major carps in the total fish catch has also declined considerably.

Riverine fishes of Karnataka comprise over 75 species, about 48 species have potential for aquaculture, 53 species for capture fishery, and 27 species for game fishing and some have ornamental value. The contribution of this resource to inland fish production of

the state is only about 1000 MT and the productivity is about 100 to 150 kg/km as against the productivity potential of 1000 kg/km (10 folds higher).

1.5.6.3 Constraints in Riverine fisheries

Over the period, the fishery resource of rivers has been negatively affected due to changed anthropological activities in river catchment areas, urbanization, industrialization, soil erosion, sedimentation, multiple uses of water, reduced and regulated water flow, environmental degradation etc. Construction of reservoirs across the rivers (Mogalekar, et.al., 2016), waste weirs, barrages etc. have affected the movement of migratory fish. The following are the concerns that need to be addressed in order to sustainably utilize these resources:

1. Aquatic pollution associated to weed infestation and discharge of Industrial and domestic effluents into rivers
2. Loss of aquatic biodiversity due to degradation of riverbed, habitat alteration- siltation, sand mining activities, changed land use activities and prolific breeding of exotic fishes like African catfish, tilapia etc.
3. Over-exploitation of fish stock, Indiscriminate fishing, use of destructive fishing methods viz., dynamiting, poisoning etc. to catch fish which results in loss of fish species and killing of brood stock and juveniles.
4. Absence of specific institutional arrangement in support of this resource development
5. Lack of focused initiatives related to stock enhancement and fisheries development in rivers such as river ranching, regular stocking with indigenous /cultivable fish species etc.
6. Poor enforcement of regulations related to mesh size of fishing nets and close season ban on exotic fishes that are detrimental to the local fauna

1.5.6.4 Strategies to promote riverine fisheries

The developmental strategies for promoting riverine fisheries with policy support include the following:

1. Facilitate natural breeding of local fish fauna
2. Establish exclusive hatcheries and/or prioritize existing hatcheries to propagate selected breeds of indigenous fish species
3. Carry out river ranching, in situ stocking for rehabilitation and restoration of fish stock in rivers
4. Effective enforcement of ban on use of small meshed net, ban on fishing in non-fishing areas, ban on use of non-tackle fishing methods like dynamiting, poisoning etc.
5. Implement resource management mechanisms, habitat conservation and restoration measures such as closed fishing season, protection of breeding grounds etc.
6. Protect and strengthen fish sanctuaries and establish new ones for conserving fish biodiversity
7. Develop river stretches for Aqua – Eco tourism and sport/game fishing.

1.5.7 Estuarine Capture Fisheries

Estuaries formed by the rivers are important from the ecological and biological points of view and the resources are known for both biodiversity and productivity. The state has 25 estuaries with WSA of around 7202 ha spread across three coastal districts: Dakshina

Kannada – 5 (1,140 ha), Udupi – 8 (1,885 ha) and Uttara Kannada – 13 (4,176.5 ha). The estuarine ecosystems are considered highly productive and are known for their contribution to fish fauna and crustaceans comprising prawns and crabs and mollusan resources. The share to total fish production of the state though significant, there has not been much published data on fish production status of different estuaries. The Taluk-wise Estuaries and area is provided in Table 1.6.

Sl. No.	District and Taluk	Nos.	Estuaries Area (in ha)
Dakshina Kannada (D.K)			
1	Mangaluru	5	1140.00
Dakshina Kannada Total		5	1140.00
Udupi			
2	Kundapura	4	1535.00
3	Udupi	4	350.00
Udupi Total		8	1885.00
Uttara Kannada (U.K)			
4	Ankola	4	1725.00
5	Bhatkal	2	80.00
6	Honnavar	2	800.00
7	Karwar	2	1116.50
8	Kumta	2	455.00
Uttara Kannada Total		12	4176.50
State Total		25	7201.50

Table 1. 6: Taluk-wise Estuaries and area

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

The Important fishes and shell fishes along the coastal estuaries are *Sillago sihama*, *Mugil* spp., *Etroplus suratensis*, *Strongylura strongylura*, *Gerres filamentosus*, *Scatophagus argus*, *Ambassis commersoni*, *Terapon jarbua*, *Gobius*, *Chrysophrys berda*, *Drepane punctata*, *Platycephalus indicus*, *Scylla serrata*, *Meretrix* and oysters. The most available species throughout the year are *Mugil cephalus*, *Liza tade*, *Sillago sihama*, and *Tachysurus* spp.

Clams and mussels mainly in inland waters and bays form an important fishery. Communities harvest them on a regular basis by hand picking and dredging the bed for clams and bivalves. The meat is sold both in internal markets as well as to export processing plants, and the shells are an important resource used for manufacture of lime.

The estuaries are important sources of brackish water fish seed, of which *Chanos chanos*, *Mugil* spp., *Megalops cyprinoides* and *Sillago sihama* and several prawns are the most important and are suitable for culture both in brackish water and fresh waters with proper acclimatization. Although coastal Karnataka has a number of estuaries, the fisheries resources of these are poorly known. This becomes all the more significant, since the estuaries are the main sources of fish production during the south-west monsoon period (May

to September) when sea fishing operations remain suspended making it imperative to know the fisheries potential of the estuaries in the region both quantitatively and qualitatively. However, the demand and value of the estuarine fishes steeply decreases with the end of the monsoon season and commencement of sea fishing operations. Extensive and round the year fishing for clams is carried out in most of the estuaries mainly by the fisher women in support of consumption in fresh state and as a chief source of lime shell production as most estuaries have vast beds of lime shell.

Fishing in the estuaries of the region is quite diversified, the important gears being used are shore seines (Kairampani), gill nets, cast nets, hook and line and mini-otter trawls. The fish catches in the estuaries consist of *Sillago sihama*, *Thripterygion mykiss*, *Ilisha indica*, *Kavala coval*, *Platycephalus scaber*, *Lutjanus fulviflamma*, *Gerres filamentosus*, *Leiognathus* Spp., *Sphyræna* sp., *Mugil cephalus*, *Liza parsia*, *Stolephorus indicus*, *Etroplus suratensis*, *Etroplus canarensis*, *Horabagrus brachysoma*, *Caranx carangus*, *Belone cancellata*, *Tachysurus* spp., *Pseudo sciaena* spp., *Gobius* spp. While most of the fishes mentioned above do not attain big sizes in the estuaries, fairly large individuals of a few species like the *Mugil* spp. and *Sillago sihama* are regularly caught. The fish populations in the estuaries are generally composed of the juveniles and immature individuals of several species. In a few species like the mullets and *Sillago sihama*, the catches include all stages of maturity including spawners, especially in the latter. It is also significant to note that in a number of estuaries *Sillago sihama* is the dominant species in the catches, the most efficient gear for its capture being the hook and line. *Polychaetes* are exclusively and effectively used as bait for adults while juveniles are caught on hook with prawn as bait. Another important member of the fish fauna of the estuaries is the catfish *Mystus gulio* which forms large shoals, especially around fish landing jetties in the estuaries where it appears to utilize as its food all waste materials thrown out from the fishing boats. There is good potential for developing estuarine fisheries in Karnataka.

1.5.8 Mariculture and Inland Aquaculture

Aquaculture is the process of rearing, breeding and harvesting of aquatic species, both animals and plants, in controlled aquatic environments like the oceans, lakes, rivers, ponds and streams. It serves different purposes, including food production, restoration of threatened and endangered species populations, wild stock population enhancement, the building of aquariums, and fish cultures and habitat restoration.

Globally, Aquaculture is probably the fastest growing food-producing sector and now accounts for 50 percent of the world's fish that is used for food. About 580 aquatic species are currently farmed all over the world, representing a wealth of genetic diversity both within and among species. Aquaculture is practiced by both some of the poorest farmers in developing countries and by multinational companies. Eighty percent of current aquaculture production is derived from animals low in the food chain such as herbivorous, omnivorous fish and mollusks. Based on its dynamic performance over the last 30 years, and with fairly stable catches from capture fisheries, it is likely that the future growth of the fisheries sector will come mainly from aquaculture.

Aquaculture sector is said to be a way by which the challenge to food security of the undernourished protein starved population, especially given the constraints in land resources could be met. Carp in freshwater and shrimps in brackish water form the major areas of activity in Indian aquaculture.

Brackish water farming in India is an age-old traditional system confined mainly to the bheries (man-made impoundments in coastal wetlands) of West Bengal, similar to gheris in Odisha, pokkali (salt resistant deep-water paddy) fields in Kerala, kharlands in Karnataka and Maharashtra, and khazans in Goa coasts. These systems have been sustaining production of 500–750 kg ha⁻¹ year⁻¹ with shrimp contributing 20–25 percent without additional input, except

that of trapping the naturally bred juvenile fish and shrimp seed during tidal influx (FAO 2014).

Apart from the giant tiger shrimp, certain marine/ brackish water fishes such as sea bass, mullets, milkfish, catfish and pearl spot have shown a lot of promise for commercial aquaculture.

Aquaculture activities that need immediate attention for promotion are commercial seed rearing & fish culture, cage farming in selected reservoirs, pen culture in both reservoirs and perennial tanks, in situ seed rearing for desired size in pens wherever feasible, ornamental fish farming, prawn farming etc.

However, aquaculture activities such as mariculture, seaweed farming, and ranching should be limited in their scope and not be undertaken in areas which are

1. Ecologically Important
2. Important for capture fisheries (nursery areas, fisheries reserve, spill over zones etc.)
3. Areas which are important for vulnerable communities (small scale fishers, traditional fishing grounds).

These need to be part of the marine spatial planning exercise and strongly enforced. Hence, mandatory pilot studies and specific impact assessments for all proposed aquaculture activities like mariculture, seaweed farming, ranching, by a committee of subject experts for assessing the risk of these serious environmental and social justice issues and evaluate the immediate and long-term impacts on near and distant ecosystems is also strongly recommended for sustenance of local ecologies and safeguarding current fish stocks and local livelihoods.

Moreover, these intensive production techniques such as Aquaculture, Mariculture, Ranching and seaweed cultivation project are associated with a host of serious environmental issues (Land salinization, antibiotic overuse leading to resistance, destruction of local flora and fauna, escape of cultured species, invasive species, pollution, eutrophication, dependence on reduction fisheries leading to overfishing) and social justice issues (infringement on access rights of local community, high barriers to entry and exit, aggravation of economic divide). There is a wealth of literature highlighting these deleterious impacts. In addition, rarely do the economic profits of these ventures match the environmental damage or social disruption they bring in their wake. Thus, it is recommended to employ an abundance of caution in the execution of these activities, backed by rigorous scientific studies and regulated by a set of stringent rules, impact assessments, monitoring protocols and means to ensure/enforce compliance. Appropriate Environment and Social Impact Assessment (ESIA) by an independent committee comprising Ecologist, Fisheries Scientist, Social Scientist and Hydrologist should be made mandatory before starting all Aquaculture, mariculture, Ranching and seaweed cultivation projects for sustenance of local ecologies and safeguarding current fish stocks and local livelihoods. The same has to be carried out annually to ensure safeguarding the local environment, living-natural resources, local biodiversity and local vulnerable communities.

1.5.8.1 Small Scale Aquaculture

The ongoing aquaculture activities are predominantly small-scale, conventional low-cost-low-yield practices with no consideration to water and soil quality for improving resource productivity. Although the state has huge area under minor tanks (Gram Panchayat tanks) with greater potential for pursuing small scale aquaculture activities including seed rearing, the resource utilization is very meagre. Small scale aquaculture is an emerging new

opportunity of choice for the migrant workers in rural Karnataka. The state is also endowed with several non-conventional resources viz., check dams, water harvesting structures viz., farm ponds, open wells, abandoned quarry tanks and such other small water bodies constructed under Mahatma Gandhi National Rural Employment Guarantee Act, 2005 (MGNREGA)/watershed program of Govt. of India. Most of these resources are constructed mainly for agricultural and non-farming activities, serve as rain water harvesting or water storage structures etc. In some of the districts such as Kodagu and Chikkamagaluru, a huge number of water bodies are available as 'Estate ponds' with unique resource characteristics and offer new opportunities for aquaculture, Aqua eco-tourism, sport fishing etc. Presently most of these water bodies are being used without any scientific approach. Integrated fish farming complementing with other production systems viz., dairying, live-stock, poultry, sheep & goat, pig farming etc. is being pursued in sporadic cases. These resources offer wider opportunities to promote small scale aquaculture activities as complementary to the ongoing usage without altering its present usage pattern and with no negative impacts on the ecosystem. Exploring small water bodies for fish seed rearing and such other aquaculture related activities including feed-based culture are the new opportunities.

On a limited scale, aquaculture activities are also pursued in selected reservoirs. Fish seed rearing pens is a common practice in Tungabhadra Dam. Cage fish farming of *Pangasius* was taken up in Krishna Raja Sagara Dam and in few other resources but the activity has still not gained commercial importance. The state has also positioned guidelines for the participation of private entrepreneurs to undertake cage fish farming in selected reservoirs. In situ /peripheral seed rearing is also pursued in some selected reservoirs though on a limited scale and is gaining importance. Efforts are also going on in identifying new reservoirs for further expanding of the activity and similarly for promoting fish seed rearing and fish farming in pens and coves in selected reservoirs. Due to lack of data, the extent of contribution of these small-scale aquaculture activities to total inland fish production of the state is not available.

1.5.8.2 Aquaculture in private owned ponds/tanks

Aquaculture in private owned ponds/tanks and in other production systems is still a low-key affair in the state. An estimated area of over 9000 ha is available in the state under private ownership. Farming activities in most of the farms are limited to composite fish culture of Indian major carps and common carp. Grass carp is stocked occasionally in weed infested ponds. Pond fish farming in Karnataka is mainly oriented towards Indian major carps and exotic carps. Other species that are sporadically farmed are Desi Magur, Singhi, Pabda, Vietnam Koi, Monosex Tilapia, *Pangasius*, Pacu, Chital in mono/polyculture system. The ease of culture operations, rapid growth, disease resistance and better market demand and price has provided support to pursue these activities. Farmers procure seed from hatcheries/seed production/rearing centers (Govt./private) both within and outside states depending on availability and requirement. Majority of farmers sell their fish through Channel-I (farmer to consumer) realizing 95 percent of consumer price directly, farmers who follow channel-II (farmer to retailer cum wholesaler to consumer) realize only around 57 percent of consumer price. The government has no major say in commercial aquaculture activities except registration of the farm. There is no norm for stocking or species used (other than banned species). The farmers choose species depending on empirical experience, infrastructure and management capabilities. Pond fertilization and manuring, supplementary feeding with rice bran and oil cake are the common practices in use. Only a few are practicing feeding with formulated feeds and use Company produced floating feeds for carps. The high cost of feed and the prevailing market price of fish have restricted the usage of feeding practice.

1.5.8.3 Commercial aquaculture

The state offers huge potential for promoting commercial freshwater aquaculture as a

sunrise segment. At present commercial scale farming activities are in practice mainly in command areas of Ballari, Raichur, Koppala, Mandya, Mysuru districts. Diversity of farming systems and species is happening in a few pockets with an assured irrigation network in other districts. The average resource productivity of the composite fish culture system is estimated at 3500 kg/ha although the potential is 8-10 MT/ha. The DoF is extending assistance for construction of new earthen ponds and also for one-time input support under Blue Revolution Scheme to expand fish farming area under private segment. Input based aquaculture activities are low key and most farmers use their own farm made feeds. In recent years, use of commercial extruded floating feeds in sporadic cases is gaining attention. Fish production from aquaculture systems is mainly targeted towards domestic markets, and is destined for local consumption and local fish markets. A few entrepreneurs have already taken up the commercial aquaculture activity but are yet to receive commercial attention for wider adoption. Farming of tilapia, pangasius, pacu, murrel, freshwater prawn, vannamei tech fetch better returns compared to conventional carps and is the growing new trend among aquaculture entrepreneurs.

1.5.8.4 Brackish Water Aquaculture in Saline and waterlogged area & derelict water bodies

Saline and waterlogged areas and derelict water bodies in canal fed regions owned by Govt. or private individuals are important resources for promotion of aquaculture activities in the state. The state has 2.41 lakh ha waterlogged/saline and alkaline affected area, and most of it is unproductive for any agricultural operations. Such land could be profitably utilized for commercial fish culture. Aquaculture in such lands/areas has greater opportunities both from the view point of resource utilization for profitable alternative food production activities and also to restore upland areas for agriculture through in-built soil reclamation process that is naturally taking place due to construction ponds in the low-lying water-logged areas. The district wise Water logged and Alkaline area in the State is provided in Chapter 1 Annexure 22.

1.5.8.5 Brackish water Aquaculture in Estuarine areas

Brackish water aquaculture is gaining greater momentum in the state in recent years. The state has about 8000 ha of brackish water area of which only about 4200 ha is estimated as suitable for shrimp culture (DoF report, 2018). The state has vast opportunities for the development of brackish water fish/ shellfish farming. The major brackish water bodies are the Netravati-Gurupur estuary near Mangaluru, the Mulky estuary, the Udyavara estuary, the Hangarkatta estuary, the Gangolli estuary, the Sharavathi estuary and the Kali estuary.

However, the utilization of resources for finfish and shellfish activities is low (about 10 percent) and the contribution to total fish production is also meager (<4 percent). The state has not witnessed progress either in expansion or in the intensification of the culture systems. Low input-based finfish and shrimp farming in tanks/ponds of brackish water areas is an ongoing traditional practice. Brackish water culture in paddy fields (Gazani land) is traditionally being carried out in the state mainly in Uttara Kannada district. The yields are low in the traditional practice (600 kg/ha) as against its potential. Initially, in order to encourage scientific fish farming, two brackish water fish farmer's development agencies were established, one at Karwar and another at Brahmavar (presently in Udupi). These agencies were engaged in training of farmers in shrimp culture, site selection and preparation of project reports for getting financial assistance from the banks to the beneficiaries.

The common finfishes under farming are sea bass, mullets, and shellfish are shrimp (*Litopenaeus vannamei*) and mud crab fattening (*Scylla serrata* and *Scylla tranquebarica*). Polyculture of sea bass and tilapia using trash fish and/or formulated feed is also practiced. Although culture technology for mullets and milkfish are available, farming activity depends

mainly on seed collected from the wild. Utilization of the vast brackish water area of Karwar coast for pearl spot culture under individual farming is underway. In the absence of commercial hatcheries for most species of brackish water finfishes, availability of seed from the wild assumes importance. Abundance of mullet seed has been observed in the estuaries of Dakshina Kannada. Since large quantities of grey mullet seed are available in the Mulky estuary and Netravati – Gurupur estuary, there is considerable scope for farming of mullets. Compared to all the estuaries of Dakshina Kannada, the Gangoli estuary appears to be the richest in the seed of the Sand whiting (*Sillago ciliata*). Because of the fairly fast growth and demand coupled with good market price, large scope exists for the culture of this species in coastal ponds, net enclosures and cages. The seed of pearl spot is known to be abundant in the estuaries of Mulki and Udyavara. The seed of milkfish occurs in good quantities near Kundapur and in the Kali estuary.

Although tiger prawn culture received a setback during 1996 due to the restriction imposed by the Supreme Court and outbreak of white spot virus disease, of late, farming of *Litopenaeus vannamei* has gained importance, and is going on in over 154 ha area spread out in about 418 shrimp farms. The activity is carried out by outsourcing prawn seed from other states mainly from places like Nellore, Bhimavaram and Puducherry. Some farmers also undertake tiger shrimp farming. The seeds for these are also obtained from Andhra Pradesh and Tamil Nadu. At present, only one private shrimp hatchery in Kumta (Skyline Aqua Hatchery Pvt. Ltd) is meeting the internal seed requirement. The stable shrimp seed production network (in terms of shrimp hatchery), quality feed as per the requirement of culture, scheme support of central and state, export demand is driving the expansion of activity. Apart from seed, shrimp feed is also outsourced from the neighboring states.

In recent years, Biofloc based shrimp farming of *L. vannamei* is receiving the attention of entrepreneurs. High production (~43 MT per ha.) and high profitability (recovering all the investment cost in the first harvest itself) are successfully demonstrated in farmer's ponds.

Availability of SPF seeds of *L. vannamei*; technologies for improving diagnostics and developing therapeutics, BMP protocols for farming, new farming practices, well supported backward and forward linkages are supportive for the expansion of activities in the state. Central Action plan for Mission Brackish Water/Saline Aquaculture (MBSA-2022) is also under implementation in the state and support is being extended for establishment/ expansion of hatcheries, seed rearing units, farming areas, Promotion of Cluster based approach, grow out cages including backyard cages, feed plants, diagnostic labs etc. Scheme level support for infrastructure and farming activities, regulations that are positioned under various initiatives of the Central and state government are expected to support activity enhancement and intensification in years to come.

Culture of mud crab though having been standardized in the tide-fed brackish water ponds; the farming activity has not taken commercial scale. The main crab procurement areas are Kumta, Ankola, Karwar, Kundapur and Mangaluru. Crab fattening is another potential activity with high value returns. Entrepreneurs are earning a good return by fattening the big size soft crabs in pen type culture. Both farming and fattening activities are yet to gain momentum in the region.

The constraints and suggested strategies are provided below:

Constraints	Suggested strategies
• Absence of brood bank and finfish hatcheries • Limited number of functional hatcheries in support of quality seed production for wide range of species	• Prioritization of brackish water farming in the state • Positioning of supportive policies and programs • Assessment and characterization of

• Limitations of seed production technology for commercially important brackish water fishes and shell fishes • Absence of input supply chain – feed, supplements and additives etc. due to limited scale of activities in the state • Lack of entrepreneurship and private investment in commercial activities	available resource to identify potentials for scientific development, area suitable for the farming activities and developmental needs • Promotion of semi-intensive farming of both prawns and high value fin-fishes • Improvements to the support service system to facilitate better access for quality seed, feed, health care products, and technology related services. • Capacity building at all levels for promoting scientific traditional and commercial farming.

1.5.8.6 Historical trends in coastal and brackish water aquaculture

Coastal and brackish water aquaculture is dominated by shrimp farming with very little effort focused on finfish and other species. Aquaculture of shrimps, started as an extensive culture practice more so during the latter part of last century and has now developed into semi-intensive activity, with scope for improving to intensive practices with advance inputs in production technologies such as improved seed, feed, disease management among others. The production of Shrimp from aquatic sources is attached as Chapter 1 Annexure 23.

1.5.8.7 Supply chains and value chains in brackish water Aquaculture

Most of the increase in fisheries production is likely to come from aquaculture, with brackish and coastal aquaculture playing a prominent role. With regard to the culture of fin fish, there is a ready domestic and international market. Among the fish species, sea bass and sand whiting have the highest market value followed by red snapper, pearl spot, milk fish, grouper, silver pompano and mullet. Post-harvest, the finfish are generally sold in the market as whole fish, either fresh or chilled. Presently, there is no information with regard to export of these fish as the production so far is in small quantities. Based on the market for these fishes in India, specifically in Karnataka, an estimated 40.80 MT quantity is required to meet the current market demands, which is only expected to grow.

Largely, driven by the export market, shrimp farming is by far the most common aquaculture practice in the state as is also the case throughout India. Harvesting and marketing of shrimps produced from the aquaculture farms is a highly involved and relatively organized process right through from harvesting to chilled transportation to the factory, processing and export, taking up to 7-8 days depending on export demand. For the purpose of the local market, the shrimps are sold as whole shrimps and often fresh. However, with growing urban populace the need for frozen shrimp in the metropolitan cities is increasing.

There is also a niche export market for other invertebrates, primarily crab and squids. The crabs are also sold for domestic consumption. The domestic market mainly includes the urban centers where the crab is sold in live form. However, international markets attract premium prices for soft shelled crab, live crab and other processed products including whole or parts (claws, toes and shucked meat) of frozen and cooked crab.

Karnataka has not ventured into the culture of other shellfish species. Given the potential and the marketability, a focus on farming of other high valued species such as lobster could provide niche opportunities. This will also provide opportunities for developing new and emerging technologies and skill development.

1.5.8.8 Barriers for growth of fish and finfish aquaculture

Despite several decades of farming, the state is facing a number of bottlenecks, which have prevented optimal and sustainable utilization of the potential. They include the following:

1. Non-availability of quality seeds of high value finfish and shellfish
2. Lack of high-quality formulated feeds
3. Unidentified suitable sites for cage culture
4. Lack of sea cage farming/leasing policies
5. Lack of biosecurity and disease management policies and practices
6. High reliance on export market and unorganized domestic market
7. Lack of adequate technology for breeding and rearing
8. Lack of feed and live feed at economical cost
9. Conflict in the estuarine areas with ports, navigation channels for ships and boats.

1.5.8.9 Equitable distribution of benefits in brackish water/coastal aquaculture

Typically, most current brackish water/coastal aquaculture activities are promoted by few rich entrepreneurs. The laborers in these farms are generally from outside the state (Odisha, Bihar, Jharkhand etc.). As a result, the employability of local communities in these farms presently is negligible, often resulting in conflicts. With the potential indicated above, there is a tremendous employment potential in the aquatic sector in the state that can be harnessed by addressing the constraints and providing adequate skill development, technical and financial support to fish farmers.

1.5.8.10 Frontier Aquaculture

Recirculatory Aquaculture System (RAS), Biofloc, Aquaponics, intensive pond aquaculture (IPAT) technology is some of the new high-tech fish production systems in support of commercial aquaculture that are receiving attention from entrepreneurs and planners in the country. These farming systems are regarded as frontier technologies for enhancing fish production. Pilot scale models are in operations in the state by the innovative entrepreneurs and in most case species like pangasius and mono-sex tilapia are the candidate species. The activity is still to gain commercial importance as domestic demand for these farmed species is limited and market price is not encouraging to meet economic feasibility. Further the requirement of uninterrupted power supply at reasonable cost, availability of quality water, high quality and high dense feeds, support services including technology hand holding, consultancy, capital and insurance support to reinforce the practice for scale up to commercial levels are working against wider expansion of the activity at present.

1.5.8.11 Mariculture

An increasing demand for marine finfish and shellfish and the near stagnation in marine fish production has warranted an enhancement in the aquaculture production under mariculture systems in the state. Mariculture in the state is expected to provide a new platform for higher fish production with lower environmental damage. At present the share of marine

aquaculture to total marine fish production is low.

The state has a long history of traditional coastal aquaculture in the Gazani/Ghajini lands of Uttara Kannada district. The district has over 2320 ha of Gazani land where paddy-cum-fish culture including prawns, crabs etc. is practiced through the intake of tidal waters. Mariculture of finfish and shellfish is practiced mainly in Dakshina Kannada and Udupi district. However, these activities are still in the early stages of their establishment.

The coastal stretch of Karnataka has tremendous potential for promoting coastal aquaculture. The potential areas for mariculture in Karnataka are mainly Mulky, Udupi, Kundapur, Byndur, Bhatkal, Kumta, Ankola and Karwar. The stretches that are suitable for aquaculture include the land area along the estuarine regions. Around 80 sq. km have been identified for promoting aquaculture. Of the 80 sq. km, over 10 percent of the area is under active utilization of aquaculture in areas such as Honnavara, Uppunda, Bhatkal, Mulky, Saligrama, Gangoli and Kundapura.

The major species of fish farmed in the aquaculture farms include sea bass, milk fish, grouper, red snapper, pearl spot, silver pompano and grey mullet. The shellfish under farming includes shrimps, crabs, oysters, mussels, clams and seaweeds. Both Mono and Poly culture of finfish and shellfish are in practice.

In Karnataka, the Karwar coast is considered to be an ideal site for cage farming and the activity has opened new opportunities for the large-scale production of commercial finfishes in support of enhancing marine fish production. Finfish mariculture also has greater scope in estuarine areas using low-cost cages. Currently, sea bass and milk fish are cultured in brackish/coastal setting and at only a handful of locations along the coast (Kumta and Honnavar), with the exception of sea bass and grouper cultured in cages in Udupi (Uppunda) and those of only sea bass in six other locations (Karwar, Bhatkal, Mulki estuary, Saligrama, Gangolli and Kundapura).

Bivalve farming such as oysters and mussels in shallow and calm areas of sea/shallow bays and estuaries has wider scope due to availability of natural mussel seed in abundance. The activity could be taken up on a commercial scale for additional/alternative livelihood options with immense employment opportunities for the artisanal fishermen. Green mussel (*Perna viridis*) and oyster farming has greater opportunities in coastal and estuarine waters of Dakshina Kannada and Udupi districts.

CMFRI has developed farming technologies for green mussel using rack, raft and longline in estuarine and coastal waters, integrated farming of mussels and shrimps, mud-crab fattening, offshore open cage culture of finfishes viz., cobia, snappers, rabbit fish, sea bass and groupers at selected places along the coastline of India. Most of the technologies developed have been validated in a participatory mode, refined and the success has been demonstrated. The organization has also documented several success stories of the technology adoption (CMFRI, 2016).

Typically, fin fish farming activities can be broadly categorized as;

1. Procurement/production of brood stock
2. Hatchery propagation
3. Nursery
4. Rearing
5. Stocking

Unfortunately, the most basic inputs i.e., brood bank and hatchery are not available in

Karnataka for any of the fin fish species suited for mariculture in the area. The seeds are either currently obtained from wild or from RGCA, Tamil Nadu. Lack of seed production is a key bottleneck that is hampering the promotion of aquaculture in Karnataka.

Though Karnataka has the required resource base and a great potential for developing mariculture, the activities continue to be in low profile and limited only to a few pockets here and there in the three coastal districts. Diversification in the form of finfish culture, particularly the cage culture offers immense potential. The state is endowed with 26 major and minor brackish water creeks which are suitable for small-scale cage culture. Cage culture, rack culture, raft culture and long line culture can also be pursued in the open sea areas. In addition, long line culture of seaweeds and mussels in the open sea is also a possibility.

1.5.8.12 Experience of demonstration Pilots

1. Mr. Vasudeva Byndoor is a fisheries professional having experience in both the private and government sector. He found that Shrimp seed is the main critical input. Quality Shrimp seed could minimize the production related risks by 50 percent. However, the farmers from the west coast have to depend on the hatcheries in the east coast as there were no hatcheries in the region. He had to depend on the middle men to procure seeds from the east coast and in that process the quality of shrimp seed supplied to the west coast was poor and the cost was also high. Therefore, he decided to establish a shrimp hatchery on the west coast. Similarly, he understood that dependence on a single species for farming would be a risk and felt that brackish water aquaculture needs diversification. He established Anugraha Aquatech Tiger Prawn Seed Hatchery at Head Bunder in Vannalli Village, Kumta Taluk of Uttara Kannada District in Karnataka. He has a farm located at Alvekodi Kalbag Village, Kumta Taluk on 10 acres. His farm gets water from a small creek and in the recent years, this creek has become a dumping place for chicken and mutton wastes from Kumta area besides Municipality sewage drain, hence is highly polluted. It was very difficult for him to carry out the culture beyond 40-50 days. He developed raw water treatment before use in farming. He screened all the inputs to get rid from possible diseases and increased the scope of assured production. He also tried seabass cage farming and bought the inputs like cage, fencing and seed from RGCA. Nursery rearing was carried out in tanks of 10 MT capacity. Daily thrice, feeding was done with slow sinking and floating feed. Grading was done to minimize cannibalism using an adjustable mechanical grader once every 7-10 days. Post grading a salinity shock was given to control parasite infestation. Nursery rearing was carried-out for three months until they reached 10-12 cm and 30- 45g. Grow-out farming was done in cages installed in the pond with a stocking density of 75 to 130 no/m³ or 3.7 -3.9 kg/m³.

During culture, three sizes of the seabass were observed during each grading, out of which 60 percent were good growing seeds. The remaining 40 percent were slow-growing and not viable for culture. This caused huge production and economic loss for the farmer and a mechanism was required to improve the size variation in seeds in early stages or identify better performing seeds at the early stage of larval rearing and use for culture. Availability of hatchery reared seeds round the year and good quality feed at fair price will aid in sustaining Asian Seabass farming. Grow-out farming was practiced for 220 days and seabass grew up to 931.6 g with an average weight of 438 g. Out of 3,869 seeds stocked, 3509 were harvested, realizing a total 4690 kg of seabass with more than 90 percent survival. A food Conversion ratio of 1.8-2.0 was obtained. Planned marketing could fetch a rate of 250/ kg.

2. Mr. Sanju Fernandes has been practicing brackish water aquaculture since 2014 and has a 0.2 ha tide fed pond. The farmer practiced the traditional tide fed farming which was a polyculture of shrimps and finfishes by auto stocking of seeds during high tide and cultured for 6 – 8 months. This traditional system had low productivity and uncertainty in

production. He faced a lot of problems in farming due to lack of technical inputs and was looking for an alternative. He learnt about the importance of Asian seabass farming and its market demand. After the success of Asian seabass farming, he expanded the farming area up to 8 acres (on lease basis) for Milkfish farming.

Asian seabass seed are reared in his nursery and the juveniles (average total length 13 cm & 15 g weight) were stocked in the 0.18 ha pond, and reared for 11 months, fed with trash fish (Sardine and Tilapia) at the rate of 5 percent body weight twice a day. Fishes attained a body weight ranging from 980 – 1050 g with an average total production of 512 kg/0.18 ha. He sold the farmed fish in the Goa market (during Christmas) at the rate of 450 INR/kg.

Economics of Asian Sea Bass Farming	Cost (INR.)
Cost of Asian sea bass fingerling (600 no's at INR25/Piece (15g. 13cm))	15,000
Transportation Cost	10,000
Feed Cost: - Trash fish (Sardines/Tilapia) at INR 35/Kg (1686.95 Kg)	59,043
Miscellaneous (Pond Preparation, liming, Harvesting)	15,000
Total (A)	99,043
Total Production from 512 Kg/0.18ha * Market Price (INR. 450/Kg) as on December 2017 (Christmas Eve) in Goa Market (512*450)	2,30,400
Total (B) Gross Income	2,30,400
Net Income (A-B)	1,31,357

Table 1. 7: Economic Viability of Asian Sea Bass Farming

3. Mr. Sunny D'souza is a shrimp farmer from Mangaluru. He came across a blog article written by Prof. Yoram Avnimelech after which he made a small trial in his backyard which encouraged him. He started biofloc based shrimp farming in a leased 1.4 ha farm in Padupanambur village in Mangaluru. He adopted biofloc technology and he obtained a production of 43 MT/ha. He took support from the Fisheries College, Mangaluru in analysing water and checking the pathology in vannamei shrimp like Vibrio load, Calcium, Magnesium in pond water on a regular basis. For the first time in India, he followed root aeration in farming using diffused aeration replacing traditional Paddle Wheel Aerators. The results are tremendous and this has saved nearly 65-70 percent power. He harvested 1070 kg of Shrimp with 1 HP of power. Initially he used membrane diffusers which are very costly and later replaced with aero tubes which are much cheaper (almost 75 percent) compared to membrane diffusers with better efficient aeration. He started on one acre with 4 tanks of 1000 sq ft each based on funding from friends and relatives. The total cost was INR 42 lakhs including working capital and 1st crop itself he harvested 11 MT of shrimp which was sold at INR 450/40 count and recovered all the investment and slowly expanded phase by phase enabling them to purchase and establish an 8.5 acres new farm in Thalassery, Kerala.

1.5.8.13 Ornamental fish farming

Ornamental fish farming, although a non-food activity, also has a promising future and is likely to contribute to the overall growth of the fisheries sector in the coming years in terms

of foreign exchange earnings and additional livelihood opportunities both in the urban and rural areas. Currently, India's share in the global ornamental fish industry is minimal. The Ornamental fish industry is yet to take priority in the State. Breeding and propagation of indigenous ornamental fish varieties for exports and domestic market, tissue culture of ornamental plants (exotic and indigenous), freshwater pearl farming, breeding fish for public health are the new entrepreneurial opportunities.

1.5.8.14 Constraints faced by Aquaculture sector

Vertical growth of fish culture in most of the small water bodies is constrained due to several intrinsic reasons of resource characteristics. Commercial fish farming is constrained by high cost of production, market/consumer obligations/requirement, quality and safety of fish produce, environmental concerns. The main constraints are as follows:

1. Limited availability of tanks / ponds under private ownership constructed exclusively for aquaculture activities
2. Lack of development approaches addressing complete production, supply and value chain etc.
3. Inadequacy in handholding for backward and forward support services across the entire supply-value chain
4. Inadequacy in appropriate support system – quality seed, other inputs, challenges of power supply, limited access to quality water etc.
5. Lack of managerial experience in bringing down factor cost and enhancing cost effectiveness.
6. Low market price and reduced market absorption for most of the present candidate fish species farmed in RAS, Biofloc, aquaponics etc.
7. Inadequacy in innovative marketing, improved post-harvest, processing and value-addition. Lack of awareness, training, technology demonstrations and its economic viability, technology hand holding, and limited supportive schemes.
8. Inadequacy in institutional mechanism – infrastructure support, institutional finance, insurance back up, inter-institutional collaborations etc.

The state is yet to witness rapid growth in the aquaculture segment of farming. There is a need to address issues constraining the growth of aquaculture to steward development towards technology and management led growth approaches with appropriate investment, infrastructure support and institutional arrangement backed up with pro-sector schemes and policies/ guidelines. The strategies to boost growth in the aquaculture sector are provided in the **Summary Outline Blue Economy Development Plan**.

1.5.9 Conclusion - Inland fisheries

The State is endowed with rich inland water resources of 5.65 lakh ha which provide enormous scope for growth of inland fisheries sector. The annual production of inland fisheries for the year 2018-19 was 1.98 lakh MT whereas the annual estimated fish production potential from inland water resources in the state is around 4.02 lakh MT taking into account the full utilization of all inland water resources for fisheries. The sector in the state is predominantly demand driven with over 30-40 percent deficit in fish supply. For example, the present resource utilization for fisheries in tanks and ponds is about 60-65 percent and estimated

productivity is 550 kg/ha as against potential of 2.5 MT/ha. The contribution of riverine resources to inland fish production of the state is only about 1000 MT and the productivity is about 100 to 150 kg/km as against the productivity potential of 1000 kg/km. Moreover, the average resource productivity of composite fish culture systems is estimated at 3500 kg/ha although the potential being 8-10 MT/ha.

Although the state has vast aquatic resources with potentials to promote fishery enhancement and commercial farming, it has not been realized. The wide gap between demand and supply of fish, decreasing resource productivity, production and sector sustainability and declining income of stakeholders involved in the entire supply and value chain of the sector are the major concerns of the segment. Although the inland water resources such as tanks/ponds, reservoirs, riverine and estuarine resources of the state have high potential and greater scope to boost productivity, there are various constraints that hinder the optimum utilization of these resources. The main constraints impacting the growth in the Inland fisheries sector are gaps in resources, technology, support systems, infrastructure, institutional arrangements and policy frameworks.

This position paper has discussed the various resource specific constraints as well as constraints in aquaculture, fish seed production and rearing, fish processing and value addition and fisheries co-operative societies (FCS). The recommendations for each of these are highlighted with a greater focus on implementation of conservation measures that could pave the way for harvesting sustainable yields along with enhancing the economy of the state and promoting all-inclusive growth.

A transformation of the sector is the need of the hour and that can be achieved only if changes occur at the ground level. This consists of adoption of new technologies, processes and management tools appropriately at all levels to support in enhancing systems, overall productivity and efficiency. Another key to driving sector growth is to revitalize existing fisheries development programs and make them more relevant.

Around 6.33 lakh fishermen across 30 districts in the state are dependent on Inland water resources for their livelihood and sustenance. Implementation of sustainable strategies for enhancing growth in Inland water fisheries will result in poverty reduction through generation of revenues and address major development gaps such as food security, income and economy. The specific recommendations for enhancing the inland fisheries sector have been provided in the **Summary Outline Blue Economy Development Plan**.

1.6 Potential Ocean Surface Seaweed Farming

Seaweed cultivation is a diversification activity of mariculture. Commercially available varieties of marine macro algae are commonly referred to as “seaweeds”. They are classified as red algae (Rhodophyta), brown algae (Phaeophyta) or green algae (Chlorophyta), based on the pigmentation and on their nutrient and chemical composition. Seaweeds are rich in vitamins and minerals and are consumed as food in various parts of the world (red and brown algae). They are also used in the production of phytochemicals such as agar, carrageenan and alginate which are widely employed as gelling, stabilizing and thickening agents in the food, confectionery, pharmaceutical, dairy, textile, paper and paint industries. Seaweeds have been used since time immemorial in East Asia as spice, delicacy, and traditional medicines. Seaweeds have been a staple food in Japan, China and the Republic of Korea for a very long time. The green seaweeds *Enteromorpha intestinalis*, *Ulva lactuca*, *Caulerpa* and *Codium* are utilized exclusively as a source of food. These are often eaten as fresh salads or cooked as vegetables along with rice. *Porphyra* (Nori), *Laminaria* (Kombu) and *Undaria* (Wakame) are used for making fish and meat dishes as well as soups and accompaniments.

Seaweed farming based primarily on the culture of species has grown significantly in

the Philippines and Indonesia over the last two decades, with growth also taking place at a smaller scale in India and a few other developing countries. Unlike other forms of aquaculture, seaweed farming foregoes the use of feed and fertilizers and has minimum technological and capital requirements. In addition, grow out cycles are short, normally lasting less than two months. Given these unique characteristics, seaweed farming has generated substantial socio-economic benefits to marginalized coastal communities in developing countries, most of which have reduced access to alternative economic activities. In some communities, seaweed farming has emerged as the most relevant livelihood strategy. Given the rising global demand for seaweed-derived products, seaweed farming has the potential to generate further socio-economic benefits to coastal communities in tropical regions.

Global seaweed harvests from wild stocks ranged between 1.0 and 1.3 million MT from 2000 to 2009 (FAO 2014). Globally in 2018, farmed seaweeds represented 97.1 percent by volume of the total of 32.4 million MT of wild-collected and cultivated aquatic algae combined. Seaweed farming is practiced in a relatively smaller number of countries, dominated by countries in East and Southeast Asia. The world production of marine macroalgae, or seaweed, has more than tripled, up from 10.6 million MT in 2000 to 32.4 million MT in 2018. India presently harvests only about 22,000 MT of macro-algae annually compared to a potential harvest of 8,70,000 MT, a mere 2.5 percent.

There are 624 species of marine algae belonging to 215 genera and 64 families in India (Untawale et al. (1983)). Of these, nearly 60 species are commercially important. In a revised checklist of marine algae¹⁶ 844 species were reported from India, comprising 216 species of Chlorophyta, 191 species of Phaeophyta, 434 species of Rhodophyta and 3 species of Xanthophyta indicating a considerable increase in the species recorded from India. The standing stock of seaweeds in India is determined to be 2.6 lakh MT¹⁷ comprising 6 percent agarophytes, 8 percent carrageenophytes, 16 percent alginophytes and the remaining 70 percent green and other non-commercial seaweeds¹⁸.

In India, seaweeds are used as raw materials for the production of agar, alginate and Liquid Seaweed Fertilizer (LSF). There are about 20 agar industries, 10 algin industries and a few LSF industries situated at different places in the maritime states of Tamil Nadu, Karnataka, Andhra Pradesh and Gujarat. The red algae *Gelidiella acerosa*, *Gracilaria edulis*, *G. crassa*, *G. foliifera* and *G. verrucosa* are used for agar manufacture and brown algae *Sargassum* spp., *Turbinaria* spp. and *Cystoseira trinodis* for the production of alginates and liquid seaweed fertilizer. The quantity of seaweeds exploited is inadequate to meet the raw material requirement of Indian seaweed industries. Seaweeds such as *Gracilaria edulis*, *Hypnea musciformis*, *Kappaphycus alvarezii*, *Enteromorpha flexuosa* and *Acanthophora spicifera* can be successfully cultivated in long-line ropes and nets by vegetative propagation method. This activity has a potential to provide income and employment to about 2,00,000 families¹⁹. With a good amount of carbohydrates, magnesium and potassium, the seaweed serves as natural manure for agricultural lands. The seaweed, which has medicinal properties, was being used in the preparation of materials, namely gels, lipsticks and ice creams. A company in Tamil Nadu was the first in the country to enter commercial seaweed cultivation employing more than 600 fisherfolk in the restricted districts of Tamil Nadu and they cultivate at least 600-800 MT of seaweed per year. Apart from producing carrageenan, which is a binding, food thickening and gelling agent sold to the food industry, the cultivated seaweed is also used to produce bio stimulants which can improve crop yield by 20 percent.

¹⁶Oza and Zaidi, 2001

¹⁷Chennubhotla, 1992

¹⁸Devaraj et al., 1999

¹⁹Guidelines for Seaweed Cultivation, National Fisheries Development Board

The distribution of marine algae in the littoral zone of the entire Karnataka coast has been studied in detail. A total of 78 species of seaweeds belonging to 52 genera and 28 families²⁰ have been observed along the Karnataka coast. The intertidal rocks in the St. Mary's Islands and Mugali rocky beach have registered a fairly good flora of brown seaweeds dominated by *Sargassum ilicifolium*, having economic importance for extracting algin. Occurrence of red seaweed, *Gracilaria corticata* and green seaweed, *Chaetomorpha antennina* (Bory) Kützinger in Surathkal beach of coastal Karnataka indicates the possibility of its farming in the estuary. In Karwar Bay, a total of 32 species of seaweeds have been recorded (Chlorophyceae, brown algae and red algae)

Seaweed gathering is traditionally carried out by women in the coastal regions. Seaweed gathering being a seasonal activity provides additional income to the coastal communities. The harvested seaweeds are dried and supplied to industries for production of Phycocolloids such as agar, alginates and carrageenan. Agar yielding red seaweeds such as *Gelidiella acerosa* and *Gracilaria* sp. are collected throughout the year while algin yielding brown algae such as *Sargassum* and *Turbinaria* are collected seasonally from August to January. Unlike Southeast Asian countries, Indian seaweed industries rely heavily on wild harvests for phycocolloid production. *Gelidiella acerosa* and *Gracilaria edulis* are harvested for agar production, while *Sargassum* spp. and *Turbinaria* spp. are the source material for alginate production. These resources have a great potential for the development of seaweed-based industries in India.

However, site-specific research, phase wise planned development, pilot demonstration projects along with robust Environmental and Social Impact Assessment studies is extremely essential before promoting sea-weed cultivation. Native species of seaweeds should preferably be chosen as a precautionary principle so as to not aggravate problems like invasive species, competition to local marine flora and fauna. Moreover, if many would opt for this kind of farming without proper planning and controls, a lot of nearshore areas would be in a big danger of privatization of coastal commons (ocean grabbing), unsustainability and large amount of marginalization of local communities.

1.6.1 Constraints for growth in seaweed cultivation in India

Although the seaweed cultivation presents several opportunities such as carbon sequestration, provision of nursery grounds for fish and shellfish, medium for pollution abatement and diversified uses as animal feed and fertilizers etc., the Indian seaweed industry suffers from lack of commercial cultivation practices, infrastructure and absence of policy support. Since, seaweed is not an important aspect of the Indian diet, its cultivation remains a low priority area. Multiple and conflicting uses of coastal areas, grazing by fish and illegal exploitation of seaweeds are some of the foreseeable threats to the sector.

1.6.2 Scenario of Seaweeds Cultivation in Karnataka

Unlike in the coasts of Tamil Nadu and Gujarat, seaweed farming is not being adopted in Karnataka, though the State's coastline is suitable for it. There is a lack of awareness on benefits of seaweed cultivation among fisher folk and presently it is not a part of their life since for ages they have relied on fish yield. With the decrease in fish catch every successive year in the coastal region, the fishermen can diversify to seaweed farming for earning extra income. The Prime Minister of India, during his visit to coastal Karnataka suggested that fishermen and self-help group members could take up seaweed cultivation since it has major pharmaceutical applications and nutrient values and will fetch good income for women and fishermen. As an attempt to make serious inroads in the sector, CMFRI, Mangaluru demonstrated the method

²⁰P. Kaladharan et.al, Coastal and Marine floral biodiversity along the Karnataka coast, Journal of the Marine Biological Association of India (2011)

of culturing seaweeds to the coastal community of Alvekodi village of Udupi district, Karnataka, south west coast of India in March 2018. The demonstration program was carried out as a part of the “Climate Smart Village (CSV)” program under the National Innovations on Climate Resilient Agriculture (NICRA) project with a key objective to create awareness to the coastal community on alternate livelihood options. A demonstration Seaweed project was also implemented by Shri Kshethra Dharmasthala Rural Development Project (SKDRDP), Dharmasthala, Karnataka & AquaAgri, Manamadurai, Tamil Nadu, in Uttara Kannada District.

The National Fisheries Development Board (NDFB) has set guidelines for seaweed cultivation and has laid out components of assistance to support seaweed cultivation which includes assistance for training and demonstration as well as establishment of seaweed processing units.

However, lack of awareness and absence of local market demand are some of the reasons the coastal districts have not ventured into seaweed farming. Hence, creation of demand will automatically prompt fishermen to take up seaweed farming in the coastal states of Karnataka.

Hence, considering the great demand for these resources in the international market, availability of adequate manpower and interest in the country, seaweed cultivation has a very good prospect in coastal Karnataka. Hence, it can be developed as a successful cottage or co-operative sector industry. Implementing ocean seaweed farming in the state will also provide a sustainable source of income for coastal communities provided native species are chosen, potential locations are selected as per the Marine Spatial Plan (MSP) and robust preliminary and ongoing ESIA studies are carried out. Moreover, it has to be taken up in a planned and phased-wise approach to avoid the dangers of privatization of coastal commons (ocean grabbing) and marginalization of local communities. The recommendations for sustainable seaweed cultivation are provided in the **Summary Outline Blue Economy Development Plan**.

1.7 Medicinal Plants and Seaweeds

Mangroves are a source of bioactive compounds that have profound medicinal, therapeutic and health benefits to humans and livestock. Historically, in Karnataka, many mangrove plants have been used as medicinal plants and are recognized as a repository of unusual biochemicals on account of their modified physiology to survive in stressful conditions of the intertidal zone. These include chemicals with insecticidal and bactericidal properties. There are novel agrochemicals, gums and glues, alkaloids, saponins, phenolics, steroids, terpenoids, amino acids, carbohydrates, proteins, fatty acids, alkaloids, carotenoids, rare mineral combinations. Nevertheless, unlike terrestrial plants, the species diversity and richness of marine plants and the equally unique and diverse bioactive compounds they harbor are relatively underexplored. Renewed discoveries therefore could lead to exciting innovative fields which could stimulate afforestation, conservation and protection of mangrove vegetation. A list of mangrove medicinal plants of Uttara Kannada is provided in Table 1.8.

Sl. No	Name of the species	Family	Part used	Uses
1	<i>Acanthus ilicifolius</i> L.	Acanthaceae	Leaves	Asthma, Diabetes, Rheumatism
2	<i>Avicennia alba</i> Blume	Acanthaceae	Leaves	Rheumatism, smallpox, ulcers
3	<i>Avicennia marina</i> (Forssk.) Vierh	Acanthaceae	Leaves	Joints and Ulcers
4	<i>Lumnitzera racemosa</i> (Willd)	Combretaceae	Leaves	Snake-bite, Asthma
5	<i>Excoecaria agallocha</i> L.	Euphorbiaceae	Latex	Paralysis
6	<i>Acrostichum aureum</i> L.	Pteridaceae	Leaf juice	Wounds and boils
7	<i>Ceriops tagal</i> (Perr) C.B.Rob	Rhizophoraceae	Leaf juice	Malaria
8	<i>Rhizophora mucronata</i> Lam.	Rhizophoraceae	Whole plant	Diarrhoea & vomiting
9	<i>Sesuvium portulacastrum</i> (L.) L	Aizoaceae	Whole Plant	High blood pressure
10	<i>Ipomoea pes-caprae</i> (L) R. Br	Convolvulaceae	Leaves	Swelling of body parts
11	<i>Clerodendron inerme</i> (L.) Gaertn.	Verbenaceae	Leaves	Malaria & Jaundice

Table 1. 8: Mangrove medicinal plants of Uttara Kannada (Karnataka)

Marine pharmacology has been studied extensively in the past all over the world as well as in India, but still there is a need to study the potential of the oceans as a source for the development of new drugs, considering the advantage of their abundance in nature and large-scale production.

The potential of Indian marine habitat has remained largely unexplored for their potential of new drugs and biotechnological programs. Some of the selected institutes such as NIO, Goa; Central Drug Research Institute (CDRI), Lucknow; Bose Institute, Kolkata; CIFE, Mumbai; RRL, Bhubaneswar are presently working for exploration of life saving drugs from marine sources.

Seaweeds are also one of the most important living resources of the ocean. In spite of their wide applications in food and feed industries, they have gained importance as medicinal sources because of their high healing, antimicrobial and antioxidative properties. The “folk medicine” in coastal zones made extensive use of a variety of seaweed species. Knowledge of the tonic and healing powers of seaweed was passed down among coastal peoples from generation to generation because the mineral content of sea vegetables is extraordinary, and is seen as the root of most of their healing properties. With advances in medicine today, the reasons behind the success of some of these treatments are being elucidated, because we now understand more of the nutritional and biochemical properties of different seaweeds or algae.

Marine algae are also a rich natural resource of many biologically active compounds such as polyunsaturated fatty acids (PUFAs), sterols, proteins, polysaccharides, antioxidants, and pigments. They contain more than 60 trace elements in a concentration much higher than in terrestrial plants. They also contain protein, iodine, bromine, vitamins, and substances of stimulatory and antibiotic nature. Many marine organisms live in complex habitats exposed to extreme conditions and, in adapting to new environmental surroundings, they produce a wide variety of secondary metabolites which cannot be found in other organisms. Numerous marine bioactive molecules have been identified, whose biological activities could interfere with the pathogenesis of many diseases²¹.

Seaweeds rich in iodine such as *Asparagopsis taxiformis* and *Sarconema* sp. can also be used for controlling goiter disease caused by enlargement of thyroid gland. Indian marine algae have all the essential amino acids needed in the human diet which are not available in other vegetable food materials. Seaweeds yield the most important products such as agar-agar and algin. They are colloidal carbohydrates present in the cell walls of these algae. From the literature, it is observed that the edible seaweeds contain a significant amount of the protein, vitamins and minerals essential for the human nutrition (Fayaz et al., 2005). Seaweeds were the source of about 35 percent of newly discovered chemicals followed by sponges (27 percent) and cnidarians (22 percent) between 1977 and 1987 (Smit, 2004). Currently, Carraguard, a non-spermicidal microbicide containing carrageenan, a red seaweed derivative has been clinically tested to be a promising product capable of blocking the transmission of HIV/AIDS (Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome). Regular consumption of dietary seaweed in Japan and Korea is attributed to low prevalence rates of HIV/AIDS and low risks of various cancers (Teas, 2005). However, demand for phycocolloids is expected to increase by 8-10 percent every year (Dhargalkar and Verlecar, 2009), a much higher demand for seaweed natural products should be expected from the rapid development of novel applications in the phyco-supplement industry culture, and utilization as food²².

1.7.1 Conclusion and Recommendations

Various species of seaweeds and mangroves are a futuristically promising source of medicinal drugs and increased research is a crucial part for their application of curing various types of diseases. The seaweeds also contain important proteins, lipids, minerals, polysaccharides, enzymes and vitamins so it can be used as a food source in the future.

Mangroves and Marine algae biodiversity need systematic study to explore the presence of different bioactive compounds that can be easily extracted with solvents and can be used for development of drugs in the pharmaceutical industries. These need to be further characterized and evaluated for their bioavailability. By proposing Marine Biotech Parks in Mangaluru and Karwar, the state is paving way for further research on these lines and utilizing the medicinal properties these aquatic plants and seaweeds provide.

1.8 Energy Plantation in The Salinity Intruded Areas Unfit for Agriculture

The increasing extent of primary salinization due to climate change and secondary salinization caused by human interventions has become an emergent problem. Salinization of both the terrestrial and aquatic environment is a significant global problem, increasing in the last few decades. Overexploitation and mismanagement have increased the potential of saltwater intrusion, negatively affecting the agricultural yield of coastal crops and plantations

²¹Wang H, Fu Z and Han C: The potential applications of marine bioactive against diabetes and obesity. *American Journal of Marine Science* 2014; 2(1): 1-8.

²²Piyusha Suresh Shelar et. al., *Continental J. Pharmacology and Toxicology Research* 5 (2): 1 - 22, 2012

through the accumulation of salts causing adverse effects on soils and plants.

In many coastal agricultural areas where only marginal quality water is available and where soil conditions are negatively affected by salinity, farmers are still able to grow crops profitably by changing to more salt-tolerant crops²³. Often the crop adaptation is accompanied by nutrients augmentation (in fertilizers) and soil quality improvement (e.g., adding gypsum, sulphuric acid and iron pyrite to reduce the negative effects of soil sodicity). Another potential solution would be to use salinity intruded areas for culture of microalgal biomasses as potential feedstock for biofuel production.

The growing demand of conventional fuels and its limited reservoir has ignited the attention of scientific communities to produce alternative fuels including biofuels from renewable sources. The use of biomass-based bioenergy or biofuel is gaining public attention due to their environment friendly aspects. Earlier biofuel was produced from food and non-food crops which ultimately put pressure on the limited land resources. To circumvent such negative impacts, scientific communities have explored the use of microalgae for the production of biofuels. The characteristics and benefits of microalgae-based biofuel are described below:

1. Microalgae can produce high oil (more than 300 times) than other existing resources such as terrestrial plants.
2. Microalgae do not require cultivable land and fresh water for cultivation and are not edible as well. Therefore, no effect is expected on human and animal food chains.
3. Microalgae can be grown to several folds irrespective of seasonal conditions
4. Non-cultivable soil such as salinity intruded areas and waste water can be used for the cultivation of microalgae. This renders the process more efficient from a cost perspective and doesn't affect the agricultural land resource and drinking water balance in the environment
5. Production of microalgae-based biofuel has been shown to be a carbon neutral process because the carbon generated in the fuel combustion is almost neutralized by the carbon consumption during micro-algal growth.

In one study, the salinity stress induced physiological and biochemical changes in microalgae *Scenedesmus* sp. CCNM 1077 was studied. A significant improvement in lipid content, carbohydrate content along with higher biomass was noticed²⁴.

In another study²⁵, the salinity induced growth response and total lipid content of a native strain of oleaginous freshwater microalga *Ankistrodesmus falcatus* was studied and a significant salinity induced growth and lipid content was observed leading to an overall improvement in calorific value. The native *Ankistrodesmus falcatus* strain could be a potent renewable biomass feedstock of biofuels.

Water resources in many parts of India are limited. Therefore, in order to be

²³Weert et. al., 2009; NIH, 2014b

²⁴Pancha, Imran & Chokshi, Kaumeel& Maurya, Rahul& Kumar& Trivedi, Khanjan& Patidar, Shailesh & Ghosh, Arup & Mishra, Sandhya. (2015). Salinity induced oxidative stress enhanced biofuel production potential of microalgae *Scenedesmus* sp. CCNM 1077. *Bioresource Technology*. 189. 341-348. 10.1016/j.biortech.2015.04.017.

²⁵Talukdar, Jayanta & Kalita, Mohan & Goswami, Bhabesh. (2012). Effects of Salinity on Growth and Total Lipid Content of the Biofuel Potential Microalga *Ankistrodesmus falcatus* (Corda) Ralfs. *International Journal of Scientific & Engineering Research*. 3. 1-7.

sustainable, the algae biofuels technology should not put additional demand on freshwater supplies and low-quality water such as brackish/saline groundwater should be used. Sustainable algae production also implies that the farming facilities would not be located on valuable fertile agricultural lands but on wastelands. These lands include degraded cropland and pasture/grazing land, industrial/mining wastelands and salinity intruded areas. It is estimated that the extent of these lands in the country is about 55.27 million ha (approximately 18 percent of the total land area). If India dedicates only 10 percent (5.5 million ha) of its wasteland to algae production, it could yield between 22–55 MT of algal oil which would displace 45 percent–100 percent of current diesel consumption and would consume about 169–423 MT of CO₂ would offset 26 percent–67 percent of the current emissions. Using these areas provides a cost-effective solution to water, land, and nutrients considerations that would cover nearly all costs.

1.8.1 Salinity intruded areas in Karnataka

Total annual rainfall in the coastal areas varies from 3000 to 5000 mm, resulting in heavy floods during monsoon. Flood waters in the rivers of the coastal area discharge in the Arabian Sea. Though there is abundant flow during monsoon, there is shortage of water for drinking and other purposes during summer. In summer season, when there is lean flow in these rivers, sea water enters the river course (up to 5 to 15 km upstream) during high tide and mixes with freshwater enhancing the salinity and making it unfit for agricultural and drinking purposes. Further this saline water encroaches upon the habited lands and adjoining agricultural lands rendering them unfit for agriculture. If water is drawn from open or borewells adjoining the river channels, the saline water movement is induced into the subsurface that affects groundwater quality. Groundwater extracted from such open and bore wells cannot be used for meeting the drinking water needs, resulting in acute shortage of drinking water supply. Vegetation in the area also gets affected/ degraded due to soil and water salinity. The soil becomes more and more saline ('Khar land') from October onwards. Coastal land inundation is at its peak in January and February due to high tidal waves. As a result, rabi crops are raised only in the upper reaches of coastal tracts which do not get submerged but possess sufficient residual moisture content for crop growth. With the onset of the monsoon, the salts get diluted and are washed back into the sea²⁶. Table 1.9 below, lists the salt affected areas in the Dakshina Kannada and Udupi districts which can be taken up for production of biofuels from microalgae biomasses. Figure 1.17 shows the salt affected areas in coastal districts of Karnataka

Sl. No.	Zone/river basin	Affected coastal Zone	Remarks
1	Netravati River Basin	Up to 10 km from sea	Dakshina Kannada
2	Gurupura River Basin	Up to 10 km from sea	Dakshina Kannada
3	Nandini River Basin	Up to 4 km from sea	Dakshina Kannada
4	Shambhavi River Basin	Up to 5 km from sea	Dakshina Kannada
5	Sankadagundi River Basin	Up to 4 km from sea	Udupi
6	Yedamavina River Basin	Up to 5 km from sea	Udupi

²⁶Report on Problems of Salination of Land in Coastal Areas of India and Suitable Protection Measures Hydrological Studies Organization Central Water Commission New Delhi July, 2017

7	Byndoor River Basin	Up to 6 km from sea	Udupi
8	Varahi River Basin	Up to 8 km from sea	Udupi
9	Chakra River Basin	Up to 6 km from sea	Udupi
10	Kolluru River Basin	Up to 5 km from sea	Udupi
11	Seetha River Basin	Up to 8 km from sea	Udupi
12	Swarna River Basin	Up to 7 km from sea	Udupi
13	Udyavara River Basin	Up to 9 km from sea	Udupi
14	Madisalu River Basin	Up to 5 km from sea	Udupi
15	Shambhavi River Basin	Up to 6 km from sea	Udupi
16	Pangala River Basin	Up to 4 km from sea	Udupi

Table 1. 9: Salt affected areas in the Dakshina Kannada and Udupi districts.

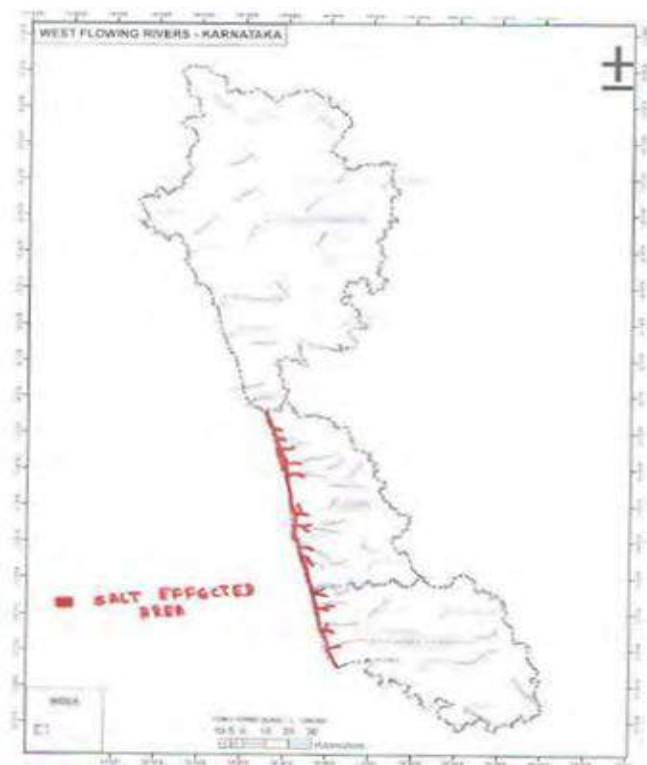


Figure 1. 17: Salt affected areas in coastal districts of Karnataka

1.9 Using Ocean Surfaces for Submerged Food Production Systems

Growing land-based food to meet the demand of a growing population requires huge cultivable lands that are water intensive and also use high amounts of fertilizers that ultimately pollutes oceans due to agricultural runoffs. This increase in the nutrient load in waters give rise to harmful algal blooms and cause hypoxic conditions for fishes that threatens their survival and also destroys other marine flora such as sea grasses by blocking the passage of sunlight through the waters. Additionally, the fisheries sector also contributes significantly to

global food security, livelihoods and the economy. However, unsustainable fishing practices over the years have led to overfishing and reduced fish stocks impairing the functioning of ecosystems and reduced biodiversity with negative repercussions for sustainable, social and economic development.

Owing to these constraints, an innovative approach for sustainably growing food would be to utilize ocean surfaces and their submerged portions for food production also known as Vertical Ocean farming systems. The most successful model of ocean surface farming implemented is a 3D ocean farm, located in the Long Island Sound, which is basically a vertical underwater garden wherein Kelp (seaweed) and mussels grow on ropes floating above the oyster and clam cages located at the bottom of the sea. This simple setup is capable of truly impressive yields. By using the entire food column, the farm has the capacity to grow 20 MT of sea vegetables and 500,000 shellfish per acre every year. 3D farming requires no pesticides, fertilizers or freshwater, making it the most sustainable form of food production. The harvested kelp is full of nutrients as it contains more protein and iron than red meat and more calcium than milk. Other significant benefits are that these submerged food production systems also help clean up the waters in the ocean by uptake of nutrients such as nitrogen and phosphorus from untreated sewage discharges and agricultural runoffs and protects the oceans from turning more acidic. It is estimated that the kelp species of seaweed produced in these systems absorbs five times more carbon than land-based plants, and the crops do not require any fertilizers, freshwater, antibiotics or pesticides. Rather than conventional and vulnerable monocultures, this approach creates resilient, biodiverse ecosystems using the entire water column from sea-bed to the surface. The harvested seaweeds can serve as food, organic fertilizer, fish feed, animal feed as well as to generate biofuels. Implementing this farming technology gives an opportunity to grow food the right way, clean up ocean waters, provide livelihood prospects to coastal communities, restore ecosystems and feed the planet.

The overview of ocean surface and submerged food production systems is depicted in Figure 1.18 which shows the components of polyculture vertical farming systems.

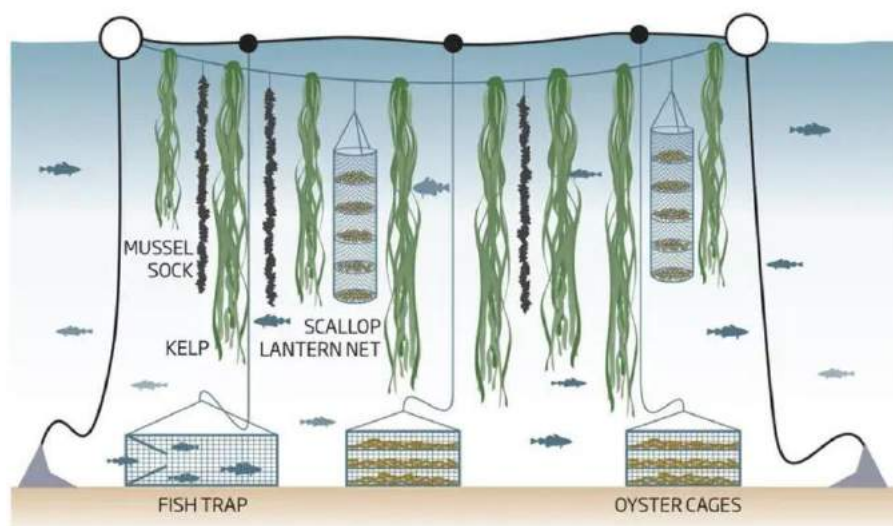


Figure 1. 18: Overview of Ocean surface and submerged food production systems
Polyculture vertical farming systems

Aquaculture production of several species of mussels in sheltered marine waters is also well established and occurs in many countries worldwide. The primary method of production of high-quality mussels is suspension of ropes with attached mussels from floating rafts or surface long lines that are anchored to the seafloor. While demand for fresh, frozen,

and canned mussel products continues to increase, growth in production is hampered by a lack of suitable space for expansion in sheltered waters. For more than a decade, there has been interest in developing production methods suitable for open ocean environments where wind and wave conditions preclude the use of either rafts or surface long lines. Recent advances in the use of long lines that can be submerged below the sea surface and therefore avoid the upper portion of the water column that is most affected by wave energy indicate that open ocean production is feasible.

1.9.1 Conclusion and Recommendations

The concept of using ocean surfaces and their submerged portions for integrated cultivation of seaweeds, mussels, oysters, clams etc. are at present novel to the state. With the seaweed cultivation on ocean surfaces that has just taken a kick start, the awareness on integrated submerged food production systems will further ensure optimum utilization of the entire water column from sea-bed to the surface and also further create livelihood opportunities for the coastal communities. It is assessed that places that do not see much sea wave action and where the salinity level is constant are best suited for seaweed cultivation. However, recent advances in the use of long lines that can be submerged below the sea surface and therefore avoid the upper portion of the water column that is most affected by wave energy can make open ocean submerged integrated food production systems feasible in the state.

However, site-specific research and development, pilot demonstration projects along with robust preliminary and ongoing Environmental and Social Impact Assessment studies is extremely essential before promoting submerged food production systems. Unlike the United States we do not have a kelp forest system and most of our clams do not grow in deep sea water hence it is important to utilize only native species of seaweeds, clams, oysters, mussels etc. as a precautionary principle so as to not aggravate problems like invasive species, competition to local marine flora and fauna. Moreover, if many would opt for this kind of farming, a lot of near shore areas would be occupied resulting in a big danger of privatization of coastal commons (ocean grabbing), unsustainability and large amount of marginalization of local communities.

Hence, in the upcoming years, the government can promote submerged food production systems in the State's coastal region in association with self-help groups or non-government organizations by providing adequate training. This will create jobs, livelihood opportunities and income generation in coastal communities. We can therefore conclude that the potential for increased food production from the sea is vast, provided that it remains within environmentally sustainable boundaries.

1.10 Development of Pharmaceutical Products based on Seaweeds, Sea Grasses and Aquatic Animals and Other Life Forms

Marine bio-resources and their products are used extensively for industrial applications, drug development, agriculture, fisheries, biofuel, oil spills, tissue and dental applications. Marine Biotechnology/Blue biotechnology is defined as the application of science and technology to living organisms from marine resources, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services." Marine Biotechnology is one of the fastest emerging sectors in the Blue Economy. It has wide-ranging applications in industrial sectors including pharmaceuticals, cosmetics, nutritional supplements, molecular probes, enzymes, fine chemicals and agrichemicals. Some of the marine biotechnology products include biopolymers used in wound dressing, bio-adhesives, dental biomaterials, tissue regeneration and as 3D tissue culture scaffolds. Among various sub-sectors of marine biotechnology, the bio-pharmaceutical sector is expanding globally.

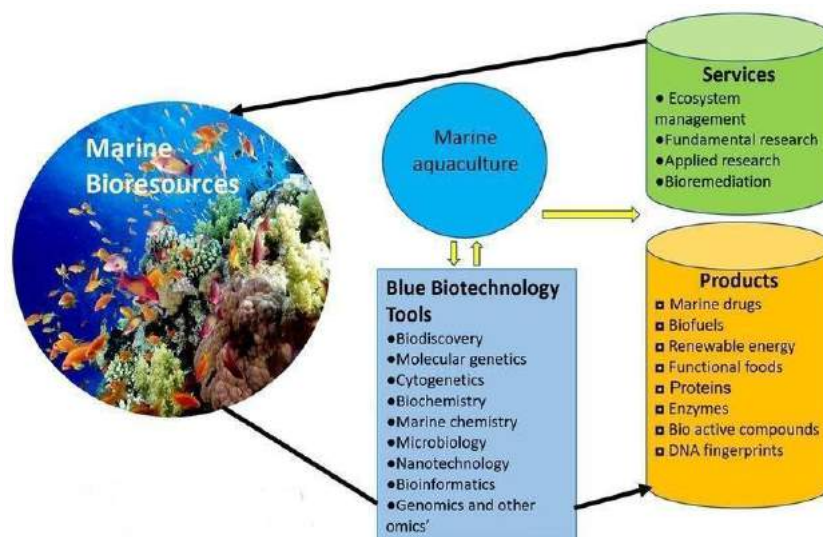


Figure 1. 19: Overview of Marine Biotechnology

In recent years pharmaceutical firms have started looking towards marine organisms, including seaweeds, in their search for new drugs from natural products. Global utilization of macroalgae is a multi-billion-dollar industry. Much of this is based on farming of edible species or on the production of agar, carrageenan and alginate. Of all seaweed products, hydrocolloids have had the biggest influence on modern western societies. They have attained commercial significance through their use in various industries which exploit their physical properties such as gelling, water-retention and their ability to emulsify²⁷. Little commercial exploitation of products extracted from seaweeds occurs outside the hydrocolloid industry. However, seaweed-derived bioactive materials and extracts have been shown to possess a wide spectrum of biological actions, including antioxidant, anti-inflammatory, antiviral, anticancer, antihypertensive, fat-lowering, and neuroprotective activities. Hence, seaweeds have gained much importance in pharmaceutical product development due to their rich bioactive compounds including polysaccharides, pigments, phlorotannin's, peptides, minerals and vitamins. Intensive efforts are still being made to isolate and identify new bioactive ingredients derived from seaweeds with potential medicinal, health, or pharmaceutical activities. Substances that currently receive most attention for use in drug development or medicine-related research include sulphated polysaccharides as antiviral substances, halogenated furanones from *Delisea pulchra* as antifouling compounds, and kahalalide F from a species of *Bryopsis* as a possible treatment of lung cancer, tumors etc.

Sponge is used to prepare drugs for diseases like cancer, inflammation, viral infections, malaria and cardiovascular issues; coral for inflammation and wounds; marine fishes for inflammation, cancer, neo-vascular diseases and hypertriglyceridemia, among others. There are certain drugs available in the market for specific critical diseases that are manufactured using marine bio-resources and these drugs as shown in Table 1.10 below.

²⁷Renn, 1997

Product	Source	Disease
Cephalosporins	<i>Cephalosporium</i> sp., marine fungi	Antibiotic
Ara-C	Marine Sponge	Cancer
Yondelis	Sea Squirt	Cancer
Dolastatin	Sea slug	Cancer
Bryostatin-1	Bryozone	Cancer
Squalamine Lactate	Shark	Cancer
PL512602 (steroid)	Sponge	Inflammation, Asthma
Manoalide	Marine sponge	Molecular Probe
Ara-A	Marine sponge	Viral

Table 1. 10: Select marine pharmaceutical products, their sources and use
(Source: Thakur and Thakur (2006))

Blue biotechnology is the search for potentially useful genetic resources from fungi, bacteria, and other microorganisms found in marine habitats. Blue biotechnology is commercially sensitive for which detailed micro-level information is mostly reserved with companies, public research centers, patent databases etc. Marine biotechnology offers ample business opportunities to the Small and mid-size enterprises (SMEs) and large business conglomerates in various fields of activities. At the same time, the sector faces several challenges including regulatory ones which are vital for the healthy growth of the sector.

A total of 78 species of seaweeds have been observed along the Karnataka coast belonging to 52 genera and 28 families by Kaladharan et al. (2011). Table 1.11 provides the distribution of green, brown, red and blue green algae along the Karnataka coast.

Taxonomic groups	Chlorophyceae	Phaeophyceae	Rhodophyceae	Cyanophyceae	Total
Order	3	7	7	1	18
Families	9	6	12	1	28
Genera	14	14	22	2	52
Species	26	21	29	2	78

Source: P. Kaladharan, P. U. Zacharia and K. Vijayakumaran. 2011. Coastal and marine floral biodiversity along the Karnataka coast J. Mar. Biol. Ass. India, 53 (1): 121 – 129.

Table 1. 11: Distribution of Algae along the Karnataka coast

Sea grasses are considered one of the most important coastal habitats, as they support a wide range of ecologically important marine species from different trophic levels. They are marine-flowering plants that thrive fully submerged in shallow oceanic and estuarine habitats, colonizing soft substrates, especially in wave-sheltered conditions. Estimates of global seagrass spatial distribution differ greatly throughout the published literature, ranging from 1,77,000 to 6,00,000 sq. km.

In India, the total seagrass cover is estimated to be 517 sq. km with 14 reported species. The overall distribution of seagrass meadows in India occurs from the intertidal zone

to a maximum depth of 15 m with varying species diversity. Recent estimates suggest that 471.25 sq. km of seagrass meadows are distributed along the mainland coast of India, the Andaman and Nicobar Islands (Ganguly et al., 2017) and the Lakshadweep. Of the 72 globally existing species of seagrass descending from four evolutionary lineages (Short et al., 2011), 14 species belonging to six genera are known to occur in peninsular India and the archipelagos (Ganguly et al., 2017).

Sea grasses are severely impacted by anthropogenic activities and its effects. Dredging directly removes seagrass plants and results in lower light levels due to increased amounts of sediments in the water. Nutrients from fertilizers and pollution that wash off into the water cause algal blooms that block sunlight. Sediments washing into the water from agriculture and land development damage seagrass beds by both smothering them and by blocking sunlight. Removal of fish leads to seagrass death by disrupting important components of the food web.

The potential of Indian marine habitat has remained largely unexplored for their potential for new drugs and biotechnological programs. Some of the institutes such as NIO, Goa; Central Drug Research Institute, Lucknow; Bose Institute, Kolkata; CIFE, Mumbai; RRL, Bhubaneswar and Council for Scientific and Industrial Research are presently working for exploration of life saving drugs from marine sources.

Marine pharmacology has been studied extensively in the past all over the world as well as in India, but still there is a need to study the potential of the oceans as a source for the development of new drugs, considering the advantage of their abundance in nature.

The list of the various marine flora and fauna that are explored for pharmaceutical purposes are provided in Table 1.12 below showing the status of clinical trials that they are in, the marine organisms from which the compounds have been extracted and the area of diseases they can be used for.

Clinical Status	Compound Name	Marine Organism	Chemical Class	Disease Area
Approved	Cytarabine, ara-C	Sponge	Nucleoside	Cancer, leukemia
	Brentuximab vedotin (SGN-35)	Mollusk/cyanobacterium	ADC (MMAE)	Cancer, lymphoma
	Vidarabine, ara-A	Sponge	Nucleoside	Anti-viral
	Omega-3-acid ethyl esters	Fish	Omega-3 fatty acid	Hypertriglyceridemia
	Ziconotide	Cone snail	Peptide	Pain
	Eribulin mesylate (E7389)	Sponge	Macrolide	Breast cancer
	Trabectedin (ET-743)	Tunicate	Alkaloid	Cancer
Phase III	Plitidepsin	Tunicate	Depsipeptide	Cancer
	Tetrodotoxin	Pufferfish	Guanidinium alkaloid	Chronic pain
	Soblidotin (TZT 1027)	Bacterium	Peptide	Cancer

Phase II	DMXBA (GTS-21)	Worm	Alkaloid	Cognition, Alzheimers, schizophrenia
	Plinabulin (NPI-2358)	Fungus	Diketopiperazine	Cancer
	Glembatumumab Vedotin	Mollusk/cyanobacterium	ADC (MMAE)	Breast cancer, melanoma
	Elisidepsin	Mollusk	Depsipeptide	Cancer
	PM1004	Nudibranch	Alkaloid	Cancer
	Tasidotin, synthadotin (ILX-651)	Bacterium	Peptide	Cancer
	Pseudopterosins	Soft coral	Diterpene glycoside	Wound healing
Phase I	Bryostatin 1	Bryozoa	Polyketide	Cancer
	Pinatuzumab vedotin	Mollusk/cyanobacterium	ADC (MMAE)	Non-Hodgkin lymphoma,
	(DCDT-2980S) and (DCDS-4501A)			Chronic lymphocytic leukemia
	Hemiasterlin (E7974)	Sponge	Tripeptide	Cancer
	HuMax®-TF-ADC	Mollusk/cyanobacterium	ADC (MMAE)	Cancer of ovary, endometrium, cervix, prostate
	Marizomib (salinosporamide A)	Bacterium	Beta-lactone-gamma lactam	Cancer
Preclinical	Chrysophaentin A	Alga <i>Halobacillus alinus</i>	Shikimate	Bacterial infections
	Phenethylamine	Bacterium lyngbyoic acid	Shikimate	Bacterial infections
	Geodisterol sulfates	Sponge	Peptide	Fungal infections
	<i>Pseudoalteromonas</i> Sp. metabolites	Bacteria	Polyketide	Bacterial infections
	<i>Peziza vesiculosa</i> -carboline	Bryozoa	Alkaloid	Fungal infections
	Bromophycolides	Alga	Terpene	Malaria
	Plakortin	Sponge	Polyketide	Malaria

	Homogentisic acid	Sponge	Shikimate	Malaria
	Cladonia Cervicornis Diterpene	Alga	Terpene	Protozoal infections
	Hymenidin	Sponge	Alkaloid	Tuberculosis
	Ggyrosanols	Soft coral	Terpene	Viral infections
	Dysidine	Sponge	Terpene	Diabetes
	Arenamides A and B	Bacteria	Peptide	Inflammation
	Capnellene	Soft coral	Terpene	Inflammation
	Floridosides	Alga	Glycolipid	Inflammation
	Grassystatins A-C	Bacteria	Peptide	Immunity
	Callyspongidiol	Sponge	Polyketide	Immunity
	Calyculin A	Sponge	PKS/NRPS	Nervous system
	Pulicatin A	Bacteria	Alkaloid	Nervous system
	Dysideamine	Sponge	Terpene	Nervous system

Table 1. 12: Marine organisms & their potential compounds of pharmaceutical importance

1.10.1 Status of Marine Biotechnology in Karnataka

Karnataka has emerged as a leading player in the biotechnology revolution of India. Today Karnataka is considered as the biotech hub of the country and is the preferred destination for biotech investment in the country. More than 60 percent of the biotech companies in the country have a base in Karnataka. The state is responsible for 50 percent of the total revenues being generated in the biotech sector in India.

The report commissioned by Department of Information Technology (IT), Biotechnology (BT) and Science and Technology (S&T), Government of Karnataka has proposed a Marine Biotech Park in Mangaluru and Karwar for promoting research in marine biotechnology areas such as structural and functional genomics, cultivation of seaweeds and bioprospecting from marine organisms (seaweeds and microbes) etc. The department has also been focusing on semi-intensive prawn culture, intensive carp culture, feed and seed production, disease diagnostics/vaccine development, bioactive compounds, transgenics, etc. The programs on semi-intensive prawn culture and intensive carp culture have demonstrated high production levels and could lead to process and product development for commercialization.

1.10.2 Conclusion and Recommendation

The Karnataka government is keen to establish the state as a competitive destination in the global biotech sector. The state currently has the largest biotechnology industry cluster in the country. The government is providing for various incentives in the production facilities through the Karnataka State Industrial policy. Moreover, the state has a strong resource base coupled with the advantage of having well-developed research capabilities such as vast talent pool, skilled manpower, infrastructure facilities, cost-effective manufacturing facilities and Special Economic Zone (SEZs) that are exclusively focused on development of the sector.

Currently, the state's marine organisms such as sea weeds, sea grasses and other aquatic life remain largely unexplored for their potential as new life saving drugs. The proposed Marine Biotech Parks in Mangaluru and Karwar which are situated in the coastal belt of the state will spur research and innovation in areas of drug discovery (new antibiotic and other natural entities) from marine organisms. Moreover, Karnataka has a strong pharmaceutical sector that exports around 40 percent of the pharma production taking place in the state. The presence of a large number of life sciences start-ups in the state that boosts innovation in the biotech sector are also an added advantage.

Another important aspect that requires much attention is the conservation of biodiversity in Karnataka's rivers, lakes, estuaries and the seas which are under great stress. Human threats to marine environments include overfishing, serious disturbance of the sea bottom habitats through trawling in the sea, global warming, introduction of alien species and pollution which have resulted in rapid decline in global marine biodiversity, as reflected in species extinctions, population depletions, and community homogenization. This loss is occurring at a time when pharmaceutical companies are focusing their attention on marine organisms as the greatest, and as yet little explored treasury of bioactive compounds on the earth. This biodiversity loss may result in changes in ecosystem function and a reduction in the provision of ecosystem services. In coastal areas, human impacts have depleted > 90 percent of formerly important species, destroyed > 65 percent of seagrass and wetland habitat, degraded water quality, and accelerated species invasions. Since so little is known of our marine organisms, it is entirely likely that there are on-going extinctions of biodiversity resources of much economic potential, of which we are quite unaware.

Conservation of the marine ecosystems will increase the potential exploration of pharmaceutical products based on available seaweeds and sea grasses and aquatic animals and other life forms.

1.11 Promotion of traditional practices-Gazanis

The coastal area in Uttara Kannada is prone to being washed by the sea when in spate and the saline water is pushed inland resulting in submergence of croplands. As a result, these lands, particularly the low-lying agriculture lands, become unfit for crop production. These coastal wetlands along the natural estuarine borders and river banks known traditionally in Karnataka as gazanis are used for cultivation of paddy variety unique to this region and shrimp cultivation. Rice and shrimp are alternatively cultivated. Gazanis offers ample scope for enhancing the livelihood of thousands of farm families and also contributes to the nutritional needs of people who opt for pigmented rice and organic shrimp in their diet.

Aghanashini estuary in Uttara Kannada district is surrounded to an extent of about 22.136 sq km of ghazni land or khar land. A salt tolerant variety of rice called 'Kagga', a variety rich in protein known for its flavor is cultivated in rotation with prawn culture. The rich mangrove vegetation of this estuary has a significant role in food supply for the diverse faunal life dependent on this estuary. The mangrove swamp acts as food rich and protective nurseries even for many species of marine fishes and prawns, which lay eggs in the swamp. The Biofloc and Recirculatory Aquaculture System of shrimp farming which is environmentally friendly, ecologically sustainable, economically profitable and socially acceptable is being practiced here.

Sustainable management of coastal wetlands and near-shore marine ecosystems also offer a wide range of co-benefits, including shoreline protection, nutrient cycling, water quality maintenance, flood control, habitat for birds, other wildlife and harvestable resources such as fish. Together, these increase the resilience of coupled ecological and social systems to the impacts of climate change. Moreover, the coastal wetlands of the state also play an important role in the ecology, economy and social well-being of the people. Hence, this integrated

farming system where saline tolerant paddy is cultivated along with integration of fishery offers an opportunity of climate resilient farming practice in the event of the change in climate scenario particularly in the recent decades.

Bund / embankment formation and plantation of mangrove and mangrove associates are taken up for maintenance of gazani farm lands which provide benefits such as protecting freshwater sources from seepage of saline water into it. The plantation of mangrove trees around the bund will improve soil conditions, protect biodiversity and bunds will act as a barrier against wave action and sudden sea surges and prevent coastal erosion. This system of rice–shrimp cultivation is of great importance for improved income in the context of climate change.

1.11.1 Social, Economic and Environmental benefits from Gazani farming

Kagga rice grown in the saltwater paddy fields of Aghanashini creek is pest-free and resilient to environmental stress besides having good nutritional quality, taste and adaptability. The social benefits from integrated rice and shrimp farming include improved quality of life for local farmers through higher disposable incomes and increasing job opportunities to agricultural laborers and fishermen. Given the high local demand for rice and shrimp (both local and international), the promotion of gazani farming would improve the disposable incomes of local farmers and ensure food security while also improving export and earning foreign exchange. Rice and shrimp farming reduce the cost of production of both rice and shrimp and give a dual crop from the same land at a time.

Encouraging this type of farming also protects local biodiversity through the use of local paddy varieties and indigenous fish/ shrimp varieties that improves soil quality leading to improved rice yields as well as fish production.

Since farming is practiced in an organic way (without the use of any inorganic fertilizers and pesticides), there is no adverse impact on the environment. Moreover, planting of mangroves on the outer boundary of the bunds (on the river side) protects the bunds and creates a favorable condition for increased biodiversity and for improvement of fishery wealth. Besides, the dead and decayed mangrove vegetation increases the overall fertility of the wetlands. Bunds with mangroves along the river side act as a barrier to wave action and sudden sea surges.

Revival of gazani farming would provide more employment opportunities to the local community especially women folk. Traditionally, in paddy farming, most of the activities like preparation of seed for sowing, sowing of sprouted seed, harvesting, winnowing and other post-harvest processing are mostly done by women as also the traditional shrimp filtration (sorting of shrimps and its packing). In addition, collection of shrimps in traditional ways like hand-picking of shrimps, aggregation and collection of shrimps in shallow waters are common in gazani wetlands which also give additional income to women. The fodder from gazani wetlands support cattle rearing of nearby areas, which also provides extra income mainly to women.

The Management of wetland offers the following benefits, in addition to other ecosystem services provided to the local community.

1. The straw and stubble retained in the rice field after paddy harvest can be profitably utilized for fish culture as they provide nutritious supplements for fin fish/prawn.
2. Integration of shrimp/fish in rice will not only improve rice yield and fertility status, but also check the pest and weed problems and avoid the use of pesticides, weedicides and inorganic fertilizers.

3. Rice/shrimp rotational practice will check the present undesirable trend of reclamation of wetland.
4. Utilization of rice fields for shrimp culture, especially during the flood season will help to reduce flood effects as it provides large surface area to accommodate flood waters.
5. Provides year-round livelihood to the farmers.
6. Supplementary stocking with selected high value species and other inputs increases the production, productivity and income so that farmers are motivated to take up both paddy and fish farming.

1.11.2 Recommendations to promote Gazani farming

The area under Kari Kagga farming has come down from about 3,000 acres to about 800 acres due to several constraints faced by farmers. Given the tremendous benefits from gazani farming, this traditional practice should be well promoted in the state for sustainable socio-economic development of the coastal communities. Some of the ways to promote gazani farming are as follows:

1. Funding towards Integrated rice and shrimp farming system (such as National Adaptation fund for Kerala for promoting Kaipad and Pokkali coastal wetlands of Kerala)
2. Timely supply of quality seeds is to be ensured since gazani farming is facing threat of extinction as farmers are complaining of shortage of seeds
3. The 12-km-long bund at Aghanashini estuary, built in 1973-74, is in a deplorable state. As many as 16 sluice gates have collapsed, resulting in flooding of the area and subsequent crop loss. Hence construction of strong bunds is the only preventive measure that could be taken to protect their crops from sudden flood due to unexpected climatic variations. Construction of bund and its maintenance is most expensive and limited in gazani farming system. Therefore, allocation of funds for construction of strong bunds with enough height to withstand the flood and high tides and more also implementing timely and regular maintenance of critical infrastructure is required to carry out farming in gazani lands. Hence, repair of bunds, sluice gates and scientific plantation of mangroves/mangrove associates is crucial.
4. Gazani farmers do not receive a very good price for their produce compared to other rice varieties in the market since the quality of this rice is not well known. This has demotivated farmers to pursue kagga rice farming and go for other varieties that will fetch better prices or take up other petty jobs. Hence, the Government has to create awareness on the benefits of this rice variety and ensure Minimum Support Price for kagga rice variety to promote all-inclusive growth and equity benefits to the local communities.
5. Capacity building on this eco-friendly and organic integrated rice and shrimp farming such that more youth and farmers/fishers are encouraged to practice and preserve this tradition since scarcity of laborers in wetlands is another bottleneck in culture activity.

Many farms which were operational have become non-operational and are in a state of disrepair. As per the farmers, poor market returns, commercial prawn cultivation and government apathy is fast wiping out this rice variety, though its cultivation is easy and requires little labor. The farms need to be brought back to the eco-friendly farming of paddy and shrimp.

Otherwise, these fields will remain fallow or underutilized and uneconomic. This will be harmful to the environment's stability. Hence the farmers are to be motivated for operating the farms by providing input assistance for the integrated paddy and shrimp farming.

Karnataka Biodiversity Board has recommended the Union Government for the grant of geographical indication (GI) tag to 2 varieties of paddy grown at ghazni kagga Paddy cultivation in Kumta Taluk. A change in the Government policy to protect indigenous rice varieties and their cultivars is the need of the hour without which the resilient rice variety, so uniquely suited to the ecosystem, may be lost forever. It is estimated that about 29,000 hectares of land may be affected due to sea level rise over the next few decades and in this context, conservation of salt tolerant landraces like kagga becomes important.

1.12 Aquaponics

Aquaponics is a fast-growing and more sustainable method of food production. It is the combination of intensive aquaculture and hydroponics. Aquaponics is the combination of raising fish (aquaculture) and growing plants without soil (hydroponics) in a controlled, integrated, natural system organically and sustainably.

This bio-integrated food production system helps in ensuring food security, quality and returns to investment. It provides people with clean healthy fresh organic food grown sustainably and there are examples of farms in Bengaluru where aquaponics method is used to grow crops and fish together in a recirculating system wherein fish naturally produce the nutrients that plants need to thrive. The fish generates waste which contains rich nutrients that the plants like and the plants take up all the nutrients in the water and leave fresh water back into the tanks for the fish. Hence, using only 5 percent of the water used in conventional farming. In this system the same resources such as water and nutrients from the fish waste get continuously recycled minimizing the use of water. This waste is then pumped through a filter to make it into ready food for plants. Aquaponics produces both fish and chemical free vegetables in a bio dynamic environment.²⁸

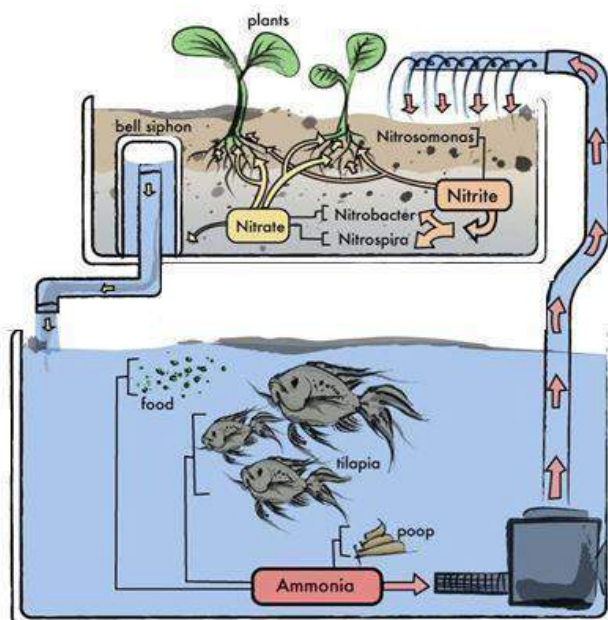


Figure 1. 20: Overview of Aquaponics system

²⁸<https://aquaponictrend.blogspot.com/2018/08/aquaponics-farm-in-karnataka.html>

As for the investment cost, it can range from as low as INR 1,000 to INR 2 lakh. This farming is used to practice terrace gardening to restaurants to schools. 40 types of vegetables can be grown in a tiny space in a vertical system.²⁹ The fish and plants work together in a system that produces 2 to 4 times the crop yield per acre and use 95 percent less water than traditional agriculture³⁰.

Aquaponics offers a nature-based innovative form of therapeutic horticulture, which can provide employment and promote well-being for communities. If implemented as a program to be managed by local communities, aquaponic systems also have the potential to address issues such as food security and food sovereignty, especially in urban areas. Increasing public familiarity with aquaponics has seen a number of social ventures being set up around the world. However, the viability of these depends not only on stakeholder commitment, thorough market analysis, clear governance structures, and a robust business plan but also on external factors, such as the local political context and regulations.

On account of being almost completely dependent on produce imported from other regions, urban consumers are particularly vulnerable to food insecurity. For those of low socio-economic status, this dependence means that any fluctuation in food prices translates into limited purchasing power, increased food insecurity, and compromised dietary options. Community-based aquaponics enterprises offer a new model for blending local agency with scientific innovation to deliver food sovereignty and food security, by re-engaging and giving communities more control over their food production and distribution (Laidlaw and Magee 2016). If implemented as a program to be managed by local people, Aquaponic systems have the potential to address food sovereignty. In turn, food security is boosted by consuming the fish, which is a significant source of protein, essential amino acids, and vitamins. Even when consumed in small quantities, fish can improve dietary quality by contributing essential amino acids, which are often missing or underrepresented in vegetable-based diets³¹.

1.12.1 Recommendations to promote Aquaponics in Karnataka

The urban and rural population who face land and water shortages and are still interested in growing their own food and being self-sufficient can be very-well encouraged to take up Aquaponics. Although there are several examples of entrepreneurs in Karnataka who have made serious inroads into this sector, there is still lack of awareness amongst populations in the state on the benefits of Aquaponics.

Increase in Capacity building and awareness creation in urban and rural areas will promote this eco-friendly, organic and sustainable horticulture that can help populations being self-sufficient in growing their own food, provide employment and promote well-being for communities.

1.13 Integrated fish farming and Polyculture

Integrated fish farming is a process of farming where you produce fish in combination with other farm products and livestock, centered around the fish farm. It is a type of polyculture wherein the system links each of the involved sub-systems in it, such as fish, crops, and livestock, in such a way that the waste or byproduct from one sub-system can be used as an input for the next system.

In the case of an indoor pond or aquarium-based fish farming, you could have a vertical

²⁹<https://www.thebetterindia.com/204078/aquaponic-method-farming-how-to-space-requirements-waste-organic-india/>

³⁰<https://eatneatproject.in/>

³¹S. Milliken and H. Stander, S. Goddek et al. (eds.), *Aquaponics Food Production Systems*,

aquaponic system for growing fish and plants at the same time. In a properly integrated fish, livestock and crop farming system, the waste, excretion and manure from animals can be used as feed for the plants and the leftover waste from plants can be used to feed animals. Excrement from fish and livestock is high in ammonia and nitrogen, which acts as a high-quality fertilizer for farmlands. Water and the bottom silt of fish ponds are also rich in nutrients and can be good sources of fertilizer for irrigating the crop land. Therefore, it is possible to integrate a variety of subsystems in a small area to produce a variety of products such as fish, meat, vegetables, fruits, eggs, fodder etc. resulting in lower production costs and wastage.

Fishermen from an ancient port town called Poompuhar in the Nagapattinam district of Tamil Nadu embraced integrated fish farming in the face of climate change. In 2004, the lives and livelihood of these fishermen was impacted by the tsunami. The MS Swaminathan Research Foundation (MSSRF) worked with local communities on rebuilding their lives after the tsunami by offering training programs to fishermen to better their livelihood for a sustainable income. As overfishing, and exploitation of marine resources was becoming rampant, small scale fishermen could not depend on one source of income for a sustainable livelihood. Hence, Integrated Fish Farming was introduced by MSSRF and National Bank for Agriculture and Rural Development (NABARD) to create community fishing ponds. Unutilized farm ponds were brought back to life and converted into fish ponds. Overall, 152 farm ponds were rejuvenated to convert them into fish ponds in the Nagapattinam district. Along with this fish pond, farmers also diversified their livelihood through horticulture, floriculture, apiculture and other components. By integrating these components in their farmland, fish farmers had increased incomes and could reduce their livelihood risks in times of changing climate. Hence, fisherfolks in the state could be scientifically trained and micro-financed to pursue various kinds of integrated fish farming for increasing their incomes and livelihood opportunities.



CHAPTER 2

Scientific Extraction and Potential for Utilization of Non-Living Resources

Chapter 2: Scientific Extraction and Potential for Utilization of Non-Living Resources

2.1 Introduction

The oceans contain about 3.5 percent of dissolved salt, and early in history, humankind acquired the art of salt making from the evaporation of seawater. Petroleum and natural gases were the first underwater hydrocarbon resources to be exploited. Presently, about 30 percent of the world's crude oil and natural gas requirements are met by drilling the seabed for these hydrocarbon resources. Though major submarine deposits of petroleum and natural gas were discovered in India at the Mumbai High Field (formerly "Bombay High") off the west coast of Mumbai, in 1965, commercial exploitation was initiated only in the year 1974 and currently about 12 million MT of crude oil is being produced per year. Other discoveries have been made over the years.

The ocean beds are also promising reserves of manganese and polymetallic (copper, lead, zinc, gold, nickel, cobalt) nodules, sulfide and phosphate deposits. India is fairly well endowed with this assorted mineral wealth and has carried out substantial marine geological surveys for the delineation of the metallic mineral and industrial mineral deposits.

In the offshore region, apart from the abundant mineral resources, there is an immense potential for generating energy from renewable marine element resources such as waves, tides, salinity, temperature, currents and osmotic power. Wind energy and solar energy are the two prominent renewable energy sources being exploited currently. Offshore wind energy production is a mature technology and numerous wind farms have been installed in the coastal and offshore waters of many countries. Offshore solar energy is a comparatively newer technology and is currently in its infancy stage.

The ocean-based renewable energy sources are inexhaustible resources and should, therefore, be developed to replace exhaustible resources such as fossil fuels.

Though mineral wealth has been discovered in the offshore regions, they need to be judiciously and sustainably exploited as they are non-replenishable resources. For the sustainable conservation of mineral resources, the challenge lies in integrating economic development while addressing environmental concerns. Traditional methods of resource use result in generating enormous quantities of waste as well as creating other environmental problems. Hence, sustainable development calls for judicious conservation of resources for future generations.

2.2 Generation and use of Offshore Energy

In the light of the rapidly depleting fossil fuel reserves and the ever-increasing energy demands, energy from renewable sources, especially from the ocean, is an attractive alternate option. Renewable energy is the energy that is generated from natural processes that cannot be exhausted and is continuously replenished and/or revived. Examples of renewable energy include solar light, geothermal heat, wind, tides, waves, salinity gradient and various forms of biomass. Renewable energy is also called "clean energy" or "green power".

Renewable energy enjoys almost 22 percent share of the global energy mix. Considering that Marine Renewable Energy (MRE) has the potential to generate sizable returns on capital, more inflow of investments into the sector could provide a solution to the "Energy Trilemma" of energy security i.e., energy, equity and environmental sustainability.

There are diverse options for generating offshore renewable energy. These include:

- (1) Offshore Solar
- (2) Offshore Wind
- (3) Wave
- (4) Tidal
- (5) Ocean Thermal
- (6) Osmotic Power
- (7) Ocean Current
- (8) Marine Biomass

The nature of harnessing energy from the above sources varies with the source. Energy potentials in some of these sources have been studied in detail in the past in India, with solar and wind recognized as two most important sources of MRE. Due to significant advances, other renewable energy technologies may become commercially viable in the near future.

Amongst the various offshore renewable energy technologies currently available, offshore wind energy is by far the most advanced and mature. The total installed offshore global wind energy capacity is around 35GW (end 2020) and is expected to expand beyond 230GW by the end of 2030. The world's exploitable offshore wind resource is around 30 times higher than the global estimation of average electricity generation. Offshore solar energy is by far the only other offshore energy in deployment other than offshore wind energy, though the scale of deployment is very low. Other offshore renewable energy technologies are still mostly in the experimental/development stages.

In India, renewable energy has started playing an increasingly important role in the augmentation of grid power, providing energy access, reducing the consumption of fossil fuels and helping India effectively pursue its low carbon development path. India has pledged to install 175 GW of renewable power capacity by 2022. Through its Intended Nationally Determined Contribution (INDC), outlining the country's post-2020 climate actions, India has committed to increase the country's share of non-fossil-based installed electric capacity to 40 percent by 2030 in addition to reducing its GHG emissions intensity per unit GDP by 33 to 35 percent below 2005 levels by 2030 and to create an additional carbon sink of 2.5 to 3 billion MT of carbon dioxide through additional tree cover.

To meet its ambitious targets and commitment to the entire world in the fight against climate change, India has been rolling out multiple initiatives, programs, policies and incentives to accelerate the development of the renewable energy sector. It has driven the growth of the sector by holistically driving investments, proactively resolving industry issues, addressing policy concerns, all the while generating employment for the nation's burgeoning youth population and skilling them in accordance with the needs of the sector.

By December 2019, a capacity of 85.90 GW had been set up constituting more than 23 percent of the total installed capacity. Globally, India is in 4th and 5th positions in the wind and solar power deployment, respectively. From 2013-14 till December 2019, the renewable power deployment has more than doubled. Solar power capacity has increased by more than 14 times in the last five years from 2.63 GW to 37.51 GW in December 2019.

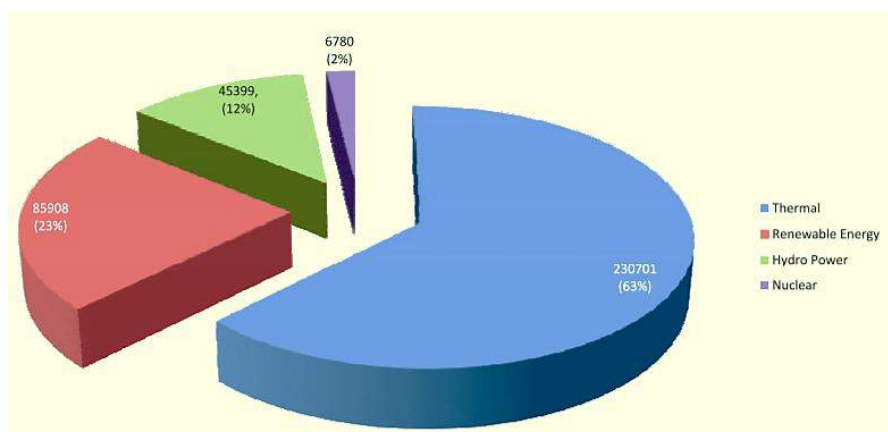


Figure 2. 1: Installed Power Generation Capacity (MW) in India as on 31-12-2019

2.2.1 Offshore Wind Energy

Wind power is one of the fastest-growing renewable energy technologies in the world and has seen significant growth in the past decade. Global onshore wind capacity has increased fourfold since 2009, rising to more than 594 GW in 2019 as nations around the world move further away from fossil fuels. Wind power is used on a commercial basis in more than half of all the countries in the world. In 2018 wind energy generated enough electricity to meet 14 percent of the EU's electricity demand. Electricity generation from wind power in terms of percentage of the total electricity production is as high as 41 percent in Denmark, 28 percent in Ireland, 24 percent in Portugal, 21 percent in Germany and 19 percent in Spain. Wind power's share of worldwide electricity usage at the end of 2018 was 4.8 percent, up from 3.1 percent four years earlier.

Offshore wind energy took its first steps in the 1990s and has been growing in scale ever since. In recent years, however, there has been a sudden acceleration in its growth. From being 1 percent of the global wind installations by capacity in 2009, it has grown to over 10 percent in 2019. Since more than 70 percent of the planet is covered by sea, and wind speeds are considerably stronger offshore than onshore, offshore wind energy looks highly promising.

Globally, new offshore wind installations grew from 3.4 GW in 2015 to 6.1 GW in 2019. The global offshore market grew on average by 24 percent each year since 2013, bringing the total installations to 29.1 GW. Europe remains the largest offshore market as of end 2019, making up 75 percent of total global offshore wind installations with the UK, Germany, China, Denmark and Belgium being the top five markets in Europe. In Asia, China has taken the lead followed by Taiwan, Vietnam, Japan, and South Korea. It is anticipated that with an average annual growth rate of 18.6 percent until 2024 and 8.2 percent up to the end of the decade, new annual installations would sail past the milestones of 20 GW in 2025 and 30 GW in 2030 with over 205 GW of new offshore wind capacity being added over the next decade. Buoyed by expansion into new markets and acceleration of the global energy transition, offshore wind will play an increasingly important role in the overall growth of the global wind market, and is expected to contribute more than 20 percent of total wind installations by 2025.

Peninsular India has a vast coastline of about 7500 km and has tremendous prospects of harnessing offshore wind energy. Keeping this in view, the Government of India has notified the "National Offshore Wind Energy Policy" in October 2015. As per the policy, the Ministry of New and Renewable Energy (MNRE) will act as the nodal Ministry for development of Offshore Wind Energy in India and work in close coordination with other government entities for development and use of maritime space within the Exclusive Economic

Zone (EEZ) of the country and shall be responsible for overall monitoring of offshore wind energy development in the country.

The National Institute of Wind Energy, India (formerly known as Centre for Wind Energy Technology (CWET)) and Lawrence Berkeley National Laboratory have conducted reassessment studies and reported that the wind power potential in India is 102.7GW at 80m hub height, compared to earlier estimates of approximately 49.1GW at 50m hub height, with an estimated 2 percent of India's land mass eminently suitable for development.

The variation in offshore electrical power and wind energy at different water depths such as 0–30m, 30–50m, 50–100m, 100–200m, and 30–200m has been modeled, with an estimated electrical power capacity of 5434 GW and 3274 GW on the west and east coast of India, respectively. The model results revealed that the states of Tamil Nadu, Gujarat, and Andhra Pradesh (South), with a sustained wind speed of >7.5m/s for 9–10 months of the year, offer high potential for offshore wind energy generation.

Nearly 70 GW potential area has been earmarked for offshore wind development. MNRE has set an offshore wind energy target of 5 GW by 2022 and 30 GW by 2030. The tender for the first 1 GW offshore wind project in the Gulf of Khambhat (Gujarat) has been delayed. Cheaper land-based renewables have proved to be a stumbling block for the growth of Offshore wind in India.

Even though Karnataka has a coastline of about 320 km bordering the Arabian Sea along the west coast of India, so far there are no offshore wind and solar projects along its coast. Currently, wind turbines have been installed on several hill tops especially in parts of Chitradurga, Gadag, Ballari, and Hassan districts of interior Karnataka. However, along the coastline, such projects are yet to be implemented.

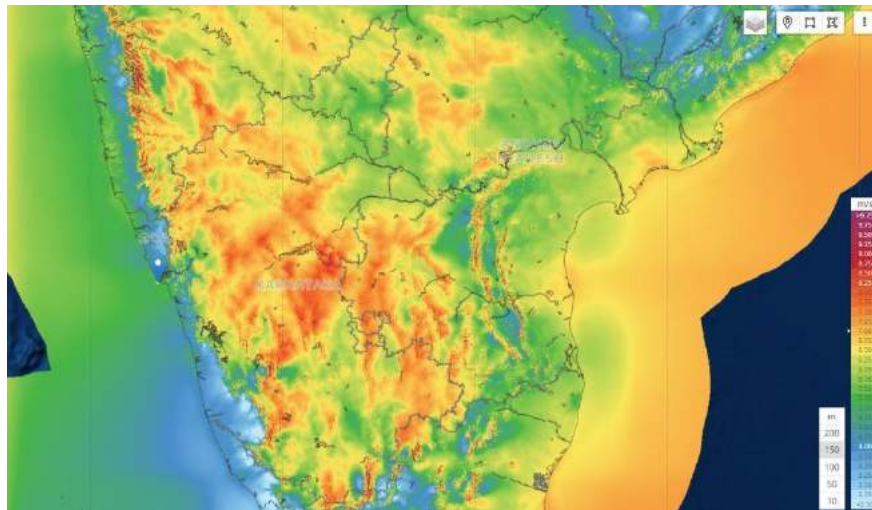


Figure 2. 2: Map of Mean Wind Speed for Karnataka

The mean wind speeds at a hub height of 100m in a 100 km zone along the entire Karnataka coast are between $3.0\text{--}5.5\text{ms}^{-1}$ (Figure 2.2 and 2.3). Currently, offshore wind projects are commercially viable at average annual wind speeds of 6.5m/s or greater at 80m. Hence, offshore wind projects along the Karnataka coast are currently not viable. However, with advancements in technology they may be viable in the future.

During stakeholder consultation, SAC-ISRO (Space Applications Centre - Indian Space Research Organization) informed that SAC has a database of altimeter,

scatterometer/SAR based wind energy data. These can be utilized for selection of sites for installation of wind mills in coastal areas of Karnataka.

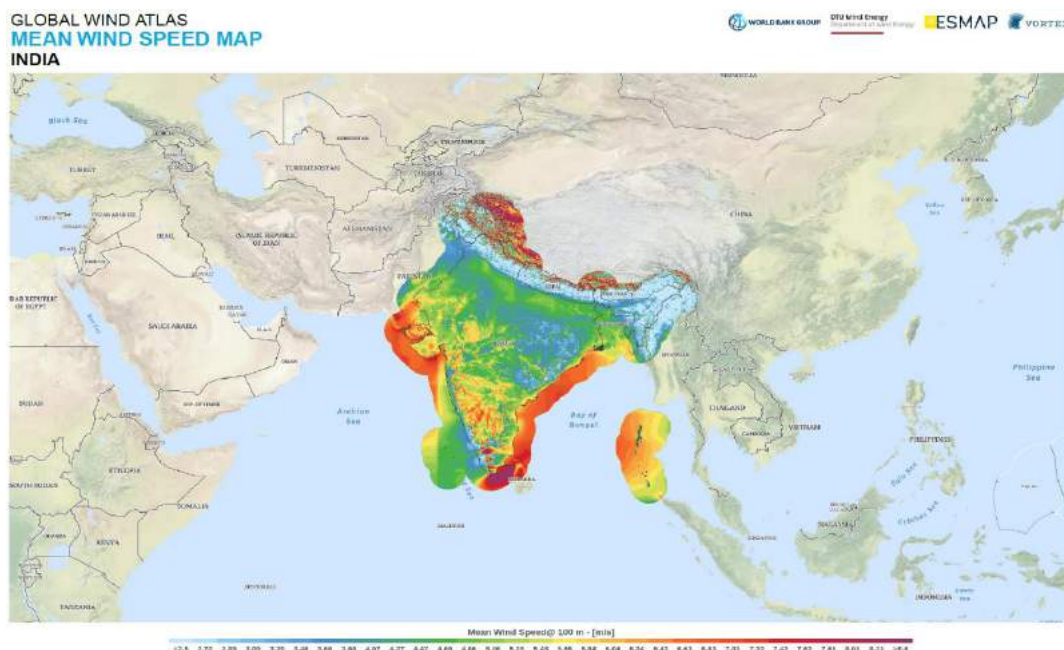


Figure 2. 3: Mean Wind Speed map for India with 200km buffer zone
(Source: Global Wind Atlas Project, <https://globalwindatlas.info>)

2.2.2 Offshore Solar Energy

Offshore solar energy is a new and sustainable way to generate clean energy because it does not occupy land space. In densely populated coastal regions, where half of the world's population lives, space on land is severely limited and is greatly needed for housing, recreation, industry, roads, and agriculture. By moving solar energy installations to sea, land constraints are solved, spatial pressures on land are relieved and land is freed up for other equally strategic sectors. Consequently, floating solar has been widely tested in countries such as Japan, China and in general in Southeast Asia, which must cope with the lack of available land. Floating solar has the additional benefit of higher panel performance than in-ground installations as water and ventilation help to cool the cells and dissipate the heat developed, improving their efficiency and productivity. 87 percent of the global floating solar capacity is currently concentrated in the Asia Pacific region with China having the largest number of plants installed, with a capacity of around 1.1 GW. It is to be noted that except for two projects (one commercial and one pilot) installed in offshore waters, the rest have been installed in inland waters only.

Offshore solar is the ideal way to make many coastal regions, islands and remote locations sustainable. Islands and remote locations which have limited space on land but have a lot of sea space around, can become 100 percent renewable using the sea. Offshore solar offers great advantages when using the same sea area as offshore wind farms. When solar modules float in the sea space between the turbine foundations, 5 times more energy is generated at the same area of sea-space. Also, sun and wind together offer a more stable and continuous power supply as the winters have more wind than sunshine while the summers are sunnier. Further synergies can be achieved when offshore solar energy production is combined with aquaculture, such as cultivation of hang culture mussels, seaweeds etc. with significant positive impacts.

Floating solar power plants have several benefits over land-based installations, such as:

1. Improved energy efficiency due to the cooling effect of water and decreased presence of dust
2. Elimination of shading of panels by their surroundings
3. Elimination of the need for major site preparation (leveling, laying of foundations) required for land-based installations
4. Easy installation and deployment in sites with low anchoring and mooring requirements, with a high degree of modularity, leading to faster installations

In addition to the above benefits, installation of floating solar power projects in fresh water reservoirs has unique benefits, such as:

1. Reduced evaporation, as the solar panels provide shade and limit the evaporative effects of wind
2. Improvements in water quality, through decreased algae growth
3. Lower input costs owing to usage of cheaper, less corrosion resistant materials

Though there are several inland floating solar power projects, offshore solar power plants have been set up only at two locations, as on date. Oceans of Energy, a company in the Netherlands, have designed and successfully installed an offshore floating solar farm (pilot project) in the Dutch North Sea. The system is designed and tested to withstand 13 m high waves and has already survived several storms, including "Ciara", "Dennis", "Bella" and "Evert" in 2020; up to 62 knots of maximum wind speeds, > 5 meters maximum waves and 2 knots sea currents while, remaining stable and intact in all conditions. The Sunseap group of Singapore has installed the world's first commercial Offshore floating solar project with a capacity of 5 MW in the Straits of Johor, on the border between Singapore and Malaysia in March 2021.

In India, offshore floating solar power projects have not been conceived till date. However, fresh water floating solar plants have been installed in Kerala (0.5MWp at Banasura Sagar Reservoir, Wayanad in 2017), Karnataka (1MW canal-top above the Almatti Right Bank Canal (ARBC) in Bagalkote district) and Andhra Pradesh (2MW at Mudasarlova Reservoir, Visakhapatnam in 2018). These floating solar projects are usually coupled/associated with hydroelectric power-generating projects. Some of the upcoming (in various stages of tendering) floating solar power projects in India are as follows:

1. 3 MW at Meghadrigedda Reservoir, Visakhapatnam, Andhra Pradesh
2. 4 MW at Kalpong Dam, Diglipur, North Andaman
3. 5 MW in Sagardighi Thermal Power Plant, Murshidabad, West Bengal.
4. 15 MW at Singareni Collieries Company Limited (SCCL), Telangana
5. 20 MW at Union Territory of Lakshadweep
6. 150 MW at Rihand Dam, Uttar Pradesh
7. 1 GW at Ujjani Dam Reservoir, Solapur, Maharashtra

The Karnataka Urban Water Supply and Drainage Board has planned to set up floating solar power projects over reservoirs in Manvi, Sirguppa, and Ballari City.

Karnataka has around 4,37,291 ha³² of water surface area spread over 4679 reservoirs. Even if 1 percent of this area is used to set up floating solar power projects, it has the potential to generate a substantial amount of electricity. Floating Solar power projects need to be actively pursued, especially in inland water bodies. In addition, by combining wind and solar in the same location, a hybrid energy project is possible, provided viable wind speeds are existent. Hybrid energy projects have a higher power production density than conventional mono energy projects.

Karnataka, with a coastline of 320km, the adjacent EEZ and the large number of near-shore and offshore islands has a vast potential for the development of offshore solar energy. The direct solar irradiance and the solar photovoltaic power potential for Karnataka and India is provided in Figure 2.4. As may be seen, the power potential in Karnataka is similar to other coastal and inland states in India.

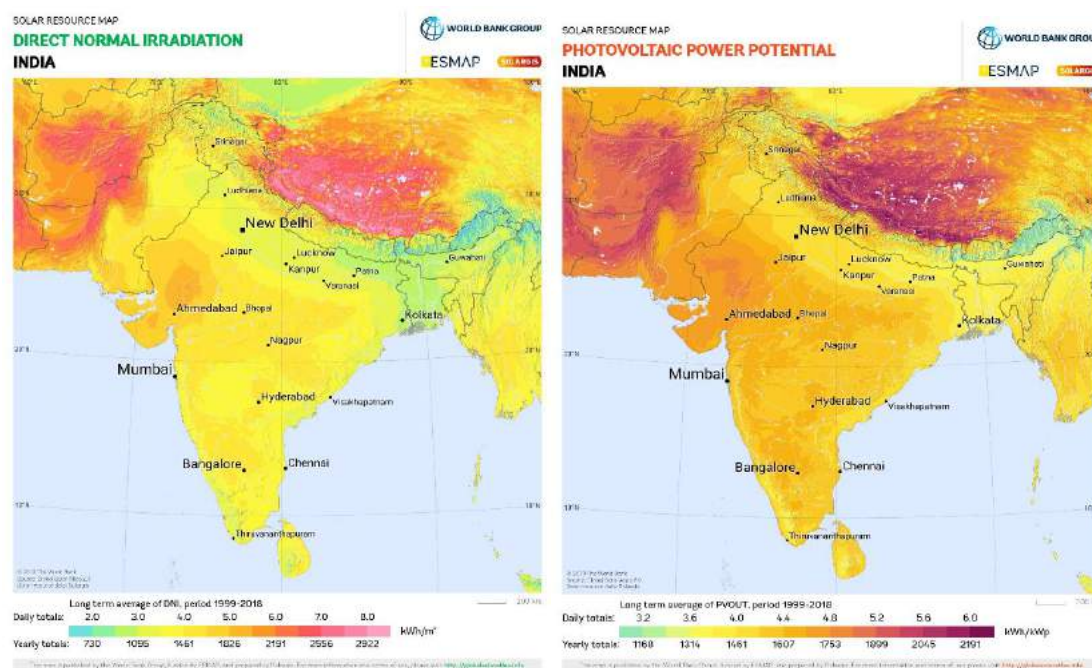


Figure 2. 4: Direct Normal Irradiation and Photovoltaic power potential maps of India

Offshore solar projects are more expensive than their inland counterparts as more corrosion resistant materials of construction need to be used. In addition, the offshore system needs to be designed to withstand storms, tides, waves, high velocity winds etc which make the offshore floating solar system capital intensive compared to inland floating solar system.

Offshore solar is ideal at locations where land space is limited and badly needed for housing, recreation, industry, roads, and agriculture like Japan, Netherlands, etc. While Karnataka and India as a whole have not yet reached this stage in spite of the rapid population growth, owing to its unique advantages over onshore solar and rapid advances in technology, offshore solar may one day become cost competitive compared to conventional solar and other renewables.

2.2.3 Osmotic Power

Osmotic power or salinity gradient power is the renewable energy created from the difference in salt concentration between two fluids, commonly fresh and saltwater, e.g., when

³²<http://www.fao.org/3/v5930e/V5930E06.htm> accessed on 03rd November 2020

a river flows into the sea³³. Around the world, there are two technologies for which demonstration projects are running. They are:

1. Pressure Retarded Osmosis (PRO)
2. Reverse Electrodialysis (RED)

Pressure Retarded Osmosis (PRO) uses a membrane to separate a concentrated salt solution (like sea water) from freshwater. The freshwater flows through a semipermeable membrane towards the sea water, which increases the pressure within the seawater chamber. A turbine is then spun as the pressure is compensated and electricity is generated.

Reversed Electrodialysis (RED) uses the transport of (salt) ions through membranes to generate electricity. RED consists of a stack of alternating cathode and anode exchanging perm selective membranes. The compartments between the membranes are alternately filled with sea water and freshwater. The salinity gradient difference is the driving force in transporting ions that results in an electric potential, which is then converted to electricity.

An important factor for both the performance and costs of PRO and RED are the membranes. Current net power density of membranes is maximum 2.7 W/m², but the latest laboratory experiments have achieved a net power density of 14.4 W/m² (for a PRO process). Currently, there is little hard evidence for the costs of both PRO and RED technologies. Based on feasibility studies, costs are estimated to be around USD 65-125/MW for PRO, and USD 90/MW for RED³⁴. Levelized costs of electricity are estimated to be around USD 0.15-0.30/kWh for PRO, and USD 0.11-0.20/kWh for RED in 2020. The lower ranges in cost are for hybrid applications that make use of existing infrastructure.

The cost of the membrane has been an obstacle in the implementation of projects. In addition, research and development efforts have been hit by a lack of reliable financial support mechanisms. Statkraft, which is one of Europe's largest generators of renewable energy and the leading power company in Norway, has discontinued its osmotic power efforts in 2014 for this reason.

Though the osmotic power sector has been struggling for decades to find commercial viability, the latest advancements in nanotechnology could spell the beginning of a new era for osmotic power. In late 2016, Nature magazine announced the development of a three-atom thick membrane of molybdenum disulfide able to produce up to 1 MW/m². Besides their low production cost, these membranes do not require any power stations, but can be placed directly in river estuaries to generate electricity. Just as with other nanotechnology advancements, the challenge currently lies in the production of consistent and homogeneous membranes on an industrial scale.

The technology holds promise for regions like coastal Karnataka endowed with several estuaries and coastal lagoons where fresh river water admixes with saline water tides of the sea. Currently, Osmotic Power is not feasible, however it is worth exploring for future implementations.

2.2.4 Ocean Thermal Energy

Ocean Thermal Energy Conversion (OTEC) technologies use the temperature difference between warm seawater at the surface of the ocean and cold seawater at a depth of 800–1000 m to produce electricity. The warm seawater is used to produce a vapor that acts as a working fluid to drive turbines. The cold water is used to condense the vapor and ensure

³³IRENA Ocean Energy Technology Brief, www.irena.org

³⁴IRENA Ocean Energy Technology Brief, www.irena.org

that the vapor pressure difference drives the turbine. Open Cycle OTEC uses seawater as the working fluid, while Closed Cycle OTEC uses mostly ammonia. So far, only OTEC plants up to 1 MW have been built.

Depending upon the availability of deep sea near the coast from a depth of 600 to 1000m, the OTEC system could be installed in three possible types of locations.

- 1. Floating plant:** Where the deep sea is at a distance of 10 to 15 km from the coast.
- 2. Self-mounted plant:** Where deep water is found within a distance of 10 km from the coast.
- 3. Land-based plant:** Where deep-water conditions are available within 2 – 3 km of the coast.

Some of the advantages of OTEC Systems are:

1. Power from an OTEC system is continuous, renewable and pollution free.
2. The cold deep-sea water is rich in nutrients and can be utilized for aquaculture.
3. Open cycle OTEC system provides fresh water as a by-product. The closed cycle system can also be combined with a desalination plant to get fresh water.
4. OTEC is an attractive source of power for remote islands.
5. A floating OTEC plant could generate power mid-sea, and can be used to provide power for operations like offshore mining and processing of manganese nodules.

India is geographically well placed to generate ocean thermal energy, with around 2000 km of coastal length along South India, where a temperature difference of 18-22°C is available throughout the year, which translates to about 1.5×10^6 sq. km of tropical water in the Exclusive Economic Zone around India with a power density of 0.2 MW/sq. km. The total OTEC potential around India is estimated as 180,000 MW, allowing 40 percent of gross power for parasitic losses. In case of Karnataka, a temperature difference of 20-22°C is available for a depth greater than 1000 m along almost the entire Karnataka coast.

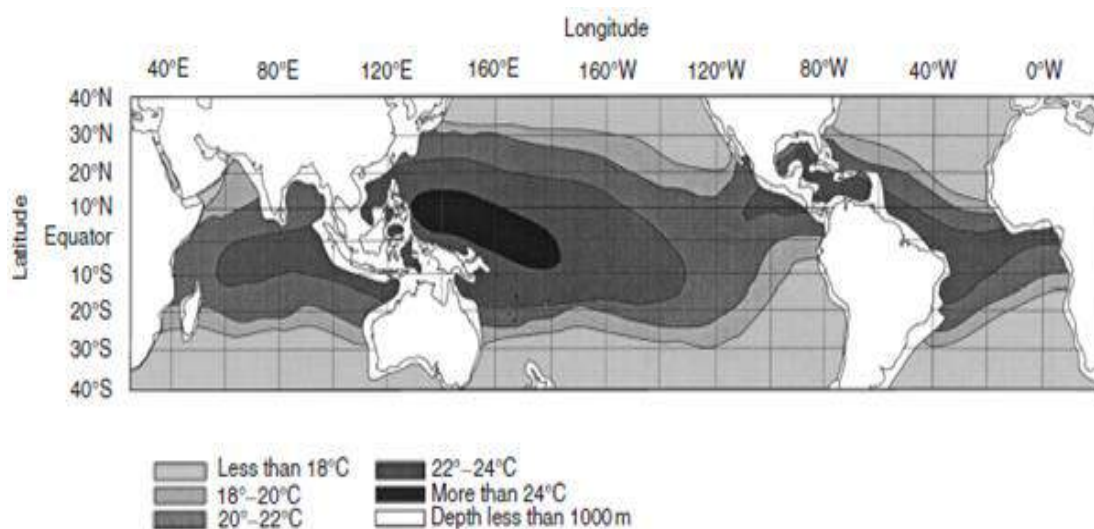


Figure 2. 5: World Map of temperature difference between surface & deep-Sea Water

In 1997, the Department of Ocean Development (DOD), Government of India, proposed to establish a 1 MW gross OTEC plant in Tuticorin, in Tamil Nadu. Subsequently, with the foreign vendor closing down its operation, it had to be abandoned. Currently, the NIOT is working on a 200 kW OTEC powered desalination plant at Kavaratti, the capital of the

Lakshadweep archipelago and the project is currently in the design phase. In case of Karnataka, as on date, there are no plans for implementation of OTEC.

During stakeholder consultation SAC-ISRO (Space Applications Centre - Indian Space Research Organization) informed that SAC can assist in the identification of hot-spot regions for OTEC using satellite data and numerical models and provide suggestions on its cost-effectiveness (high stratification of water column and distance from the coast).

OTEC power can be cost effective only if the unit cost of power produced is comparable with power produced from conventional sources. Currently, OTEC power is not cost effective. In addition, OTEC technology is not fully developed. Hence, OTEC is currently not a viable option.

2.2.5 Ocean Wave Energy

Wave energy converters capture the energy contained in ocean waves and use it to generate electricity. Since waves are essentially always in motion and are never interrupted, they are a reliable source of revenue compared to other sources such as solar and wind. It is reported that for every meter of wave along the shore, the generated energy density is between 30kW and 40kW.

There are three main categories of wave energy converters. They are:

1. Oscillating Water Columns
2. Oscillating Body Converters
3. Overtopping Converters

Oscillating Water Columns are conversion devices with a semi-submerged chamber that keep a trapped air pocket above a column of water. Waves cause the column to act like a piston, moving up and down and thereby forcing the air out of the chamber and back into it. This continuous movement generates a reversing stream of high-velocity air, which is channeled through rotor blades driving an air turbine-generator group to produce electricity.

Oscillating Body Converters use the wave motion (up/down, forwards/backwards, side to side) to generate electricity. They are either floating (usually) or submerged (sometimes fixed to the bottom). They exploit the more powerful wave regimes that normally occur in deep waters where the depth is greater than 40 m. In general, they are more complex than OWCs, particularly with regards to their Power-Take-Off (PTO) systems.

Overtopping converters (or terminators) consist of a floating or bottom fixed water reservoir structure, and also usually reflecting arms, which ensure that as waves arrive, they spill over the top of a ramp structure and are restrained in the reservoir of the device. The potential energy, due to the height of collected water above the sea surface, is transformed into electricity using conventional low head hydro turbines.

More than 100 pilot and demonstration projects exist throughout the world, but only a handful of technologies are close to commercialization. Wave energy is still one of the least mature renewable energy technologies. Wave technology shows no design consensus so far and the bulk of wave projects are still in testing/pre-commercial phase. Wave energy is not expected to be ready for large-scale deployment in the near future.

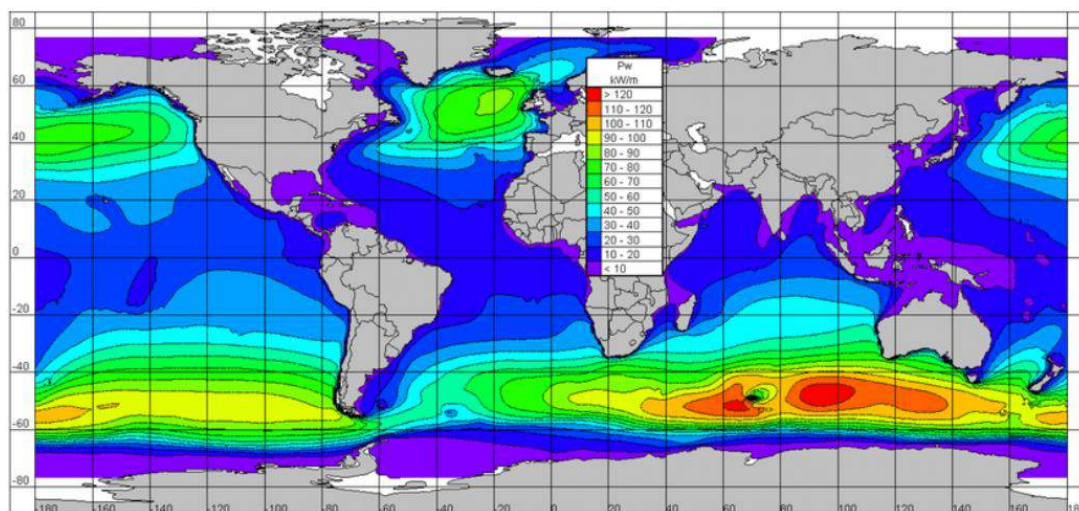


Figure 2. 6: Global distribution of annual mean wave power

(Source: A global wave energy resource assessment made by Andrew M. Cornett. Proceedings of the 18th international offshore and polar engineering conference, Vancouver Canada)

Figure 2.6 shows the wave energy levels in kW/m for the entire world. It is worthy to note that the wave energy increases as latitudes increase north or south. Latitudes greater than 40° generate the highest energy.

India with its vast offshore regions has the potential for extraction of wave power in the future as a renewable green energy source. The wave power potential of India was mapped in a study³⁵ conducted by the Indian Institute of Technology, Chennai, in association with CRISIL Risk and Infrastructure Solutions Limited, and the potential was estimated to be around 40 GW. Higher power was observed along the west coast as compared to the east coast, probably due to the strong waves during the south-west monsoon. The total wave power potential for Karnataka has been estimated to be around 6100 MW. Based on the study, five potential sites for deployment of wave energy devices were proposed. They are: Kudal (Maharashtra), Trivandrum (Kerala), Kanyakumari (Tamil Nadu), Pondicherry (Tamil Nadu) and Kaviti (Andhra Pradesh).

IIT Madras set-up the World's first Oscillating Water Column wave power pilot project in India at Vizhinjam. The plant was built in 1991 with an investment of Rs. 99 lakhs. The plant was to generate 150 kW of electricity on a continual basis that would be transferred to the state grid. The amount of power generated varied considerably. During the April – November period, the plant would generate only 75kW, and an even lesser 25kW from December – March. The plant used to work at its maximum level only during the monsoon months. The plant was out of use for a long time and in 2004, NIOT took up the project to revive it to desalinate ocean water. It was proposed to treat 10,000 liters of water per day by the reverse osmosis process but the project was not successful.

NIOT has installed a wave powered navigational buoy near the navigational channel of Kamarajar Port in Chennai. This buoy is based on the oscillating water column technology and the electricity generated is used for powering the beacon lamp and oceanographic sensors (wind & water current) housed on the buoy.

During stakeholder consultation SAC-ISRO (Space Applications Centre - Indian Space Research Organization) informed that SAC has a database of altimeter, scatterometer/SAR

³⁵Study on Tidal & Waves Energy in India: Survey on the Potential & Proposition of a Roadmap, CRISIL & IIT Madras, December 2014.

based wave energy data. These can be utilized for selection of sites for potential wave energy installations in coastal areas.

In Udupi, Karnataka, a company called Susi Global Research Centre, has been researching electricity generation from wave energy for several years. In 2015, they designed and installed a pilot power plant for generating power through sea waves on Kadike Beach near Udupi. Susi Global Research Centre's power plant converts the mechanical motion of waves into pneumatic energy which is then used to drive an alternator thereby generating electricity. Based on the success of the pilot project, Susi Global Research Centre has submitted a Detailed Project Report to the state government to set up a 10-MW power plant at Maravanthe beach. Susi Global Research Centre has claimed that the proposed plant would not cause any problem to fishermen and would not affect the marine movement. In addition, the power plant would not be in violation of the Coastal Regulatory Zone norms and it would not come in the Naval path.

The unique home-grown technology developed by Susi Global Research Centre needs to be given due consideration and its economic feasibility needs to be established before large-scale implementation is embraced. At the same time, the team from Susi Global Research Centre needs to be supported (technically and financially) to bring about further advancement and refinement in the technology.

2.2.6 Tidal Energy

Tides are the result of the interaction of the gravity of the sun, earth, and moon. The rise and fall of the tides – in some cases more than 12 m – creates potential energy. The flows due to flood and ebb currents creates kinetic energy. Both forms of energy can be harvested by tidal energy technologies as renewable energy.

In most tidal energy generators, turbines are placed in tidal streams or tidal lagoons. A tidal stream is a fast-flowing body of water created by tides. A tidal lagoon is a body of ocean water that is partly enclosed by a natural or manmade barrier. Tidal lagoons might also be estuaries, with freshwater emptying into them. Tidal lagoons fitted with turbines generate power as the lagoon is intermittently filling and emptying with tidal water.

Tidal energy plants are limited. Since 1966 till date, only eleven tidal power stations have been set-up with eight plants being operational after three plants were decommissioned. The current capacity of the tidal energy plants is about 510 MW.

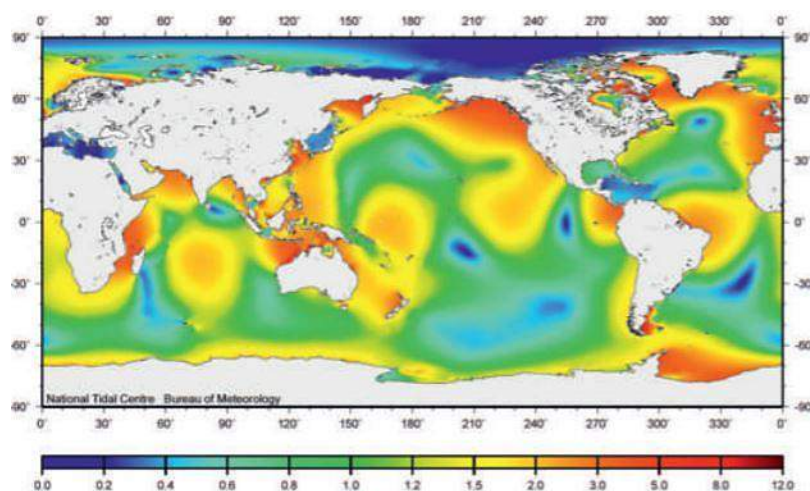


Figure 2. 7: Tidal Range Resources Worldwide

The tidal power potential of India was mapped in a study³⁶ conducted by the Indian Institute of Technology, Chennai, in association with CRISIL Risk and Infrastructure Solutions Limited, and the potential was estimated at around 12,455 MW. The potential areas with low/medium tidal wave strength are in the Gulf of Khambhat, Gulf of Kutch & southern regions in Gujarat, Palk Bay- Mannar Channel in Tamil Nadu, and Hoogly River, South Haldia & Sunderbans in West Bengal. According to the study, the Gulf of Khambhat and Gulf of Kutch near Gujarat have an estimated potential of 7,000 MW and 1,200 MW, respectively, with Sunderbans having a potential of 100 MW. Based on the above study, India had planned to set up two tidal energy plants, a 50 MW tidal power plant in the Gulf of Kutch and a 100 MW plant in the Sunderbans, West Bengal. However, India has shelved both the projects owing to high capital cost and extremely high cost per unit power (INR 30 crores to 60 crores per MW).

Though coastal Karnataka has a wealth of coastal lagoons and tidal estuaries such as at the confluence of Rivers Netravati and Gurupur, Mulki (Shambhavi) and Pavanje (Nandini), Udyavara, Swarna and Seetha, Varahi and Chakra, Sharavati, Aghanashini, Gangavali, Kali, etc., the tidal power potential is lower as compared to the Gulf of Khambhat, Gulf of Kutch and the Sunderbans. In addition, current tidal stream generators are an immature technology and are not commercially feasible owing to the high input costs. Consequently, tidal power is currently not a feasible option for Karnataka.

2.2.7 Ocean Current Energy

The relatively constant flow of ocean currents carries large amounts of water and energy across the earth's oceans. Most ocean currents are driven by wind and solar heating of surface waters, while some currents result from density and salinity variations of the water column. Currents are also caused by Thermohaline circulation, which is part of the global ocean circulation that is driven by density gradients created by surface heat and freshwater fluxes.

Ocean currents have a relatively constant flow in one direction, in contrast to tidal currents along the shore. While ocean currents may move slowly relative to wind speeds, due to the density of water they carry a great deal of energy. Water is more than 800 times denser than air, so for the same surface area, water moving 20 kmph exerts the same amount of force as a constant 180 kmph wind. Due to this physical property, ocean currents contain an enormous amount of energy that can be captured and converted to a usable form.

The kinetic energy of ocean currents can be converted in much the same way that a wind turbine extracts energy from the wind, using various types of open-flow rotors. With oceanic or marine current energy, potentially large resources can be exploited with little environmental impact, thereby offering one of the least damaging methods for large-scale electricity generation. Countries in the European Union, Japan and China are exploring the commercial viabilities of power generation using marine currents.

The offshore region of Karnataka has immense potential to explore and harness replenishable ocean current power generation in the future. The interrelatedness of tides, waves and currents makes it possible to harness kinetic energy associated with multiple aspects of natural mobility of coastal and oceanic waters, in a synergistic way.

During stakeholder consultation SAC-ISRO (Space Applications Centre - Indian Space Research Organization) informed that SAC can aid in the identification of hot-spot regions for efficient ocean current energy generation as an alternate and clean source of energy. Further

³⁶Study on Tidal & Waves Energy in India: Survey on the Potential & Proposition of a Roadmap, CRISIL & IIT Madras, December 2014.

studies can be undertaken to establish the potential and viability of utilizing Ocean Current Energy in the offshore regions of Karnataka.

2.3 Underwater Mineral Resources

2.3.1 Undersea sand deposits

The term 'sand' refers essentially to arenaceous unconsolidated sediments consisting of particles of grain size ranging between 0.0625 mm and 2 mm. Based on the environment of occurrence, sands can be beach sands, dune sands, river sands, marine sands, etc. Based on composition, sands can be distinguished as: quartz sand, silica sand, calcareous sand, basaltic sand, Ilmenite sand, monazite sand, etc. However, from the commercial perspective the following types are generally recognized: (a) Ordinary sand or River sand (b) Silica sand or Molding and Foundry sand and (c) Rare Earth beach sands.

In a dynamic developing economy like India, the ongoing infrastructure developments on land require large quantities of ordinary sand for construction. River sand is a commonly preferred construction material because of its low market price (especially in the coastal region). The river sands of coastal Karnataka are an annually replenishing resource since they are derived from the weathering, erosion and deposition of material in the river beds. Every year, about 7 million MT of ordinary sand gets deposited in the river beds of Karavali (coastal) rivers. Karavali sands are rich in quartz particles and hence are suitable for construction purposes.

Since time immemorial, the river sands have been manually extracted from the river beds using bamboo or creeper knitted baskets which retain the sand and let the water seep through. The traditional sand collection is an environmentally friendly process which helps in maintaining the river's health by removing the extra load of sediment added each year.

The tectonic structure of the West Coast and the Western Ghats is delicate and complex, being riddled with numerous faults and weak zones, and any imbalances such as river clog, exacerbate erosions along the coast and landslides in the interior. Massive sand mining employing dredging style sucking or use of other mass sediment grabbing equipment can cause disturbance and damage to the river environment. It is a common misconception that extraction of ordinary sand leads to destruction of river ecosystems, environment and the aquifers. However, this is not true with regard to traditional sand extraction. In contrast, judicious mining lends a helping hand, facilitating access to estuarine and coastal nursery grounds for a variety of fish and shellfish.

According to data from cement manufacturing companies, around 18 million MT of cement is sold in Karnataka every year. The cement-sand mix ratio is either 1:4 or 1:6 (four or six bags of sand per cement bag). Considering the 1:4 ratio, 72 million MT of sand is needed every year. As per the official data from the Department of Mines and Geology, a total quantity of 30 million MT of sand (river sand, patta land, blocks allocated to govt. departments, and manufactured sand) is produced in the state. Thus, there is a difference of at least 42 million MT of sand compared to the cement sold in the state.

In view of the huge demand for ordinary sand to meet the demands of infrastructure development, alternative sources are required. The government of Karnataka in its Sand Policy of 2011, has encouraged consumption of M-sand (manufactured sand) as an alternate source to river sands by giving it top priority while allotting quarries. M-sand is the product of crushed aggregates produced from hard granite stone which is cubically shaped with grounded edges, washed and graded with consistency. M-sand produced under strict industrial control and manufactured to meet BIS standards has proven to produce stronger concrete compared to river sand. However, stone quarrying and crushing has been associated

with high environmental damage and air pollution concerns. Despite the initiatives taken by the state government towards alternative materials for sand such as M-Sand, the requirement of sand remains disproportionately high.

A possible source of future sand extraction is the ocean bed. Across the world, the offshore production of construction materials such as sand and gravel far exceed the offshore production of other non-fuel minerals both in value and volume. Considering the high transportation costs, it may be cheaper to turn to offshore sources than to attempt to develop inland deposits. In addition, environmental concerns about onshore quarrying and the growing competition between land users are additional incentives for switching to offshore mining of construction materials. Sand mining from the seabed for construction and land filling has been practiced by certain countries in EU, Japan, United Kingdom and UAE. The artificial creation of man-made Palm islands in Dubai involved sand materials drawn from deserts as well as sea bed. The most extensive offshore sand and gravel industry is in Japan and supplies up to 20 percent of its total sand and gravel production.

Since 1984, the Geological Survey of India (GSI) has been actively involved in the systematic mapping of the seafloor within the Indian EEZ, Territorial Waters (TW) and adjoining international waters acquiring geoscientific data on the seabed sediments, seabed morphology, mineral resources, geochemistry and geophysical parameters. The surveys have revealed the presence of construction grade silica sand in five blocks in the TW off the Kerala coast. Construction grade sand has not been discovered anywhere else.

2.3.2 Lime shell deposits

Marine invertebrate lamellibranches (mollusks) thrive well in the marine saline water conditions. However, several species surviving in the tidal environments enter estuaries during the high tide conditions. The mollusks accustomed to the saline environs perish in the estuaries as they find their brackish water environment difficult to survive on account of the freshwater influx from the river. As a result, the dead shells of lamellibranches species get accumulated in the estuaries periodically. Since the composition of the shells correspond to lime carbonates (CaCO_3), these deposits are known as lime-shells.

Small deposits of lime shells have been reported along the coastlines of Karnataka. Traditionally, these shells, collected by the coastal communities, were sent for processing by burning and powdering and are used for white washing walls. Lime shell is used mainly in Chemical and White Cement Industries. It is also used in the manufacture of polyfibre and in the Tanning Industry.

In India, lime shell is produced only by Karnataka and Kerala and the production is confined to three districts, namely Uttara Kannada in Karnataka and Alappuzha and Kottayam in Kerala. Lime shell production in the country is entirely carried out by private players. Karnataka produced around 47 percent of India's lime shell production in 2018-19(P) and 30.7 percent in 2017-2018. Efforts can be made to increase the production capacity and towards discovery of new lime shell deposits in the state.

2.4 Extraction of Rare Earth Minerals from Coast and Undersea Surfaces

2.4.1 Extraction of Rare Earth Minerals from Coastal Surfaces

Rare Earths are a group of 17 elements, namely scandium (Sc), yttrium (Y) and the lanthanides which are lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb) and lutetium (Lu). They are moderately abundant in earth's crust but not concentrated enough to make them economically

exploitable. Rare-earth elements (REE) are necessary components of more than 200 products across a wide range of applications, especially defense, electronics, energy and high-tech consumer products. Significant defense applications include electronic displays, guidance systems, lasers, and radar and sonar systems. Although the amount of REE used in a product may not be a significant part of that product by weight, value, or volume, REE can be necessary for the device to function. China dominates the rare earths market with 97 percent of the exports but even at a meagre two percent, India is the second largest exporter of rare earths.

The mainland of the Indian sub-continent is endowed with a vast coastline over 7,500 km along its nine maritime coastal states. It hosts a number of multi-mineral shoreline placer deposits occurring as beach and dune sand, inland sand bodies/palaeo beach ridges and teris/red sediments. Favorable geological and geomorphological conditions coupled with tropical to subtropical climate and intricate drainage pattern have resulted in formation of these placer deposits of varied dimensions and concentrations. The heavy mineral suite in these placer deposits essentially comprises ilmenite, rutile, leucoxene, monazite, zircon, garnet, sillimanite, kyanite, pyroxene, amphibole, magnetite, xenotime, apatite, sphene, staurolite, tourmaline etc. in various proportions. Among these, seven (7) economically important minerals, viz. ilmenite, rutile, leucoxene, monazite, zircon, garnet and sillimanite are popularly designated as Beach Sand Minerals (BSM). These minerals are used in both atomic energy and other industries. The AMD (Atomic Mineral Directorate) and GSI (Geological Survey of India) are the leading organizations in exploring the placer deposits in India.

No economically significant rare sand deposits have been discovered so far along the coastal stretch or offshore region of Karnataka, though small and sporadic seasonal accumulations have been noticed in the coastal regions near Ullal and north of Gokarna.

Placer mineral potential in our country could be further studied in detail through coordinated programs in line with networking projects. The available technologies in placer mining can be fine-tuned to suit existing geo-mining conditions. Eco-friendly mining concept can be fully realized during every stage of exploitation of placer deposits. Importance should be given for development of futuristic materials and value-added products from placer minerals.

2.4.2 Undersea surface deposits

Many types of minerals are available from coastal zones to the deep sea. With different physiographic regions in the marine regime, mineral deposits such as placers, phosphorites, hydrates, cobalt rich crust deposits, hydrothermal deposits and manganese nodules are widely reported in various depths in the North Indian Ocean.

The placer/alluvial mineral sands occur in beaches and offshore areas up to 40 m depth. The phosphorite deposits and gas hydrates are located at the water depth of >1,000 m at continental zone. Around 2,500 m depth, cobalt-rich crusts are mapped and the hydrothermal deposits are seen associated with 3,500 m depth of waters. At deeper waters around 5,000 m, manganese nodules are reported. In mid-oceanic ridge areas, the occurrences of metalliferous sediments are widely reported. Indian waters are bestowed with large amounts of such mineral resources all along the sea bed.

India is the first country to have received the status of a pioneer investor in 1987 and was allocated an exclusive pioneer area in the Central Indian Ocean Basin (CIOB) by United Nations (UN) for exploration and utilization of nodules. Currently, India possesses exclusive rights to 75000 sq. km of area in international waters in the CIOB allocated by the International Seabed Authority. The estimated polymetallic nodule resource potential is 380 million MT,

containing 4.7 million MT of nickel, 4.29 million MT of copper and 0.55 million MT of cobalt and 92.59 million MT of manganese.

India is one among the top 8 countries/ contractors and is implementing a long-term program for survey and exploration, environmental studies, technology development in mining and extractive metallurgy, in which significant progress has been made. A Remotely Operable Submersible and a remotely operable in-situ soil testing equipment capable of operating at water depths of >5000m have been developed and tested successfully. Metallurgical process routes for extracting copper, nickel and cobalt from polymetallic nodules have been developed and tested in a demonstration pilot plant set up on a semi-continuous basis with a capacity to process 500 kg nodules per day.

While the extraction of metals from the polymetallic nodules lying at the deep ocean floor is not yet found to be economically viable at this stage, an area of about 7860 sq. km has been identified in the Central Indian Ocean Basin (CIOB) for the First Generation Mine Site on the basis of detailed surveys and analysis. Environmental studies for mining of deep-sea polymetallic nodules were also carried out to evaluate the possible impacts of mining on the deep-sea environment.

2.5 Pharmaceutical products based on minerals and micronutrients

The use of clay minerals, especially in biomedical applications is known from ancient times and they are regaining attention in recent years. The clay minerals are emerging as preferred candidates for various pharmacological applications because of their biological and ecological compatibility, low cost and natural availability. The clay minerals are considered as biocompatible materials with appealing properties. In the prehistory, clay minerals were used for the treatment of minor ailments including infections, pains, aches, and food poisoning. In ancient Greece, they were used as antiseptic materials for skin affliction treatments, to heal scars or to cure snake bites.

Clay minerals are a class of phyllo-silicates which usually form as a result of chemical weathering of silicate minerals at the surface of the Earth. The most representative types of clay minerals occurring in nature are kaolinite, montmorillonite, sepiolites and halloysite. The kaolin or kaolinite is also known as china clay or white clay. Besides, talc, palygorskite and smectites are also used for therapeutic purposes in pharmaceutical formulations as active principles or excipients and as drug carriers, lubricants, desiccants, disintegrants, diluents, binders, granulating agents, pelletizing agents, wetting and emulsifying agents, pigments and opacifiers.

Apart from the clays the following minerals are also commonly used as excipients: oxides (rutile, zincite, periclase, hematite, maghemite, magnetite), hydroxides (goethite), carbonates (calcite, magnesite), sulfates (gypsum, anhydrite), chlorides (halite, sylvite), phosphates (hydroxyapatite). More recently, some tectosilicates (zeolites) also feature in pharmaceutical preparations.

Minerals are also employed in the following medical applications: a) contrast diagnostic techniques, b) production of dental cements and dental molds in odontology, c) immobilization of limbs and fractures or dental and craniofacial surgical procedures in traumatology, d) bone grafts or construction of orbital implants, and e) spas and aesthetic centers. Examples of such minerals are oxides (zincite, magnetite and maghemite), sulphates (gypsum and barite), phosphates (hydroxyapatite) and phyllosilicates (clay minerals). Iron salts or iron compounds are used in the treatment of anemia or the depletion of hemoglobin content in the blood. Besides, salts containing calcium, magnesium, potassium, zinc and copper are used in pharmacological purposes for treatment of certain ailments.

Micronutrients can be divided into four categories: water-soluble vitamins, fat-soluble vitamins, micro minerals, and trace minerals. The Micronutrients are those nutrients that the body needs in smaller amounts. The micro minerals or trace elements include iron, cobalt, chromium, copper, iodine, manganese, selenium, zinc, and molybdenum. They are dietary minerals needed by the human body in very small quantities (generally less than 100mg/day) as opposed to macro minerals which are required in larger quantities. In the case of plants, there are 7 essential plant nutrient elements defined as micronutrients. They are boron (B), zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), molybdenum (Mo) and chlorine (Cl). They constitute in total less than 1 percent of the dry weight of most plants

Microalgae such as *Spirulina* spp., *Chlorella* spp., *Haematococcus pluvialis* and *Nannochloropsis* spp. are being used extensively for production of human nutrition supplements and also in aquaculture.

Bacteria, fungi, and cyanobacteria obtained from various marine sources are gaining economic value for their industrially useful bioactive compounds with antibacterial, antifungal, and antimycobacterial activities. With the advent of marine biotechnology, Marine biological prospecting (bioprospecting) is catching up for the development of marine derived pharmaceutical products of large market potential from the marine living resources. Metabolites produced by marine bacteria and invertebrates have proven pharmaceutical values and market demand. Suresh (2013) reported marine bacteria isolated from coastal waters of Karnataka with bioactive molecules.

Marine bio-resources such as sponges, corals, mollusks, sea worm, marine fish species etc., have industrial applications including pharmaceuticals, nutraceuticals and functional foods viz., production of food additives, proteins, enzymes, cosmetics, agrichemicals, agricultural products and bioremediation etc. with high market potential and traded widely across the globe. Bioactive proteins from bacterial species (*Pseudomonas aeruginosa*, *V. cholera*) associated in marine sponge *Callyspongia diffusa* (Boobathy, 2009) and novel bioactive compounds isolated from marine actinomycetes obtained from marine sediments with significant antibacterial activity against both gram-positive and gram-negative bacteria (Attimarad, 2012) are reported from marine resources of Karnataka. Though the state has wide marine biological diversity in its range of coastal resources, the potential is under explored. The pharmacological potential of the mangroves from the state still remains largely unexplored. Development of sustainable cultivation methods for microbes and biotechnological processes for selected bioactive compounds is a new opportunity that could be explored.

Sea squirts, sea sponges, jellyfish, chitosan and ocean floor fungi are being used in treatment of many diseases such as tumors, cancer (ovarian, colon etc.). Several nutritional products such as vitamins and antioxidants, vital amino acids, proteins, gelatin and food colours are extracted from marine resources such as micro algae, cyanobacteria, krill etc. Seaweeds and micro algae are being used for manufacturing cosmetics such as toothpaste, gels, lipsticks and lotions. Some of the industrial products such as paper and pulp enzymes, fouling agents and adhesives are manufactured from the extracts of marine resources such as sponges, chitosan from crustaceans and mollusks.

National Institute of Oceanography and other institutions viz., Bose Institute in Kolkata, Regional Research Laboratory (RRL) in Bhubaneswar, Central Drug Research Institute (CDRI) in Lucknow and Central Institute of Fisheries Education (CIFE) in Mumbai are working on bioprospecting and production of bioactive molecules and substances.

Considering the living marine bio-resource of the state, there is wider scope for utilization of new opportunities viz., development and commercialization of drug molecules, nutraceuticals and functional foods, drug development and product innovation.

2.6 Expansion of Salt Pans for Industrial Use

Salt pans are salt-producing open fields with stagnant saline water that eventually evaporates under the sun due to solar radiation, leaving behind layers of salt. India is the world's third-largest producer of salt, after the US and China. India produces about 27 million MT of common salt per year of which about 70 percent comes from Gujarat followed by Rajasthan, Tamil Nadu and other states. In Karnataka, the major salt producing area is around Gokarna in the estuary of Aghanashini River in Uttara Kannada district.

The Salt Commissioner's organization with its headquarters at Jaipur is responsible for monitoring production, distribution and supply of salt. The organization is also the nodal agency for monitoring production, distribution and quality of iodized salt under the National Iodine deficiency control program of the Ministry of Health and Family Welfare. The Union of India through the Salt Commissioner's Organization owns about 59951 acres of salt pan lands in the states of Andhra Pradesh, Gujarat, Haryana, Himachal Pradesh, Karnataka, Maharashtra, Odisha, Tamil Nadu and West Bengal. In Karnataka, the Salt Commissioner owns about 476 acres of land out of which 469 acres is salt producing and 7 acres is non-salt producing land.

Salt production in Karnataka is limited to Sanikatta in Kumta Taluk, Uttara Kannada District. Sanikatta is a small town on the way to Gokarna, only a few sq. km in extent. It is also the oldest salt-manufacturing village in the state of Karnataka. Beginning in 1720, Sanikatta has been manufacturing salt for 300 years. Here, brown crystal salt is produced, using the age-old 'solar evaporation process'. It is also called natural salt, as it is processed without machinery. As of 2018-19, salt is being produced in 621 acres out of which co-operative society (Only one - The Nagarbail Salt Owners Co-op Society) produces salt in 469 acres and private players produce salt in the remaining 152 acres. In 1952, the region's nearly 60 individual salt manufacturers, both big and small, joined hands to form a co-operative society. After the formation of the society, the salt-processing unit has expanded to 469 acres and is now one of the biggest such units in India. The society is involved in the manufacturing, distribution and sale of non-iodized and iodized natural salt. The region produced on an average around 12250 MT of salt during 2016-17, 2017-18 and 2018-19. During the same period, the co-operative society on an average produced around 9250 MT of salt while the private players produced around 3000 MT of salt.

The salt production season starts after monsoon (October-November) and ends just before the onset of monsoon (May end). During the monsoon no activity is carried out.

As per the CRZ 2019 notification, "Certain salt marshes which have less biodiversity, identified by NCSCM and demarcated in Coastal Zone Management Plan can be considered for salt pan activities". In addition, salt harvesting and associated facilities fall under CRZ-I B - The intertidal areas. There is ample scope for developing salt pans for industrial use along the margins of estuaries and tidal reaches of coastal Karnataka where saline water incursion takes place. Specific low-lying areas marginal to estuaries and tidal reaches characterized by natural saline incursion can be selected for developing new salt pans. Judicious care is to be exercised to avoid areas close to agricultural fields to prevent salinization and without causing damage to existing mangroves and other natural fauna and flora. Saline ponds can be utilized for shrimp culture and for Artemia cysts or brine shrimp eggs production. Artemia is in high demand in shrimp hatcheries.

2.7 Port and Transport Based Socio-Economic Development and Income Generation

India has a coastline spanning about 7,500 km, forming one of the biggest peninsulas in the world. In addition, India is endowed with an extensive network of waterways (~14,500

km) in the form of rivers, canals, backwaters, creeks and a long coastline accessible through the seas and oceans.

India has twelve major ports and 205 non-major ports. The twelve major ports are equally distributed between the East and West coasts. The twelve major ports are:

1. Kandla Port, Kutch, Gujarat (Busiest cargo port in India)
2. Jawaharlal Nehru Port, Eastern Mumbai, Maharashtra (Largest container port of India)
3. Mumbai Port, Mumbai, Maharashtra (Largest port of India)
4. Chennai Port, Chennai, Tamil Nadu (Second largest port in India)
5. Kolkata Port, West Bengal
6. V.O. Chidambaranar Port, Gulf of Mannar, Tamil Nadu
7. Kamarajar Port, Chennai, Tamil Nadu
8. Visakhapatnam Port, Andhra Pradesh
9. Mormugao Port, Goa
10. Paradip Port, Odisha
11. Cochin Port, Kochi, Kerala
12. New Mangalore Port Trust, Mangaluru

The Sagarmala program initiated by Ministry of Shipping, Govt. of India, in March 2015 aims for the comprehensive development of India's 7,500 km coastline, 14,500 km of potentially navigable waterways and maritime sector by modernizing and developing ports, enhancing port connectivity through road, rail and inland waterways, port development and modernization, supporting coastal communities and stimulating port-linked industrialization. Sagarmala aims to reduce the logistics costs for foreign and domestic trade, leading to an overall cost savings of INR 35,000 crores to INR 40,000 crores annually by 2025. It also aims to double the share of water transportation in the modal mix.

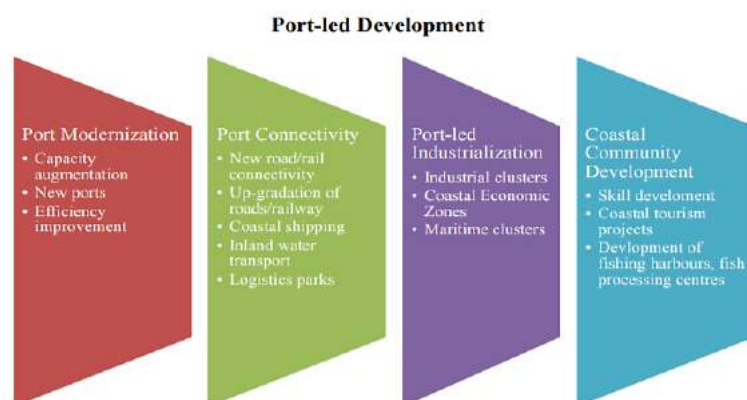


Figure 2. 8: Pillars of Sagarmala Program

2.7.1 Inland waterways

India has an extensive network of inland waterways in the form of rivers, canals, backwaters and creeks. The total navigable length is 14,500 km, out of which about 5200 km of the river and 4000 km of canals can be used by mechanized crafts. Around 90 percent of India's external trade by volume and 70 percent by value are handled by ports. Yet, roads and

railways continue to be the dominant mode for cargo movement. Water transport accounted for only 6 percent of freight transport in India in 2016-17.

Inland Water Transport (IWT) mode is widely recognized as an environment friendly and cost-effective mode of transport. The RITES Report³⁷ on “Integrated National Waterways Transportation Grid” states that 1 liter of fuel moves 24 MT/km on road, 95 MT/km on rail whereas on IWT it is a staggering 215 MT/km. The cost of movement of freight (INR/MT/km) is 1.36 by Rail, 2.5 by road and only 1.06 by IWT. Water transport is also the safest mode of transporting large quantities of chemicals and toxic materials with the least danger to the surrounding cities. In addition to the economic and environmental benefits, IWT is an attractive alternative to the two dominant modes of transport, i.e., road and rail. IWT is not without challenges, it has its own drawbacks, such as lack of last-mile/door-to-door services, operation costs such as local/terminal costs and dredging costs; and is more affected by floods, droughts, other natural phenomenon and climate change risks.

Freight transportation by waterways is highly under-utilized in India compared to other large countries and geographic areas like the United States, China and the European Union. The total cargo moved (in MT/km) by the inland waterway was just 0.1 percent of the total inland traffic in India, compared to 21 percent in the United States. Cargo transportation in an organized manner is confined to a few waterways in Goa, West Bengal, Assam, and Kerala.

The Inland Waterways Authority of India (IWAI) is mandated to develop and maintain infrastructure for fairways, navigational aids and terminals. The IWAI also provides an enabling environment for private investment in cargo vessels and operational services.

Under the National Waterways Act, 2016, a total of 111 waterways (including five National Waterways declared earlier) were declared as National Waterways (NWs). Out of the 106 NWs, 36 NWs have been considered to be technically feasible. Out of the 111 National Waterways (NWs) 13 NW's, in states such as Uttar Pradesh, Bihar, Jharkhand, West Bengal, Assam, Kerala, Andhra Pradesh, Maharashtra, Goa and Gujarat are operational for shipping and navigation, and cargo/passenger vessels are moving on them. National waterways in India handled 55 million MT in 2017-18 and 72 million MT in 2018-19 cargo respectively, and is expected to reach 100 million MT by FY 2021-22.

In Karnataka, a total of 5 rivers have been declared as National Waterways (NW's). These are:

Sl. No.	River/Canal (NWs)	Length (km)
1	Kabini River (NW-51)	23
2	Gurupur River (NW-43)	10
3	Netravati River (NW-74)	30
4	Kali River (NW-52)	53
5	Sharavati River (NW-90)	29

Table 2. 1: National Waterways in Karnataka

³⁷Integrated National Waterways Transportation Grid Study (Stage I of Phase II), Final Report, RITES, 2014.

The Detailed Project Reports (DPRs) for all the above National Waterways are currently under finalization. If the above NWs are found economically feasible, then the projects need to be implemented at the earliest to boost the local and state economy.

2.7.2 Ports of Karnataka

The Union Shipping Ministry administers the major ports, while the minor and intermediate ports are administered by the relevant departments or ministries in the respective state governments.

The New Mangalore Port at Panambur, Mangaluru is considered as the Western gateway of Karnataka and is the only major port in Karnataka. Mangaluru Old Port, Karwar Port, Malpe Port and Belekeri Port are significant minor ports managed by the State government of Karnataka. The naval base project 'Seabird' is located close to the Karwar Port. Mangaluru, Malpe and Gangolli are major marine fishing centers in Karnataka. Other minor ports in Western Karnataka such as Tadri, Mavinakuruve, Honnavar, Manki, Bhatkal, Kundapur, Hangarkatta, and Padubidri are sparingly used minor ports surviving on river mouth anchorage facilities.

2.7.3 New Mangalore Port

New Mangalore Port is a modern, deep-water, all-weather port at Panambur, Mangaluru in Karnataka, India, on the West Coast of India, 170 nautical miles south of Mormugao and 191 nautical miles north of Cochin Port. The New Mangalore Port is the deepest inner harbor on the west coast. It is the only major port of Karnataka and the seventh largest port in India. It is operated by New Mangalore Port Trust (NMPT). The major commodities exported through the port are iron ore concentrates and pellets, iron ore fines, manganese, granite stones, coffee, cashew and containerized cargo. The major imports of the port are crude and petroleum products, LPG, wood pulp, timber logs, finished fertilizers, liquid ammonia, phosphoric acid, other liquid chemicals, and containerized cargo.

New Mangalore Port was declared as the 9th Major Port on 4th May 1974 and was formally inaugurated on 11th January 1975. The Port has 16 berths and 1 SPM (Single Point Mooring) with a rated capacity of 98.00 million MT per annum. The port is approached through a 7.5 km long channel with water depths in the outer channel being 15.4 m and that of the inner channel being 15.1 m. The Port has a total land area of approximately 822 ha and water spread area of 120 ha. It handled traffic of 42.51 million MT during the year 2018-19 and 27.60 million MT during the year 2019-20 (up to December 2019). The port stands 8th in the country in terms of total traffic handled and 5th place in average output per ship-berth-day³⁸ at 18126 MT; and has the second-best turnaround time (TRT) among all major ports in the country at 1.91 days. The average capacity utilization at the port for the year 2019-20 was 52.74 percent and 43 percent for berths other than POL (Petroleum, Oil and Lubricants), which is amongst the lowest among all the major ports in the country.

2.7.3.1 Key challenges at New Mangalore Port

Due to the presence of Western Ghats on the east and lack of proper road and rail connectivity, New Mangalore port – the only major port in Karnataka – is in a state of isolation, cut off from its hinterland, including even the capital city, Bengaluru. Almost 55-60 percent of business from its hinterland is, today, routed to other ports such as Chennai, Cochin and even Krishnapatnam because of lack of connectivity.

³⁸The average output per ship berth day is defined as the ratio of the aggregate cargo to the total number of berth days

Historically, hinterland connectivity from NMPT has been the major hindrance even in attracting container cargo. Due to the presence of the Western Ghats, NMPT has limited hinterland connectivity to customers in Mysuru, Madikeri, Hassan, Shivamogga and Bengaluru. This cargo currently flows to Chennai via Bengaluru due to significantly better road infrastructure. In addition, feeder costs at NMPT are currently very high due to monopoly on both routes to Mundra and Colombo, which neutralizes the inland haulage advantage for these areas.

While most major ports in India suffer from congestion, lack of connectivity means New Mangalore port is struggling to even achieve 50 percent capacity utilization.

2.7.3.2 Boston Consulting Group (BCG) benchmarking study

The Boston Consulting Group was engaged by the Ministry of Shipping, Government of India, to carry out Quantitative Benchmarking study of New Mangalore Port on its operational, financial, human resources and efficiency related parameters for benchmarking against international standards and define Key Performance Indicators for the port and terminals. The study covered marine operations, stevedoring, jetty operations, vessel operations, yard performance, labor productivity, cargo storage, rake operations, maintenance, Gate-in & out operations, safety, customs and penetration of IT.

The final key observations and findings of the study are as follows:

1. Net profits have been declining since 2012 due to higher berthing and mooring costs, and lower cargo handling revenue.
2. NMPT has an average berth occupancy of 36 percent. Berth occupancy on general cargo berths is low and only berth 8 is highly utilized. Berth 8 handles mostly coal and fertilizer cargo and is equipped with 2 Private MHCs. Berth occupancy on POL berths is moderate and SPM is 35 percent occupied.
3. Berth productivity for containers at NMPT is significantly lower than other container handling ports. Most vessels rely on vessel gear as there are no quay cranes available. Vessels have to pay for use of MHCs and the reach of the current 64 MT cranes is limited. Hence, vessels only rely on vessel gear.
4. Hinterland connectivity, high shipping costs and sub-optimal container handling infrastructure restrict the flow to NMPT. Western Ghats have limited hinterland connectivity to customers in Mysuru, Madikeri, Hassan, Shivamogga and Bengaluru. This cargo flows to Chennai via Bengaluru due to significantly better road infrastructure.
5. Key industries in Mangaluru have a potential LNG demand if a terminal comes up at NMPT. There is a captive demand of approximately 2 million MT per annum in the Mangaluru city itself.
6. Fertilizer volumes at NMPT have decreased by 30 percent since 2008-09. Market share of NMPT in Indian fertilizer imports has decreased from 17 percent in 2006 to 4 percent in 2015. Lack of storage space inside the port is the key reason for fertilizer moving to other ports. Higher cost of handling fertilizer from discharge to rake loading due to double handling owing to lack of storage and bagging facilities inside the port and labor involvement in manual bagging and stitching.

7. Overtime costs for marine equipment in NMPT are high due to the two-shift deployment. Each employee has to work for 12 hours in a day as opposed to 8 hours in other ports and, hence, has to be paid 4 hours of overtime per day.

The key recommendations of the BCG benchmarking study to boost productivity were:

1. The port should set up a business development team for attracting customers in Mysuru and adjoining areas.
2. Port should engage with feeder operators to attract new players for starting operations at NMPT. Increased competition is expected to decrease feeder costs and increase frequency to key destinations of Mundra and Colombo.
3. Install a quay crane or a mobile harbor crane (MHC) for container handling on a PPP mode to increase productivity by 50 percent. Allocate additional yard space of 20,000 sq. m to handle additional volumes.
4. Setup an LNG terminal in NMPT.
5. Setup a mechanized facility for fertilizer handling on a PP basis to reduce handling costs thus attracting more cargo.
6. Reduce overtime cost in marine equipment by outsourcing mooring activities and migrating to a 3-shift deployment for tugs, pilot launches and mooring boats.

Important projects relating to Mechanization of Berth No. 14 for handling container and other clean cargo on PPP mode (INR 280.71 crores) and mechanization of Berth No. 16 (old No. 18) for providing equipment for handling bulk cargo on DBFOT Basis (INR 469.46 crores) have been completed. Installation of container scanners and mechanization of berths at NMPT have been carried out.

NMPT had entered into a concession agreement with M/s. Chettinad Mangalore Coal Terminal Pvt. Ltd (CMCTPL) for mechanized handling of coal and other bulk cargo in the year 2016. The entire coal cargo which was earlier handled in semi mechanized manner at various Berths of NMPT is now handled at the dedicated mechanized coal terminal. With the development of mechanized handling having a dust suppression facility, the dust pollution at NMPT will come down drastically. It will also increase the productivity and reduce turnaround time of vessels.

One study³⁹ found out that improvement in quality of port infrastructure and logistics performance would bring the greatest benefits to the economy of a country. The same study also noted that economic development is associated much more with the long-term capability of a port to attract more customers while creating and retaining employment and income. Therefore, if the quality of port infrastructure is not improved continuously, it may have a substantial adverse impact on the economy of a country.

The Government of India had instituted the Sagarmala program in March 2015 with a view to promote port-led direct and indirect development and to provide infrastructure to transport goods to and from ports quickly, efficiently and cost-effectively. The Sagarmala initiative will address focus on three pillars of development, namely (i) supporting and enabling port-led development through appropriate policy and institutional interventions and providing for an institutional framework for ensuring inter-agency and ministries/departments/states'

³⁹Munim, Z.H., Schramm, HJ. *The impacts of port infrastructure and logistics performance on economic growth: the mediating role of seaborne trade. J. shipp. trd. 3, 1 (2018)*

collaboration for integrated development (ii) Port Infrastructure Enhancement, including modernization and setting up of new ports, and (iii) Efficient Evacuation to and from hinterland.

Under the Sagarmala program, in Karnataka, a total 48 projects are planned with a total project outlay of INR 24,772 crores which include Port Modernization (24 projects, INR 6,795 crores); Port Connectivity (16 projects, INR 9,969 crores), Port-led Industrialization (2 projects, INR 7,520 crores) and Coastal Community Development (6 projects, INR 488 crores).

Under Port Modernization, 8 port capacity expansion projects (INR 3,039 crores) identified to add 300 lakh MT capacity at NMPT by 2025 are planned and a new major port is planned at Belikeri. 6 projects worth INR 454 crores are planned in minor ports such as Karwar Port, Old Mangaluru Port and Malpe Port.

Under Port Connectivity, 7 Road projects (INR 6,094 crores and 781 km), 6 Rail connectivity projects (INR 3,075 crores and 238 km) and 3 National Waterway projects (INR 800 crores, 111 km on Netravati River, Bengre to Netravati Dam, Dharmsthala on Netravati River and on Kabini River) are planned. One of the notable projects is the 6-lane straight road from Heggadde to Addahole, with (length of 23.6km), the key section in the road connectivity between Mangaluru and Bengaluru. Projects in some stretches between Mangaluru and Bengaluru have already been completed and others are in various stages of implementation.

Under Coastal Community Development, Skill development and 4 Fishing Harbor Projects are planned. Action plan for skill development has been prepared for 3 coastal districts (Dakshina Kannada, Udupi and Uttara Kannada) with INR 1.52 crores sanctioned and INR 0.76 crores released for Deen Daya Upadhyaya Grameena Kaushalya Yojana Scheme. Four fishing harbor projects with a project outlay of INR 391 crores are also planned. While the expansion of Malpe fishing harbor in Udupi is completed, construction of fishing harbors at Kulai in Dakshina Kannada, Hejmaadi Kodi in Udupi and Amadalli in Uttara Kannada are yet to be implemented.

To promote port-led industrialization, a Coastal Economic Zone (CEZ) is planned to be set up in Dakshina Kannada covering Udupi, Dakshina Kannada, Kodagu, and Mysore districts. The development of CEZ under Sagarmala Program is expected to provide impetus to the "Make in India" initiative of the Government of India, which will aid in creation of jobs in India. The CEZs are currently planned to be developed as Coastal Employment Zones (CEZs). Each CEZ will comprise Coastal Economic Units (CEUs), with single or multiple industrial clusters where there will be manufacturing units. This will promote ancillary manufacturing under MSMEs (Micro, Small and Medium Enterprises Development) and services activities and employment generation.

2.7.4 Karwar Port

Karwar port is situated at the northern extremity of the Karnataka coast at Baithkol, Karwar Bay about 100 km south of Mormugao Port on the southern side of the Kali River. Karwar port is the only all-weather natural port out of 10 minor ports of Karnataka. The port is operated by the Government of Karnataka, and services the hinterland of northern Karnataka, Goa and southern Maharashtra.

The length of the port is 355 meters. The quay has two berths, with a draft capacity of 9.25 m. The port is able to handle all types of commodities, including "B" and "C" class petroleum products. The port has liquid storage tanks for bitumen, furnace oil, molasses, and HSD.

As part of the Sagarmala project, expansion and modernization of Karwar port was planned. In addition, construction of infrastructure facilities to comply with MARPOL requirements was also planned, and the development works were initiated. However, the project has been stayed by order from the Hon'ble High Court of Karnataka consequent to a PIL filed by the Baithkol Bandaru Nirashritara Yantrikut Dhoni Meenugarara Sahakara Sangha following the withdrawal of the permission by the State Environmental Impact Assessment Authority and subsequent notices from the Karnataka State Pollution Control Board.

2.7.5 Other minor ports

The 'Karnataka Minor Ports Development Policy of 2014' has been implemented by the state government to increase the share of Karnataka state in the export and import sector, to handle 5-10 percent of India's total cargo in Karnataka and to enhance the potential of ports with public and private participation.

The government has proposed to upgrade and modernize six out of twelve minor ports in the state, which includes Belekeri, Manki, Tadadi, Honnavar, Pavinakere and Malpe ports.

2.7.6 Sustainable Port Development

The adoption of a sustainable development model is central to port upgradation/modernization for holistic development of coastal areas. This includes ensuring all port activities are fully compliant with current environmental regulations and use of renewable energy, water conservation, modern waste management (zero waste and circular economy approach) and energy efficiency are also synergically implemented.

2.8 Undersea Communication Channels and Cables

Submarine cables play a critical role in global interconnected networks, carrying about 99 percent of international communications traffic⁴⁰. Sharp growth in demand for data, fueled by bandwidth-intensive applications such as video and a proliferation of cloud-based services, has considerably driven the increase in global submarine cable deployments. The five-year period between 2014 and 2019 saw an average 26 percent increase in available capacity per year on major routes⁴¹.

The history of submarine communications cables goes back to 1850, when the first cable was laid across the English Channel to allow telegraph communications between the United Kingdom and continental Europe. Today, submarine cables use fiber-optic technology, whereby information is encoded onto light waves transmitted by lasers across thin glass fibers. The data transfer capacity varies with the optical technology used, but today's most advanced fiber links are capable of transmitting over 200 terabits per second.

There were approximately 378 submarine cables in service as of early 2019, traversing roughly 1.2 million km, connecting virtually all countries with a coastline. The cables run along the ocean floor joining nations that have large volumes of traffic to exchange.

Submarine cables are predominantly owned by consortiums of telecommunications carriers that join together to pay for these expensive projects. In the late 20th century, during the "dot-com" bubble, entrepreneurs took on some private projects, reselling the capacity once it was completed. In recent years, major web companies, such as Google, Facebook,

⁴⁰Wayne Nielsen, et al., "Submarine Telecoms Industry Report, 7th Edition" Submarine Telecoms Forum (2019)

⁴¹Submarine Telecoms Forum Report

Microsoft, and Amazon have increasingly invested in their own cables, outpacing the traditional Internet backbone providers.

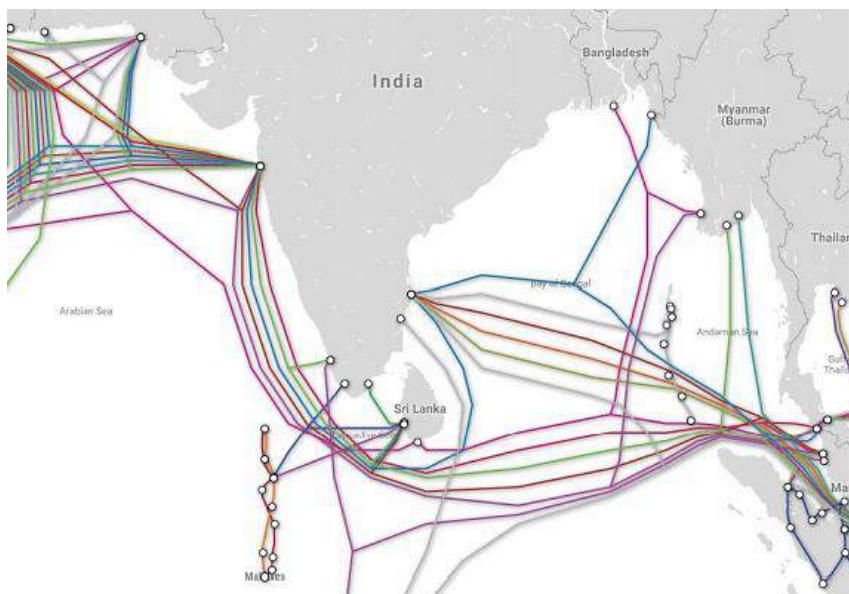


Figure 2. 9: Existing Submarine Cables near India
(Source: Information Technology & Innovation Foundation)

Submarine communication cables are laid on the sea beds between land-based cable landing stations (CLS) in order to transmit telecommunication signals across seas and oceans. The efficient transmission of telephone calls and internet data between countries depends on these expensive fiber optic cables laid in the sea bed.

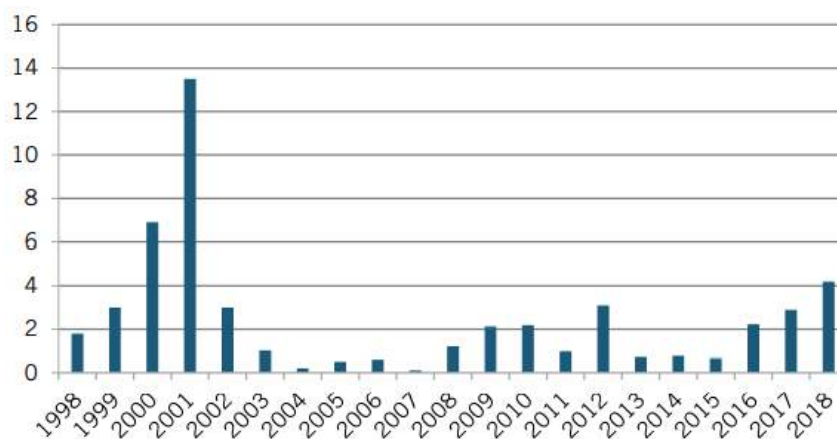


Figure 2. 10: Global Submarine Cable Capex (\$B)
(Source: Submarine Cables: Critical Infrastructure for Global Communications, Information Technology & Innovation Foundation)

Currently, in India there are 17 subsea cable landings in 15 cable landing stations in six cities across India, namely Mumbai, Chennai, Cochin, Pondicherry, Tuticorin and Trivandrum owned by six service providers (Tata Communications, Airtel, Global Cloud exchange, Reliance Jio, BSNL, Vodafone, Sify and IOX.). BSNL plans to construct new cable landing stations in Digha, Cochin, and the Andaman & Nicobar Islands. IOX is planning to construct a new cable landing station at Puducherry. Reliance Jio is also planning for new

cables and a landing station. Some of the key submarine cable routes in India are Mumbai-Marseilles and Mumbai-Dubai in the west and Chennai-Singapore-Hong Kong in the east.

In the interest of developing high speed internet communication channels between the countries, India needs deployment of more subsea cable routes.

As Mangaluru is in close proximity to Bengaluru and in view of the emergence of Bengaluru as a major international software center, Mangaluru can be considered for establishment of cable landing stations.

2.9 Deep Seabed Hydrocarbon Mining

Oil and gas are formed from organic material (flora (plants) and fauna (animals)) mainly deposited as sediments on the seabed and then broken down and transformed into hydrocarbon bearing fossil fuels such as petroleum (crude oil) and natural gas, over millions of years. Petroleum and natural gas usually occur together within sedimentary structures, with heavier petroleum at the bottom and lighter natural gas floating at the top of the synformal structure.

Petroleum is a naturally occurring complex mixture predominantly made up of carbon and hydrogen compounds, but also frequently containing significant impurities of nitrogen, sulfur, and oxygen together with smaller amounts of nickel, vanadium, and other elements. Petroleum (also known as “black gold”) or crude oil can be distilled and separated into petrol, aviation/jet fuel, diesel, kerosene, and heating oil. Besides, lubricating oils, waxes, gels, and asphalt (tar) also occur as byproducts during fractional distillation of petroleum in refineries.

Natural gas is a mixture of hydrocarbons consisting essentially of saturated light paraffins such as methane and ethane, both of which are gaseous under atmospheric conditions. Besides methane and ethane, the natural gas may also contain other hydrocarbons, such as propane, butane, pentane, and hexane.

2.9.1 Oil & Gas exploration

In the first stage of the search for hydrocarbon-bearing rock formations, geological maps are reviewed in desk studies to identify major sedimentary basins. More detailed information is assembled using a field geological assessment, followed by the main survey methods: magnetic, gravimetric and seismic. The Seismic Method is the most common assessment method used for identifying geological structures and relies on the differing reflective properties of sound waves to various rock strata beneath terrestrial or oceanic surfaces.

Once a promising geological structure has been identified, exploratory boreholes or ‘exploration wells’ are drilled to confirm the presence of hydrocarbons and the thickness and internal pressure of the reservoir. Where a hydrocarbon formation is found, initial well tests are conducted to establish flow rates and formation pressure. If commercial quantities of hydrocarbons are discovered in exploratory drilling, more wells are drilled to determine the size and the extent of the field. Having established the size of the oil field, ‘development’ or ‘production’ wells are subsequently drilled. The number of wells required to exploit the hydrocarbon reservoir varies with the size of the reservoir and its geology. Once the hydrocarbon reaches the surface, it is routed to the central production facility, which gathers and separates the produced fluids (oil, gas and water). Oil is nearly always processed at a refinery; natural gas may be processed to remove impurities either in the field or at a natural gas processing plant.

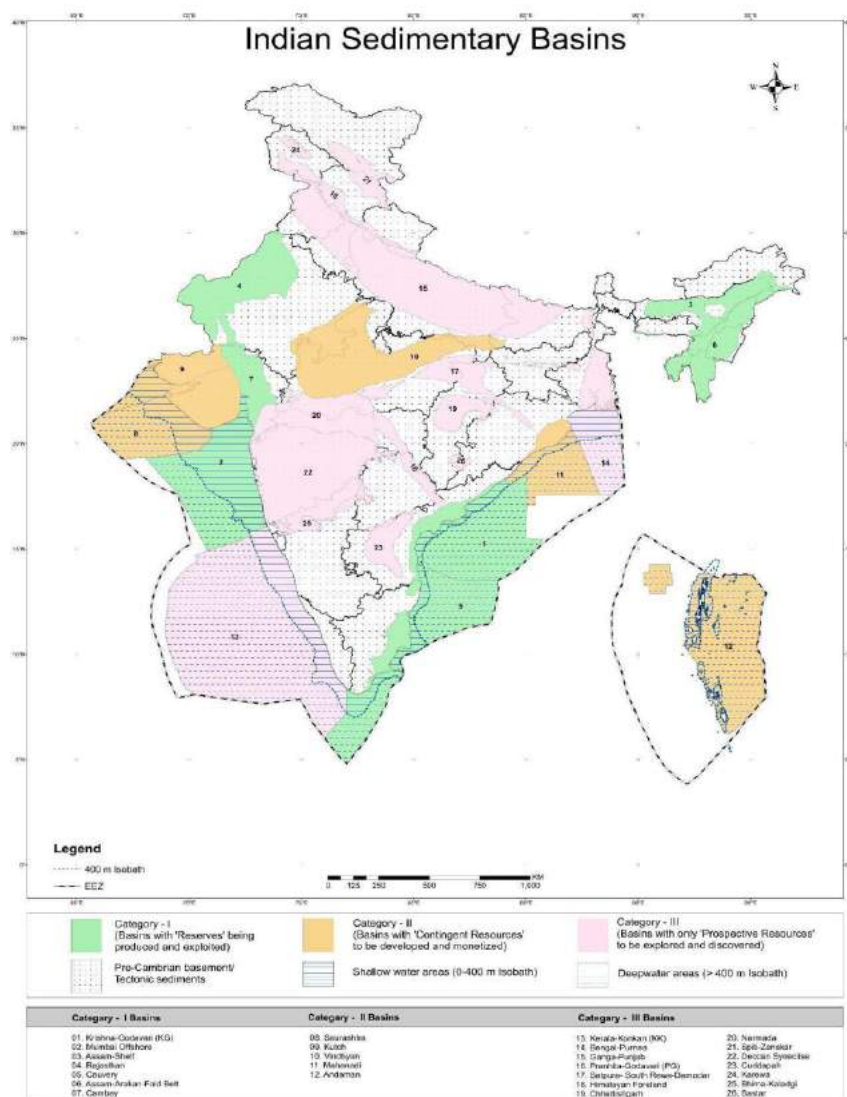


Figure 2. 11: Sedimentary Basins of India

2.9.2 Oil and Gas exploration in India

In view of the liberalized policy adopted by GoI, a need for an independent upstream regulatory body called the Directorate General of Hydrocarbons (DGH) was envisaged to oversee and review the oilfield development programs so as to conform to sound reservoir engineering practices in line with national interests. Thus, DGH was formed vide GoI resolution dated 08-04-1993.

After the Nomination era till late 1970s, Pre-NELP Exploration era (1980-95) and Pre-NELP Field rounds (1993-94), Government of India formulated a policy called New Exploration Licensing Policy in 1997. The main objective was to attract significant risk capital from Indian and Foreign companies, state of art technologies, new geological concepts and best management practices to explore oil and gas resources in the country to meet rising demands of oil and gas. This policy, NELP, was approved in 1997 and it became effective in February, 1999. Since then, licenses for exploration are being awarded only through a competitive bidding system and National Oil Companies (NOCs) are required to compete on an equal footing with Indian and foreign companies to secure Petroleum Exploration Licenses (PELs). Nine rounds of bids have so far been concluded under NELP, in which production sharing contracts for 254 exploration blocks have been signed.

2.9.3 Kerala-Konkan basin

The Kerala-Konkan basin is located south of 16° N latitude. The Kerala-Konkan offshore basin forms the southern part of the 15th western continental margin of India and extends from Vengurla Arch in the north to Cape Comorin in the south. Westward, the basin extends to the Arabian Abyssal plain. On the eastern side it is bounded by the peninsular shield. This basin covers an area of around 580,000 sq.km.

The Karwar Formation (Eocene) has rich organic matter while the Kasargod Formation (Late Paleocene) has fair-to-good source potential. The Kerala-Konkan Basin holds promise for hydrocarbons and the prognosticated resources of the basin are estimated to be 660 million MT.

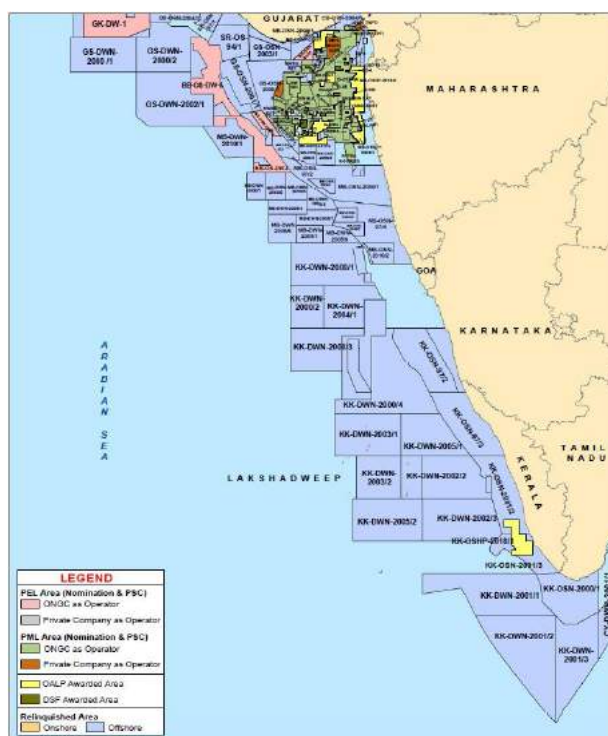


Figure 2. 12: Mumbai Offshore and the Kerala-Konkan Basin

Drilling results and adsorbed gas anomalies confirmed the generation of hydrocarbons in the basin. 15 exploratory wells have been drilled so far, but none of them are producing. Wells such as Kasargod-1, KK-OS-V1-1 and CSP-1 showed faint oil fluorescence.

The total number of blocks offered in different NELP rounds is 16. Blocks under operation at present are 12. The major operators in the Kerala-Konkan basin are Oil & Natural Gas Corporation (ONGC) and Reliance Industries Ltd (RIL).

Details of various blocks off the coast of Karnataka and their current status are provided below:

Sl. No.	Block Name	Consortium Interest	(Participating	Round	Current Status
1	KK-OSN-97/2	RIL-100 percent		NELP-I	Relinquished
2	KK-DWN-2000/1	RIL-100 percent		NELP-II	Relinquished

3	KK-DWN-2000/2	ONGC-85 percent, GAIL-15 percent	NELP-II	Relinquished
4	KK-DWN-2000/3	RIL-100 percent	NELP-II	Relinquished
5	KK-DWN-2000/4	ONGC-100 percent	NELP-II	Relinquished
6	KK-DWN-2003/1	RIL-100 percent	NELP-V	Relinquished
7	KK-DWN-2004/1	ONGC-45 percent, CIL-40 percent, TATA-15 percent	NELP-VI	Relinquished

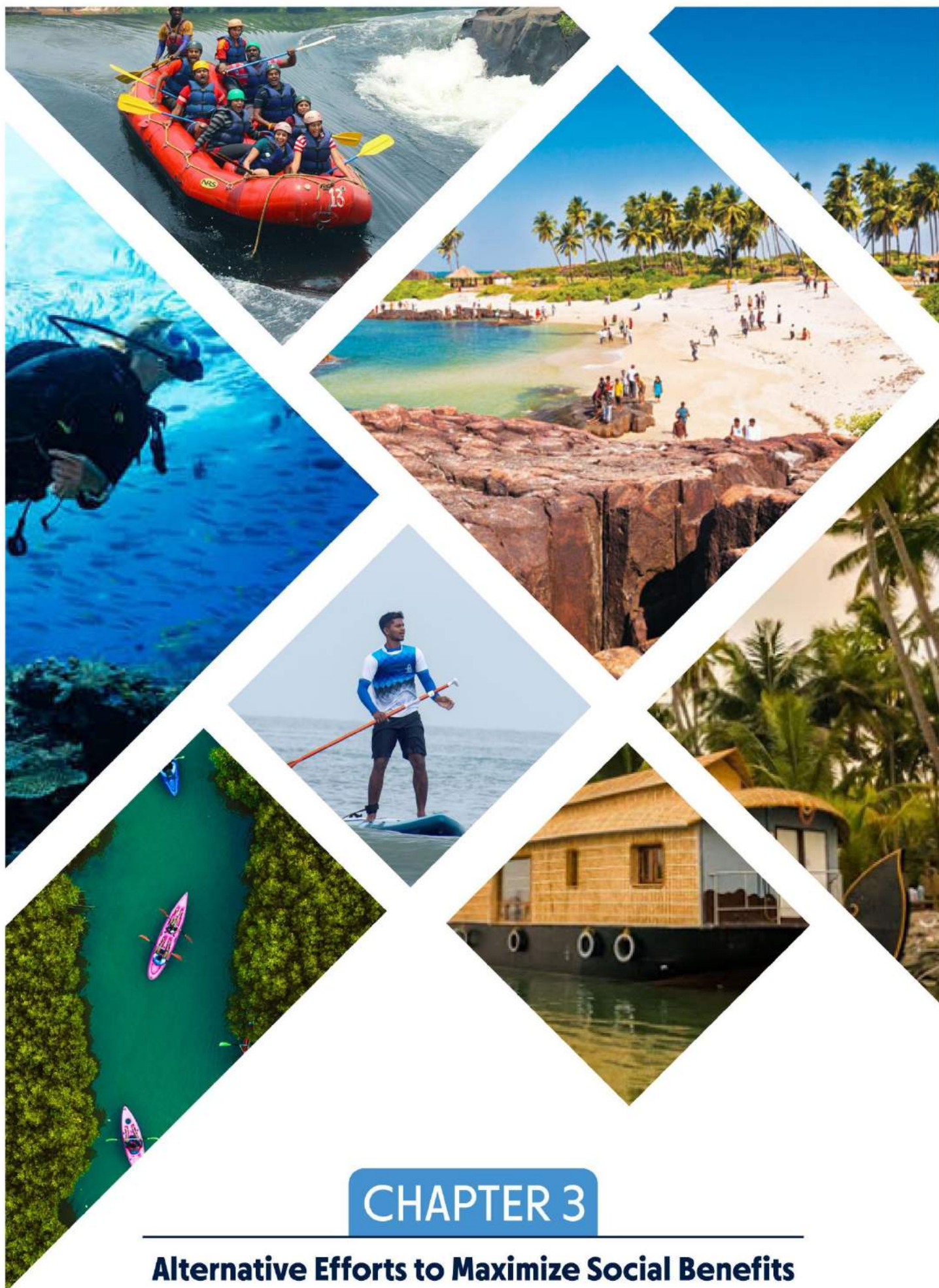
Table 2. 2: Details of Oil & Gas Blocks off the Coast of Karnataka

Hydrocarbons have been discovered all through coastal areas of India except Kerala-Konkan basin. In Kerala-Konkan basin, a petroleum system has not been established till date. Wells drilled in Kerala-Konkan have shown the presence of hydrocarbons while drilling, but production testing results are not encouraging. The Kerala-Konkan basin is considered to be a rare opportunity and turning it into a proven value accretion would necessitate an exploratory paradigm shift in terms of concepts, technology and personnel expertise. However, in the future, the Kerala-Konkan basin can be taken into cognizance in view of future exploration activity under the Open Acreage Licensing Program (OALP)

2.9.4 Onshore Basins in Karnataka

The on land sedimentary basin area in Karnataka is 21 percent of its total geographical area of approx. 191.8 thousand sq km. There are three distinctive basin/ sub-basin areas present. The Deccan Syncline basin occupies 68 percent, Kaladgi sub-basin 19 percent and Bhima sub-basin 13 percent of total state basin area of approx. 41 thousand sq km.

Till date, exploration for oil/gas reserves has not been carried out in the inland basins of Karnataka.



CHAPTER 3

Alternative Efforts to Maximize Social Benefits from Blue Economy Resources

Chapter 3: Alternative Efforts to Maximize Social Benefits from Blue Economy Resources

3.1 Introduction

Blue Economy – a term that is being increasingly used in various marine sectors and in development frameworks - covers social inclusiveness, improved livelihoods and environmental sustainability in order that the sustainable use of ocean and coastal ocean-dependent resources for economic growth are achieved.⁴² Blue economy implies "sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of the ocean ecosystem."⁴³ It follows that achieving a Blue Economy should enable livelihood opportunities for hundreds of millions of the poorest and most vulnerable people, including women and the indigenous people.

Blue Economy achieves importance in the wake of the countries across the globe committing to achieving Sustainable Development Goals (SDG), which aims at 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.⁴⁴ To conserve and sustainably use the oceans, seas and marine resources for sustainable development- *Life below Water*- is Goal 14 of SDG.

To achieve the SDGs, it is crucial to increase the contribution of fisheries and aquaculture towards food and nutritional security⁴⁵. 33 of the 169 targets under SDG can be achieved, it is said, if Blue Economy is achieved. However, it is critical that in the process of achieving SDGs the social dimensions are not overlooked but are well integrated within the Blue Economy.

It is argued that for the Blue Economy to be truly effective in contributing to achieving Sustainable Development Goals, social benefits and equity must be given at least the same amount of attention as environmental and economic concerns. The need for addressing social concerns to achieve sustainability and economic growth and focusing on social equity will facilitate "bridging the common divides between economic and environmental goals in development planning." Addressing social equity by "including human rights, access to resources, and ensuring an equitable share of benefits and costs" is therefore of utmost importance.⁴⁶

Consequently, the 'blue economy' concept seeks to promote economic growth, social inclusion, and preservation or improvement of livelihoods while at the same time ensuring environmental sustainability. It denotes marine-based economic development that leads to improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities⁴⁷. Characteristically, Blue Economy provides social and economic benefits for current and future generations by contributing to food security, poverty eradication, livelihoods, income, employment, health, safety, equity and political stability.⁴⁸

⁴²www.undp.org

⁴³The World Bank

⁴⁴Brundtland Commission, 1987 as quoted in *Life Below Water, Sustainable Development Goals* by By Ramachandra Bhatta, Lead Author, May 2019

⁴⁵FAO 2018

⁴⁶Cisneros-Montemayor, A.M., Moreno-Báez, M., Voyer, M., Allison, E.H., Cheung, W.W.L., Hession-Lewis, M., Oyinlola, M.A., Singh, G.G., Swartz, W. and Ota, Y. (2019). Social equity and benefits as the nexus of a transformative Blue Economy: A sectoral review of implications. *Marine Policy*, 109: 103702

⁴⁷UNEP 2013

⁴⁸The Potential of the Blue Economy, A recent report by the World Bank and the UN in June 2017

3.2 The Context

An assessment of the Blue Economy potential needs to keep in view the overall sustainability, potential economic growth, environmental concerns and the livelihood security of the coastal communities in the unexplored and underutilized sectors and areas. It is with this concern in mind that a Rapid Assessment of the Blue Economy in the state of Karnataka is being explored.⁴⁹ In the context of this study, Blue Economy is taken in the broader concept of one which denotes everything aquatic. In doing so, the study endorses the sustainable development goal - Goal 14 of SDG-*Life below Water*.

The assessment is based on the available secondary data. Where plausible, references/ derivatives are made by referring to data relevant to the issue/s with sources/practices followed elsewhere in India. Unfortunately, due to the pandemic discussions with the stakeholders of the coastal communities, which would provide rich dividends, were not possible. It must also be said that data availability in this sector is limited and has proved to be a constraint in assessing the true potential of the project pertaining to Karnataka. Further, site-specific studies using different methodology of data collection, including from primary sources, would be required before arriving at meaningful conclusions.

3.3 Karnataka

The State of Karnataka is endowed with rich natural resources comprising various attractive places both of heritage value and natural landscapes. Wild life, temples, forts, waterfalls, Western Ghats, hill stations, rivers and coasts mark the landscape of Karnataka. Among the Indian states, Karnataka ranks fifth as the preferred tourist destination. The figures of 2010 show that 3.8 lakh international and 382 lakh domestic tourists visited the state during the year. The tourism policy of Karnataka has set as its goals to promote tourism as the state's principal and largest economic activity in the overall capacities of an employer, revenue-generator and engine of growth. Tourism has been given high priority and is instrumental for the socio- economic growth of the State as well as providing employment opportunities for both skilled and unskilled manpower. The Sector is attracting significant investment from domestic and global players as infrastructure is being ramped up to meet the needs of the growing tourist activity⁵⁰.

Karnataka's coast consists of three districts - Dakshina Kannada, Udupi and Uttara Kannada and is known colloquially as 'Karavali'. Karnataka's coast is bestowed with rich natural resources and socio-cultural fabric covering a 300 km coastal line with 162 fishing villages representing 4.60 percent of the country, with one village for every 2.00 km of the coastline. The state ranks third in marine fish production in the country (2017-18). The fish production per fishing unit is around 20 MT/year which is above the national average of around 15 MT (GoI 2016). The three districts host 35,507 active marine fishers and 11,884 fishing crafts (CMFRI, 2016). For an overview of the socio-economic profile of the three districts see Table 3.1

The marine fisheries resource potential of the State is estimated at 4.25 lakh MT, of which 2.25 lakh MT arises from inshore areas up to a depth of 70 m and the remaining 2 lakh MT from the offshore/deep sea zone. As per the government records of 2018, 75 percent of the total fishers are small-scale fishers contributing only 15 percent of the total marine fish production, which leaves a lot of room and untapped potential for gearing up the Blue Economy.

⁴⁹ToR of 'Rapid Assessment of the Blue Economy Potential in Karnataka'

⁵⁰Development of Adventure Sports Camps on Public Private Partnership Model at various locations in Karnataka, Preliminary feasibility report, Feedback Infra, April 2012

Details	State	Dakshina Kannada	Udupi	Uttara Kannada
Total population (lakhs)	611.31	20.85	11.78	14.40
Decadal population growth rate (percent)	15.67	9.80	5.90	9.20
Area (in sq. km)	1,91,791	4,866	3,575	10,291
Density of population (persons per sq. km)	319	457	287	240
Literacy level (percent)	75.60	88.62	86.29	70
Percentage of workers to total population	44.3	50.0	44.0	40
Net District total income 2007-08 (in lakh) at current price	2,11,66,253	9,69,984	4,73,922	56,0503
Per capita income (in INR) 2017-2018 (At constant price 1999-2000)	36,945	47,151	39,307	36,243
Rank based on Human Development Index	7	2	3	5
Net district income from fishing 2017-18 (in INR lakhs) at constant price	79,773	22,534	20,529	19743
Percentage contribution of fishing to total income	0.38	2.32	4.33	4.2

Table 3. 1: Profile of the Three Maritime Districts of Karnataka

For maximizing the social benefits from Blue Economy, the area/sectors of Karnataka that are explored are (i) Onshore and nearshore islands (ii) Coastal protection works (iii) Blue Tourism and Ecotourism including aquatic sports.

3.4 Onshore and Nearshore Islands

Islands - onshore and nearshore - provide ample scope for expansion of the blue economy. This hitherto unexplored sector has the potential to create benefits, in terms of creating livelihoods, for the local community. The exploration of this sector is backed by the Government of India initiative which while emphasizing on holistic development of the islands includes providing key infrastructure to the islands, enabling solar energy self – sufficiency, digital connectivity, green energy, desalination plants, waste management as also promoting fisheries and tourism-based projects, all of which would increase the social benefits of the region. Furthermore, the development in these islands is bound by the Islands Integrated Management plan as provided in the Island Protection Zone Notification, thereby ensuring ecological sustainability.

The example of Lakshadweep Island can be cited to show the increase in tourism growth owing to provision of infrastructure (launch of Star Cruise Ship (2006-07)). The tourist arrival which was a meagre 2120 (Indian and foreign) during 1999-2000 drastically increased to 25083 (Indian and Foreign) during 2006-2007. Likewise, the revenue generated from tourism rose from 1.27 crores in 1999-2000 to 7.3 crores in 2006-07.

In Karnataka, there are a few islands which attract tourists seasonally (See Box 3.1)

Box 3. 1: Islands in Karnataka with High Tourism Potential

Some of the islands which have shown a great potential for development are as follows:

Devbagh Island, located close to Goa border, has pristine beaches, with casuarina trees adding greenery to the landscape. This island is a popular water sports destination and provides opportunities to watch Dolphins and to make a trawler tip and Island hop across to Kumaragarh Island, Oyster Rock, Anjadiv Island and Sanyasi Island.

Kurumgad Island is a tortoise shaped island located four kilometres off the coast of Karwar. It is a private island, has an old fort, a temple and a resort. The island can be reached by a 45- minute ferry ride from Karwar.

Sadashivgad is located close to Karwar, it hosts a temple, fort, Ayurveda resort and a beautiful view of the sea and other islands and rivers

Anjadiv Islands (Anjadip or Angediva) covers an area of 1.5 sq km and is the largest of the Karwar Panchdiva or chain of five islands. Anji stands for five in Tamil and it denotes the fifth island. This idyllic island is home to the Indian Navy. The island has some remains of the bygone Portuguese era, some old houses and Church ruins. Portuguese poet Luis de Camoes described it as the "Island of Amours".

Basavaraja Durga Island located at Honnavar situated 90 km from Karwar, has a Portuguese fort which can be reached by a sail upstream on river Sharavathi.

Madlingadh Island, Sanyasi Island, Devgad also known as Oyster Rocks.

Netrani Island of Uttara Kannada is known for coral reefs. It is being utilized for day tourism because of their small geographical sizes. The clear waters here attract a lot of tourists for snorkeling and scuba diving.

St. Mary's Island located in Udupi district is also utilized for day tourism. St Mary's Island is a group of small beautiful islands located north of Malpe beach from where it can be reached by boat in 30 minutes. The island has two beautiful beaches and crystallized basalt rock formations which are unique and rarely found, giving a special landscape effect to the place. Coconut trees, church and white sands add to the seascape.

The Onshore/ Nearshore Island tourism sector is still in its nascent stage. As per the information collected for purposes of this Rapid Assessment, there are around 101 onshore and near-shore islands in Karnataka. The details of these 101 Islands with their coordinates, elevation and area in sq. meter are provided in Chapter 3 Annexure 1.

In light of this, there is ample scope for sustainably developing some of these islands by including resorts/ tourist spots.

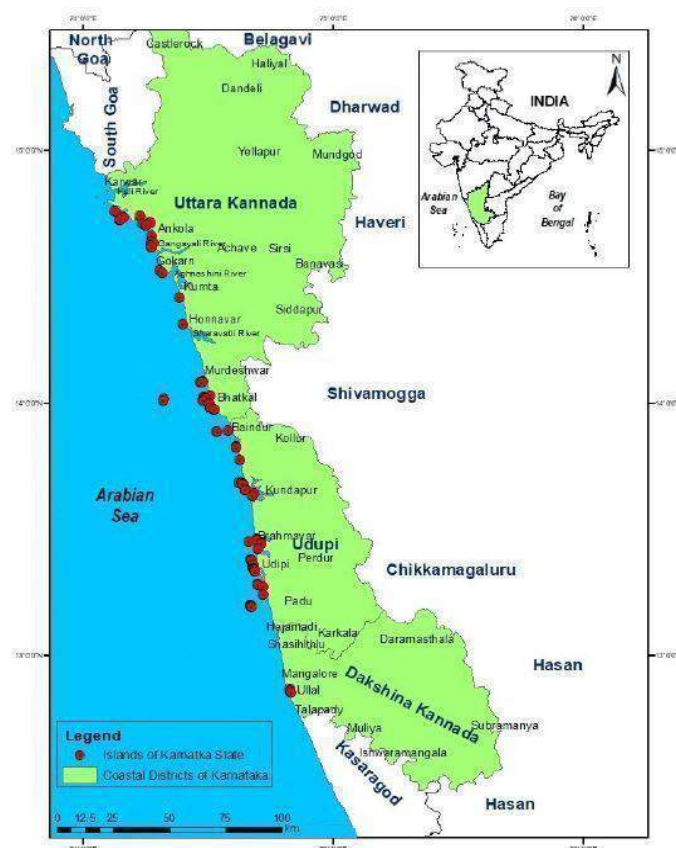


Figure 3. 1: Locations of Islands along Karnataka coast

Based on the geographical area of the islands and other parameters, a neatly designed development plan fleshing out the various tourist and allied activities could be a step closer in the direction of achieving full economic growth. Systematic analysis of the islands, formulating suitable strategies, effective implementation of well-planned strategies keeping in view the holistic development of the identified islands, would lead to creation of more jobs and generate additional income for the community. Developing a strategy to explore the Island Tourism Potential and its related social benefits needs to take into active consideration the socio-cultural and historic aspects as well as its unique environments, and it is in these very aspects that a special challenge lies. The recommendations for Island development have been provided in the **Summary Outline Blue Economy Development Plan**.

3.5 Use of Coastal Protection Works as generation of recurrent income

With climate change, onslaught of anthropogenic activities and other interventions at the sea coasts, the three maritime districts of Karnataka have shown substantial reduction in the beach width over time. Sand mining, removal of beach sand for landfills, plinth fillings and other uses upset the sediment equilibrium and result in erosion. The reduction in sea coasts has had the disadvantage of biting into the land space and in creating uncertainty and trauma to the coastal communities, accentuated especially during the rainy seasons. Degradation of coastal ecosystems has uneven impacts, with the poor communities being more susceptible.

In order to protect the coasts from erosion, many measures have been taken up in Karnataka. One of the common forms of coastal protection works is the construction of seawalls that are more often taken as emergency disaster management measures. Sea walls are not a permanent solution for protection of eroding beaches since they have short

lifespans and are considered as a waste of financial resources that is being unnecessarily spent, as per most of the coastal communities. They are destroyed by huge waves during the South West monsoon period. Beaches in front of them are lost and the near shore gradient becomes steeper. In most cases they shift the erosion site to adjacent sides. However, some coastal communities that are ignorant of the end effects of sea walls do demand it, which has further intensified erosion problems.

Of late, however, the Government of Karnataka, with loan support from the Asian Development Bank, has taken up the Sustainable Coastal Protection and Management Investment Program (SCPMIP) wherein site-specific interventions based on systematic studies are implemented to ensure that the protection measures remain sustainable and benefit the community. Sites prone to severe erosion are protected by implementing hard measures (such as revetment, groynes, offshore reefs) and those with less severe erosion are being protected by soft solutions such as dune creation and planting of vegetation (native species). In some cases, both hard and soft solutions are found suitable as a mixed solution. The areas along the coast of Karnataka where the protection works are undertaken, the nature of the protection work under SCPMIP and the potential that they offer to promote blue economy are given below:

Sl. No	Sub project sites	Coastal District	Type of coastal protection work	Potential
1	Ullal	Dakshina Kannada	Offshore reefs, Inshore berms and rehabilitation of breakwaters	Tourism
2	Someshwara		Offshore reefs, Inshore berms and Sand nourishment	Tourism
3	Mukkachery		Rehabilitation of Rock revetment along with retaining wall	--
4	Maravanthe-Trasi	Udupi	T and I groynes	Fish Cage, Tourism
5	Kodi Bengre		Rehabilitation of Rock revetment	Tourism
6	Udyavara		Groynes and rehabilitation of rock revetment	Tourism
7	Kodi Kanyana		Dune Plantation	Ecotourism
8	Yermal Thenka		Rehabilitation of Rock revetment	Tourism
9	Community Sites	Uttara Kannada	Dune Creation and Plantation	Ecotourism

Table 3. 2: List of Coastal Protection Projects under SCPMIP
(Source: SCPMIP Reports, 2014-2020)

The benefits to the community as a result of protecting the coasts are many. Of prime importance is the protection of coasts against erosion and flooding. This has a tremendous impact on the psychological ambit of the coastal community, especially women and children as they often face the trauma of losing land and infrastructure as also being relocated. This has been a recurring phenomenon which they go through every monsoon at sea coasts

which, prior to coastal protection implementation works, witnessed severe erosion. The drain on the state exchequer because of relocation would also be tremendously reduced under the new blue economy banner.

The sites at which coastal protection works have been implemented offer ample scope for opening up of newer avenues which can provide recurring income to the local community, women included. The areas offer tremendous scope for beach tourism and its allied services. It would also provide employment to the less skilled local community who could open roadside (petty) shops that would offer eateries to the travelers/tourists.

The employment potential for the women can have manifold increase by building capacities with required skill sets - the ones that could build their capacities to hone green skills too - especially in the hospitality and tourism sectors.

The youth, from the local community, also could find employment as lifeguards. SCPMIP Tranche 2 exploration has shown this as a requirement that the youth from the fishermen community has put forth. The locally formed Community Based Organizations, called the Shoreline Management Organizations (registered under the Karnataka Registration of Societies Act, 1960), could be contacted as the nodal points, to select able and interested youths from the local fishermen community, especially those who could increase their household income by pursuing this as a profession.

Site specific interventions such as locating marine fish cages – at sites like Maravanthe – are a rich source of employment generation activities that could be fruitfully pursued. Also, at other sites such as Someshwara, the offshore reefs can be used for locating fish cages where around 500 or more cages of marine fishes can be stocked for culture. Further, raft culture of edible oyster, clumps, seaweed can also be gainfully taken up.

The community projects where soft solutions of dune creation and planting of vegetation (green walls) are taken up to stabilize the dune/beach will have the additional advantage of providing flora that is rich in medicinal, nutritional and industrial value (for more details see Karnataka SDG report, life below water⁵¹). Hence, green walls (casuarina trees, Ipomoea pes-caprae and other salt tolerant plants) are to be given preference for coastal protection instead of sea walls will also provide easy access to the sea for fishermen, maintain aesthetics of the beaches and Natural resources (mainly hard rocks) are conserved which are essential for various developmental activities”

In addition, to promote vegetation planting, plant nurseries are established which train personnel in skills of plant multiplication and cultivation, thereby providing additional avenues of income generation for the local community. This sometimes is the preferred option for women when the nurseries are established closer to their homes. SCPMIP has shown that this skill has had the additional advantage of women growing vegetables near their homesteads, thus saving on expenditure on purchase of vegetables and/or increasing the nutrient content in their dietary habits. The recommendations for Island development have been provided in the **Summary Outline Blue Economy Development Plan**.

3.6 Blue Tourism and Ecotourism

The tourism sector is the largest and fastest growing economic sector in the world. For many countries, it is a major source of foreign exchange earnings. Several countries around the world are even wholly dependent on tourism. Tourism contributes to Gross Domestic Product (GDP) through its contribution to employment and income. The travel and

⁵¹Ramachandra Bhatta (Lead Author), Sustainable Development Goals, 'Life Below Water', Department of Planning, Program Monitoring and Statistics, Government of Karnataka, Bengaluru, May 2019

tourism GDP is around 10.4 percent of the global GDP. GDP growth in the global travel and tourism sector is around 4.6 percent and is higher than prominent sectors such as manufacturing (4.2 percent), Information & Communication (3.6 percent), Healthcare (2.6 percent), Agriculture (2.5 percent) and Financial Services (2.5 percent). The contribution of travel and tourism to the global economy has increased from 6.75 trillion USD to 8.6 trillion USD representing a 4.56 percent year-on-year growth. Asia Pacific is the fastest growing region in the tourism sector. Globally 313 million jobs are supported by the travel and tourism sector, which is about 9.9 percent of the global employment. Travel and tourism are a major category of international trade in services. The top 3 countries per total travel and tourism contribution to GDP in 2017 are US (1.5 trillion USD), China (1.3 trillion USD) and Germany (395 billion USD). Out of 185 countries, India ranked 7th in the 2017 list with 234 billion USD, 99th place in contribution to GDP, and 6th place in growth in 2018.

There are different types of tourism such as Adventure Tourism, Religious Tourism, Cultural Tourism, Medical/Health Tourism, Wildlife Tourism, Recreational Tourism, Historical Tourism and Ecotourism. As can be seen, Tourism has a great potential to generate employment, income, better the lifestyle of the people and impact the local, state and the nation's economy beneficially.

Karnataka ranks 4th in India in tourism. The state has various tourism assets such as beaches, hill stations, heritage monuments, national parks, wild life sanctuaries etc. Given the variety of the tourism assets, the state is promoted under the tagline "One state, many worlds". It has the largest number of tourist destinations (319) in India. The State has the second-highest number of protected monuments in the country (507 centrally and 750 additionally protected by the State Government) in nature and wildlife. During the last five years, Karnataka has seen more than 100 million tourists cross its borders. Karnataka has 25 wildlife sanctuaries and five national parks. Rough Guides Magazine of England has reported that Karnataka is one among the Top 10 Valuable Tourist destinations in the World.

With the largest number of institutes in hotel management and catering technology in the country, the State has a large pool of skilled human resources. The Sector is attracting significant investment by domestic and global players as infrastructure is being ramped up to meet the needs of the growing tourist activity.

Over the years, Karnataka has taken major steps to promote tourism in the state. One of the early initiatives that was taken was the setting up of Karnataka State Tourism Development Corporation in the year 1971 to provide basic needs of accommodation and transport facilities to the visiting tourists at its various destinations. Subsequently, Jungle Lodges & Resorts Ltd was set up in 1980 to promote Eco & Adventure Tourism and it currently owns 18 resorts across the state.

Additionally, the incredible views and stunning scenic beauty of the coastal, riverine and estuarine areas have the potential to make Karnataka one among the most sought-after destinations for water-based tourism, throwing open a whole new world of investment opportunities. However, to tap this vast potential the Government of Karnataka has to come up with various schemes and projects for the investors in houseboats, watersports, perfecting its role as a facilitator, catalyst and aggressive promoter of water-based tourism in the State. To promote the growth of water-based tourism as a major industry in the State, several incentive packages could also be offered by the Government to entrepreneurs, especially women. These include subsidies, technical guidance, marketing assistance, publicity through government publications, help in availing loans etc.

3.6.1 Coastal Tourism

Karnataka has some of the most pristine beaches in India. With a 320 km long coastline spanning three districts and numerous coastal villages, beaches here are picturesque, serene and full of natural beauty. However, the full tourism potential of these beaches is yet to be recognized and tapped.

Some of the coastal tourism spots along the shore/near-shore destinations in the three maritime districts that have the potential to be sustainably developed are highlighted below:

1. Panambur Beach: Panambur Beach is one of the most popular beaches in Mangaluru city in coastal Karnataka famous for its dramatic sunset. The beach aura warms up during the angling carnivals, kite flying contests organized by the district authorities. The festivities include boat races, beach sports and sand sculpture contests. Panambur beach has jet ski rides, boating, dolphin viewing, food stalls, besides trained beach lifeguards and patrol vehicles to ensure the safety of the visitors to the beach.
2. Someshwara Beach: Someshwara beach is known for its sunset view. The place is dotted with several large rocks with the presence of beautiful hills and lush greenery in its vicinity. The spectacular views of the hills and beautiful trees at the time of dawn and dusk are definitely worth watching.
3. Tannirbhavi Beach: Tannirbhavi beach is dotted with trees and offers a picturesque landscape. The beach has been recently developed and currently has some basic facilities like lifeguards, toilets, parking lot, few eateries and concrete benches. There is a 15-acre wide tree park nearby and a collection of trees from Western Ghats, special herbs and medicinal plants. The tree park is worth visiting.
4. Ullal Beach: Ullal Beach is one of the most serene beaches in Karnataka. Set in about 14 acres of casuarina groves, the beach offers a breathtaking view during sunset.
5. Surathkal Beach: Surathkal Beach, on the shores of Arabian Sea, is a clean beach with tremendous scenic beauty. The beach has a curving shoreline and a lighthouse at the end of the beach.
6. Sasihithlu Beach: The beach has stunning white sand adding to the beauty of it and is indeed a picturesque location to admire. The cool breeze and the silent waves are truly splendid and relaxing. Sasihithlu Beach marks the confluence of Arabian sea and the two rivers, Nandini and Shambhavi. Sasihithlu beach has also been the venue for a few surfing events and competitions.
7. Malpe Beach: Malpe beach, one of the finest beaches in the state that spreads across the Malpe port and the Swarna Nandi River. It boasts of the first sea walk in the state and is well known for the numerous adventure water sports offered there which makes the place happening. The beautiful St. Mary's Island, known for their distinctive geological formation of columnar rhyolitic lava can be reached from the Malpe harbour where the ferry ride to the island can be boarded.
8. Maravanthe Beach: Maravanthe wears the look of a fairyland with the picturesque Kodachadri Hills forming a backdrop to the Souparnika River on the east and miles of unspoilt white sand on the west both separated at the center by the National Highway 66. Maravanthe is a uniquely positioned beach in Coastal Karnataka with Arabian Sea on one side and Souparnika river on the other. This unique combination of sea and

river on each side of a highway is hard to find elsewhere and is said to be the only one in India. The golden sand, clear blue sky, swaying palm trees, and the endless shore make Maravanthe an undoubtedly attractive tourist destination. Some major tourist attractions in and around the beach are Baindur, a hamlet 45 km from Maravanthe with a lovely beach, Ottinene with its overhanging cliffs and the Belaka Theertha Falls. Outlook Traveler rated Maravanthe as Karnataka's most beautiful beach in 2005.

9. Kapu Beach: Kapu is a beach village in coastal Karnataka. Kapu's long sandy beaches offer a panoramic view of the Arabian Sea. With its tropical climate and a bevy of attractions that beckon tourists from across the country, Kapu is predominantly known for its greenery that surrounds the beach. One of the main attractions of the Kapu beach is the century old 130 ft. lighthouse.
10. Udyavara Beach: Pithrody Udyavara beach is popular for its long stretch of land between river and sea.
11. Padubidri Beach: The beach is long and sandy with palm trees lining it. The beach has numerous activities that include water scooter and banana boat rides. Padubidri end point is another place of interest, where the river meets the sea (now a Blue Flag certified beach)
12. Kodi Beach: Kodi beach is a beautiful and pristine beach located 7 km from Kundapura city and is known for its spectacular sunset experience.
13. Om Beach, Gokarna: One of the acclaimed beaches in the country. In the shape of two crescents joined together, the beach offers a breathtaking view of the sunset. The beach boasts of a long stretch of white sandy beach adjoining the rocky terrain.
14. Kudle Beach, Gokarna: One of the most popular beaches in Gokarna, Kudle Beach lies between the main beach of Gokarna and Om beach. With a wonderful spread of greenery, the long stretches of sand are a favorite among tourists.
15. Half Moon Beach, Gokarna: Half Moon beach is a quiet beach on the Gokarna town coastline. It can only be accessed by hiking or by motor boats that ply from Om beach. The hiking trail along the coast is narrow with hills on the left and deep blue sea to the right. The beach has plenty of rocks and a small patch of sparkling clean sand. The view of the sea coast from the hill is breathtaking.
16. Paradise Beach, Gokarna: There is no road connectivity to paradise beach and is accessible by motor boat from Om Beach or Half Moon Beach. Almost 70 percent of the beach is covered in rocks and the remaining section has clean white sand. This beach is an ideal place for camping.
17. Rabindranath Tagore Beach: The beach is surrounded by rocky hills and is lined with innumerable trees. Located in the heart of Karwar city, one can spend the evening on the beach witnessing the beautiful sunset which is a great way to relax. The beach is also the venue for a number of cultural activities, including the famous Karavali Utsav. The beach is also good for parasailing to get a bird's eye view of the coastal town.
18. Devbagh Beach: Devbagh beach is famous for its golden sands and cool breeze. It provides adventure sports enthusiasts with a variety of water sports such as snorkeling and kayaking. It is also famous for the delicious seafood and other local cuisines.

19. Majali Beach: Majali Beach is located at Majali Village, which is a small town that lies on the northern tip of coastal Karnataka. Apart from its scenic beauty, this beach is popular for its delicious local coastal cuisine. There is a lake situated close by, where activities like kayaking and rowing can be enjoyed. This beach also provides magnificent views of the setting sun.
20. Binaga Beach: Binaga Beach is located about 5 km from Karwar and is known for its exquisite beauty and widespread seashore. The beach is covered by green hilltops on three sides and offers a clean and calm atmosphere for the visitors.
21. Koodi Bagh Beach: Koodi Bagh Beach is located at the confluence of the Kali River and the Arabian Sea, at a distance of 4.5 km from Karwar. This beach is very clean and is a perfect destination for adventure lovers. For thrill-seekers, the beach offers water sports like canoeing, kayaking and banana boat ride.

In order to adequately support and sustain tourism, existing and potential sites need to be developed and managed well. A Public-Private-Partnership model involving local communities has been successfully adopted at Panambur beach by the Panambur Beach Tourism Development Project (PBTDP) from 2008 to 2020. This model has emerged as a viable option and has been so successful that it has been adopted in several other states such as Maharashtra, Andhra Pradesh and Goa. The concept was to use the local community in managing and developing beaches in the region thus creating a number of jobs in life saving, boating, jet ski, event management, other beach related activities and training for lifeguards. Moreover, the traditional rights of the local people were not affected under this initiative. The lifeguards of PBTDP have saved over 300 lives at the beach in the last 12 years and have also participated in rescue operations during floods in the region. Moreover, the beach in this tenure has been a hub for hosting several national and international events, including international kite festivals, national level kabaddi matches, beach festivals, boat races, surfing events, and yoga events, among others. This successful model should be encouraged and promoted in other locations in the state.

3.6.1.1 Cruise Tourism

Cruise Shipping/Cruise tourism is one of the most dynamic and fastest growing components of the worldwide leisure industry. With its vast and beautiful coastline, rich historical and cultural heritage, India can be a fantastic tourist destination for cruise tourists. The five major ports viz. Mumbai Port Trust, Mormugao Port Trust, New Mangalore Port Trust, Cochin Port Trust and Chennai Port Trust have a huge potential for cruise tourism in India.

Between 2018-19 and 2019-20, the number of vessels arriving at the above five major ports increased by 56.5 percent from 288 vessels to 455 vessels and the number of passengers arriving at these ports increased by 78 percent from 263077 to 467579. Of these five ports, Mumbai Port Trust alone handled 221 vessels and 222105 passengers in 2019-20, which translates to 48.5 percent of the vessels and 47.5 percent of the passengers. The New Mangalore Port Trust currently ranks 4th in India by handling 21 vessels and 24,080 passengers in 2019-20.

As per the Ministry of Tourism, Government of India, the development and promotion of tourist destinations is primarily the responsibility of the State Government. The Ministry of Tourism provides Central Financial Assistance (CFA) to State Governments for various tourism projects. Some of the steps taken by the Ministry of Tourism, Government of India for promoting cruise Tourism in India are:

1. Developing appropriate infrastructure at ports for handling cruise vessels and facilitating ease of movement of passengers.
2. Development of Ports to attract Cruise Ships with dedicated terminals & other related infrastructure for berthing of Cruise vessels & embarking & disembarking of cruise passengers.
3. Formation of a Task Force on Cruise Tourism for coordinated efforts to create an enabling ecosystem for development of Cruise Tourism in India.
4. Ministry of Shipping has brought out a vision paper on developing India as a cruise destination.

The vision document brought out by the Ministry of Shipping seeks to develop supporting infrastructure for cruise tourism at ports, with a focus on developing the domestic cruise industry through policy supports, incentives and port infrastructure development.

The Ministry of Shipping and Ministry of Tourism had jointly appointed a consortium of three expert companies to prepare an action plan for development of cruise tourism. The committee recommended, among other measures, simplifying the procedures for immigration and custom clearances, tax incentives to cruise industry, capacity building, marketing and creation of cruise related infrastructure at the ports.

To boost cruise tourism in the country, over the last five years, the Ministry of Shipping and Ministry of Tourism have taken key initiatives in the areas of Port Charges, Cruise Infrastructure & Operations, Immigration and Cabotage Relaxation. Some of the key interventions implemented include rationalization of Port tariff, relaxation of cabotage for international cruise vessels, easing of immigration clearance procedures (e-visa and visa on arrival facilities), guaranteed berths to cruise ships, removal of ousting charges, exemption of biometrics for 3 years for ease of travel, single e-landing card and upgradation & modernization of all cruise terminals. These interventions have resulted in India's rank in Travel & Tourism Competitiveness Index (TTCI) improving from 40 to 34 between 2018 and 2021.

Coastal Karnataka has tremendous potential to develop cruise tourism owing to its lush green forests, fields, meandering rivers, breath-taking views of the coastline, lip-smacking cuisine and a rich, unique, distinctive cultural heritage. In the past few years, the cruise tourism fraternity in the state managed a very large number of cruise liners calling at Mangaluru Port (NMPT) and handled around 30,000 foreign tourists every season before the Covid-19 pandemic took a heavy toll on the business.

The New Mangalore Port Trust (NMPT), the only major port in the state is providing all the support to improve the cruise tourism in the region. It also occupied the first rank in India on the cleanliness index among 13 major ports of the country. The assessment was done by an independent consultant, Quality Council of India (QCI) appointed by the Ministry of Shipping under the Swachh Bharat Mission.

Cruise tourism can become a major source of employment because of its labor-intensive nature. To spur growth in the cruise tourism sector, the state government needs to earnestly focus on strategic marketing initiatives and providing basic and advanced infrastructure amenities such as well-maintained roads, washrooms, parking facilities, world-class air-conditioned buses as well as licensed tour guides.

3.6.1.2 Clean and Safe Beaches with Blue Flag Certification

The Blue Flag is one of the world's most recognized voluntary eco-labels awarded to beaches, marinas, and sustainable boating tourism operators. The certification scheme aims at improving the quality of the beaches through regular clean-up operations and profiting from the renewed tourist attraction while also keeping them pollution-free. In order to qualify for the Blue Flag, a series of stringent environmental, educational, safety, and accessibility criteria must be met and maintained.

Blue Flag Certification is based on compliance to four main categories – Environmental Education and Information; Water Quality; Environmental Management; Safety and Services. A beach can be certified as an International Blue Flag beach based on its achievement of 33 imperative criteria.

Two beaches in the state of Karnataka are among the eight in India that have bagged the eco-label “BLUE FLAG” title from the International agency Foundation for Environment Education, Denmark. The two beaches that have been awarded this prestigious eco-label are Padubidri beach in Udupi district and Kasarkod beach near Honnavar in Uttara Kannada district, which has placed them on the global map.

The preparations for winning the eco label began in 2019. A number of facilities like fixing the temporary bathroom, changing rooms, water purification unit, CCTV cameras and control room, toys for the children, first-aid room, solid waste processing unit were put in place as also solar panels, street lights and footpaths. The spending on the infrastructure has been provided by the government of Karnataka to the tune of INR 2.5 crores.

Some of the benefits of the Blue Flag Certification are:

1. A better quality of environment that provides the visitors with a superior experience
2. An opportunity for the region to capitalize on the reputation for environmental protection and market itself as such a destination
3. A higher standard of environment for local people and the associated health benefits
4. Protection of the local environment from the destabilizing effects of ill-managed practices



Figure 3. 2: Layout Map of Padubidri Blue Flag Certified Beach in Karnataka

Developing home stays, tourist guides, taxi services, etc. in this area would open up new avenues of service to the people of this area and employment to the local community. A number of labor laws and rules also would follow as one of the criteria for Blue Flag certification is payment of fair salaries and ensuring that child labor is not employed, and that there is no discrimination based on gender. The tour operators are also directed to support the local economy by opting to buy and use local products.

3.6.2 Estuarine and Riverine Tourism

Estuaries are bodies of water where rivers meet the sea. Rivers spread out and slow down when they meet the sea, creating unique variations and conditions that make a plethora of creatures thrive in that setting. Estuaries are often called the “nurseries of the sea” because so many marine animals reproduce and spend the early part of their lives there. As the tide rises and falls, water depth and chemistry changes, creating a wide range of habitats. In some parts of estuaries, filtered by plants such as marsh and seagrasses, moving water becomes still, allowing mud and food particles to settle at the bottom. These variations create safe conditions, making estuaries ideal homes for plants and animals who feed, grow, or reproduce there. Estuaries are also a major stopover point for some migratory birds and animals.

Karnataka is the land of many rivers, and the ones which are west flowing and joining the Arabian sea are Netravati-Gurpur, Sita-Suvarna, Sharavathi, Panchagangavali, Badagani-Sharavathi, Aghanashini, Gangavalli and Kalinadi. Each estuary displays unique beauty and attracts many visitors who come to fish, watch birds, take photographs, etc. However, there are abundant opportunities to improve the tourism potential in these scenic rivers and estuaries in the state by promoting activities such as boat rides, canoeing, kayaking, sport fishing, etc. In addition, houseboats, floating restaurants and cruise tours also hold tremendous potential in the state to create livelihood opportunities and usher in socio-economic development. The presence of home stays, resorts as well as petty shops, restaurants, shops selling souvenirs, handmade crafts, homemade delicacies and other businesses that can create livelihood opportunities and additional income to coastal communities should be prioritized. Additionally, to boost the tourism potential, strong marketing strategies and policy initiatives are essential. It is also vital to take up these development activities around estuaries in a planned and phased manner along with stakeholder consultations to ensure holistic socio-economic development of the region. Thus, these beautiful and bountiful estuaries can be optimally utilized for recreation, jobs, tourism, fishing, etc. and hence protecting this vital resource from degradation is extremely crucial to improve the economy and well-being of coastal communities.

However, the state has not made any serious inroads to tap the enormous potential that this sector offers for socio-economic development of adjoining communities. Whereas, the neighboring state Kerala has profoundly utilized its estuarine and riverine areas to promote this kind of tourism by supporting houseboats (around 1500 Nos. employing 4,300 people in the state). The Kerala Government provides free potable water, subsidy on electricity etc. to support this sector and has also come up with schemes such as one-time financial assistance to the houseboat owners for maintenance of houseboats that were idle due to the COVID 19 pandemic. Karnataka also needs to pursue and promote sustainable river tourism in line with Kerala model/strategy to attract tourists at the national and international level. The Government must encourage houseboat businesses and attract more investment in this sector by providing subsidies for running costs (concession in electricity charges, potable water, diesel etc.) rather than for the initial investment, provide good infrastructure support (jetties, dredging of channels etc.) and guidance/publicity support through strategic marketing initiatives. This would also create a lot of alternate livelihoods to communities, indirect employment and job opportunities for the youth in the hospitality segment and also associated socio-economic development.

The areas where estuarine and riverine tourism can be tapped, in each of the maritime districts, are noted below.

1. Dakshina Kannada District: Netravati-Gurpur is the major river system of Dakshina Kannada as also Nandini river. While Netravati and Gurpur have their inlet at Mangaluru, Nandini together with Shambhavi (Udupi district) has its inlet at Sasihithlu, which marks the boundary between Dakshina Kannada and Udupi districts. Netravati River, originating from the Western Ghats, has a length of 106 km and drains through an area of about 1,353 sq. miles. Gurpur river is a tributary of Netravati. There is a rivulet opening at Batapady, which is the border of Karnataka and Kerala.
2. Udupi District: Shambhavi River opening at Sasihithlu is at the southern border of Udupi district. Further north is Hejamadi river which is a small river debouching into the sea at Hejamadi. About 32 km up the coast, the inlet of Udyavara and Swarna Rivers is seen at Malpe. Swarna and Suvarna Rivers opening at Kodi further northward is a relatively bigger river system supporting a bigger estuarine area. Further north is the Kundapura estuary which is formed by the Panchagangavali River to which the Chakra and Souparnika rivers are tributaries in the northern side. Kundapura is a major estuary of this part of the coast. River Souparnika in the north is a tributary of Panchagangavali river, it flows very close to the shore at Maravanthe where it is also known as Kolluru river. A minor river Yedamavinahole debouches into the sea further north at Koderi. Towards the northernmost stretch of the coast, the Sumna River, also called Byndoor, which is a minor river, debouches into the sea at Byndoor. Near to the northern border of Udupi district, at Shiroor, there are inlets of two minor rivers viz. Sankadagundi and Kambar.
3. Uttara Kannada District: The major river and estuarine system of Uttara Kannada district is the Kali River which debouches into the sea north of Karwar headland. Next in terms of the aerial extent of the estuarine areas is Sharavathi – Badagani river system debouching into the sea at Honnavar. The estuarine area of this river system is also well known for its biological diversity. Aghanashini River with its inlet at Aghanashini, south of Gokarna headland has another estuarine system with a significant aerial extent. Gangavali river north of Gokarna with its inlet at Gangakolle is another major river of Uttara Kannada. In addition to the above, there are several minor rivers all along the coast, but the notable among them is Chawtani, Venkatapur, Pallinadi and Alvekodi.

3.6.2.1 Mangrove Tourism

Mangrove tourism is another form of tourism which is fast growing. These floating salt-tolerant forests are home to several species of flora and fauna, and protect land against natural calamities. Mangroves prevent sea erosion and reduce wave intensity. They are an important feature of the coastal ecosystem and are breeding centers for varieties of marine and river fish.

However, these damp, anaerobic swamp areas were once considered wasteland, and were cut to a huge extent to turn the area into agricultural land. It's only recently that their importance is being highlighted, leading to initiatives to develop and protect them. Owing to their importance and the broad benefits they provide; several mangrove restoration initiatives have been taken up in the state. Mangrove forests in the estuaries of coastal Karnataka have started coming up in a big way after the forest department started growing them in 2008 under its 'Green Wall' project. According to the department statistics, over 800 hectares in the estuarine area have been brought under mangrove plantations to restore mangroves from Ullal in Mangaluru to Majali in Karwar, covering all together a distance of 306 km.

Another example is the mangrove restoration initiative that has brought about noticeable changes in Kota, a village 23 km north of Udupi. A group of villagers from Gundmi and the neighboring settlements of Parampally and Kodi Kanyana volunteered to plant mangrove trees in a 15-hectare area with guidance from the officials of the Forest department. Their efforts have paid off, and 70 percent of the saplings have grown to form a 'Green wall', acting as a coastal guard between land and sea, prepared to fight the effects of Climate Change. As a result, the local fishermen now harvest more fish as shoals of fish now come closer to the shoreline to breed since fishes prefer mangrove environments rather than hostile deep-sea environments as they are well protected against predation and strong water currents here.

These Mangrove areas are now full-fledged forests that have the potential to be developed into ecotourism spots. Recently, a Mangrove 'Boardwalk' has been developed in the mangrove forest situated on the banks of river Sharavathi, in Honnavar.

Honnavar in Uttara Kannada district, Byndoor in Udupi, and Ullal and Mulki in Dakshina Kannada district are increasingly being used for mangrove tourism. This has also picked up on the estuary of Kali River near Sadashivgad, along the rivers Sharavati, Gurupur-Netravati, Shambhavi, Kalyanpur and Souparnika. With the rich bird population, healthy growth of mangroves furnishing emerald hue to the placid waters of Aghanashini during winter and summer months, there exists great potential for sustainable ecotourism.

The luxuriant mangrove landscapes attract marine and winged creatures and is fast becoming a tourist hub and a photographer's haven, with many people even venturing deep into them to see the bustling marine and avian life thriving here. While some of them waded into the waist-level water, others use small hand-paddled canoes. Kayaking and stand-up paddling are some of the eco-friendly water sports that are being promoted in Karnataka to explore mangrove forests and indulge in the breathtaking beauty of this unique ecosystem. Mangrove based tourism for bird watching and for scenic enjoyment should be promoted as a good income generating activity for the local VFCs (Village Forest Committees). Appropriate training for local youth in arranging such mangrove tours will also provide newer livelihood opportunities.

3.6.3 Aquatic Sports

Boating, surfing, kayaking, stand up paddling, canoeing, fishing, swimming, walking etc. are among the numerous activities enjoyed during trips to beaches and estuaries worldwide. Beaches provide unique habitats for a variety of plants and animals. Most of the migratory waterfowls depend on coastal beaches during their lifespan. In the hot wet climate of the tropics, mangrove trees dominate estuarine lagoonal beaches. In the harsher weathers, beaches are dominated by a few species of hardy grasses and bushes that can withstand strong winds and the intense summer sun. With this unique beach ecosystem, there is a large scope for the development of beach tourism in an ecologically sound manner.

Beach tourism has grown significantly, bringing enormous economic benefits to host communities, thereby causing many environmental and social impacts to the coastal environment. Development of beach resorts and attractions continue to expand in order to meet the increasing intra-regional, domestic and international demand.

For the development of sustainable beach tourism, conceptual sustainable design models including an array of acceptable capacities based on the ecological, social, psychological, physical, economic, and managerial capacity thresholds of sites are necessary.

Honnemaradu, situated in the backwaters of Sharavathi River in Sagar town of Shivamogga district, is cited as a place that is actively promoting kayaking, wind-water surfing and other water sports. Several surf schools, water sport centers, recreational kayaking and camping centers along the coast of Karnataka are gaining popularity and attracting tourists all over India for their amazing water sports activities. By way of learning from its success, the sea coasts of Devabagh, Gokarna and Karwar (Uttara Kannada district) and in Maravanthe (Udupi District) could be actively rehabilitated as centers of water sports activities as they possess the potential for such development.

In addition, in the lake reservoirs and dams a number of water sports activities could be introduced. River rafting, Kayaking, Boating/ speed boats and pedal boats (both motorized and non-motorized, Jet skiing, Water skiing, Sport/Game fishing, and Trekking are some of the activities that have rich potential for drawing both international and local interest. Much employment is also generated for the local community as food stalls, restaurants and other skilled and unskilled avenues of employment open up.

3.6.3.1 Jet Skiing

Gokarna Beach in Uttara Kannada and Sasihithlu Beach in Dakshina Kannada are some of the spots in Karnataka where jet skiing could be introduced with great success.

3.6.3.2 White-water Rafting

From the easy rapids at Bheemeshwari to the ferocious streams at Kodagu, there are many spots in Karnataka that offer great scope for introducing white water rafting, which has acquired great popularity among professionals and enthusiasts alike. In the regions of Honnemaradu, Kemphole, Sitanadi and Dandeli, rafting is thriving due to the strong presence of water bodies such as river Cauvery, the backwaters of Shravanthi and river Kali, which are ideal for such activities, and which could be further harnessed for the economic benefit of this region.

3.6.3.3 Scuba Diving

Netrani Island, located on the west coast, approximately 10 nautical miles (19 km) off Murudeshwar in Uttara Kannada, offers the easiest access to clear water diving in India. The visibility is usually over 15 meters, and attracts a lot of tourists for snorkeling and scuba diving. The warm, crystal clear waters around Netrani Island make it an ideal destination for beginners to learn scuba diving and for seasoned recreational divers to enjoy the challenge of deeper dive sites. These dive sites have coral reefs, rock pinnacles and shipwrecks and a wide variety of marine life such as dolphins, whales, turtles, Napoleon Wrasse, Great Barracuda, Cobia, Stingrays, Stonefish and sharks. There are several tour operators who are generating good income out of this for their families and community, and it is also providing plentiful livelihood opportunities to many. However, conservation of biodiversity and maintenance of good water quality through minimal pollution is crucial to sustain this activity.

3.6.3.4 Surfing

Surfing is a sport of riding breaking waves toward the shore, especially by means of a surfboard. Some of the places that are considered suitable for surfing in Karnataka are as follows:

Sl. No.	Location	District	Wave Height
1	Bhatkal	Uttara Kannada	0.4-0.6m
2	Gokarna	Uttara Kannada	0.5-0.7m
3	Kumta	Uttara Kannada	0.5-0.7m
4	Murudeshwara	Uttara Kannada	0.3-0.4m
5	Maravanthe	Udupi	0.3-0.5m
6	Kapu Light house	Udupi	0.2-0.3m
7	Mulki	Dakshina Kannada	0.3-0.4m
8	Mangalore Port (Panambur, Tanir Bavi, Sasihihlu)	Dakshina Kannada	0.2-0.4m

Table 3. 3: Surf Zones along Karnataka Coast

Some of the surf clubs in Karnataka are Surfing India (Mantra Surf Club) located at Mulki, Mangaluru; the Shaka Surf Club located at Kodi Bengre, Udupi; Mangalore Surf Club (Stoked) at Tannir Bavi, Mangaluru; Kadal Centre for Sup, surf, Yoga & Kayaking, Malpe; Cocopelli Surf School located in Gokarna; Indica Surf School located in Panambur, Mangaluru, etc.

The Indian Open of Surfing was the first-ever global surfing festival in Karnataka held in May 2017 at the Sasihihlu Beach in Mangaluru to attract surfers from all over India and abroad. Sasihihlu Beach is known for its even beach with tall waves and two rivers, Nandini and Shambhavi, spilling into the ocean.

3.6.3.5 Other Water Sports

Some of the other water sports activities that have a tremendous potential are stand-up paddling, wakeboarding, bodyboarding, skimboarding, snorkeling, sailing, water skiing, backwater riverboat tours, sea and mangrove kayaking and other water-based sports activities.

3.6.4 Sport Fishing and Big Game Fishing

3.6.4.1 Sport Fishing

Angling, or sport fishing, is catching fish by using an 'angle', or a fish hook. The hook is fixed to a fishing line, which is attached to a fishing rod. To lure fish, the hook is dressed with a bait which can be natural (worms, insects, earthworms and maggots) or artificial. Angling is pursued usually for pleasure (recreation) or for food. The sporting fish includes Mahaseers, trout and large catfishes. The game fish, including small and large species, inhabits both fresh and soft waters. Based on their occurrence and ecosystem, the game fishes are classified as (a) Freshwater game fishes (b) Estuarine and sea game fishes. The All-India Game Fishing Association is engaged in promoting "sport fishing" while simultaneously protecting the fast-depleting stock of sport fish by active participation of the angler community in protecting the environment of water bodies they reside in.

3.6.4.2 Angling

The abundance of water bodies in the state has prompted many people into fishing and angling tourism. Angling involves the use of a curved fishing hook attached to a rod that is used to catch fish. Fishing and angling are some of the unusual adventure activities among the several others that are offered in the state. The clear flowing waters of the different rivers in the state as well as their branches prove to be great fishing and angling holiday destinations that are mesmerizing in their clean and crisp beauty. These waters also prove to be wealthy breeding grounds for numerous different varieties of fish. There are many destinations that are hotspots for fishing enthusiasts in the state.

Fishing tourism is a unique way to generate surplus income through the sustainable utilization of aquatic resources. It inadvertently attracts tourists to explore the lush green beauty of nature. Thus, these sustainable recreational activities help to conserve the rural coastal areas, marginal and subsistence fisheries. To promote quality in fishing tourism, training and required skills are necessary for the fishermen, which can be provided through development programs so that they may deliver quality services to the tourists. Marketing activities are essential in promoting fishing tourism to facilitate the growth of the fishing tourism sector. The Government should take adequate steps to merge tourism with fishing, which can lead to increased tourism.

While there are several incentives to develop and promote Fishing Tourism on a large scale it also comes with its own set of challenges. They include indiscriminate tourism practices on the coastline. Moreover, overfishing is a threat to fishing tourism and undisciplined and unregulated angling practices can result in reduced fish stocks, which raises a serious issue for local fishers. Another constraint is finding knowledgeable and skilled fishing experts for this form of tourism. Since fishing tourism is conducted for a few months in the year it only creates momentary opportunities for the fishermen. Non-eco-friendly development activities along the coastline cause water pollution, which also directly affects the fishing tourism industry.

The city of Mangaluru was witness to the first International Angling competition jointly organized by the New Mangalore Port Trust, All India Game Fishing Association, Mangalore Anglers Club and Panambur Beach Development Authority, where anglers from 11 countries participated and angled at South Breakwaters of Panambur in November 2018. As many as 110 anglers from India and overseas took part in the country's first 'Lure only catch and release saltwater fishing contest'. Mangaluru's popular ecotourism destination, Dr Shivarama Karanth Pilikula Nisargadhama, had opened its doors to amateur and professional anglers in the city to fish in its 20-ft deep lake spread over six acres during May 2015.

This thrill of reeling in a fish is also luring people to fishing holidays. Fishing involves fly fishing (with artificial flies in bright colors as bait), freshwater fishing (angling in rivers and streams), surf fishing (standing by the seashore and casting in the reel) and deep-sea fishing. Peninsula rivers like Krishna, Cauvery and Godavari have abundant scope for fishing.

Cauvery River is a paradise for Mahseer fishery. Its innumerable water and large stock of various fish species make it one of the best spots for angling in Karnataka. Some of the other popular destinations for fishing tourism in Karnataka are Bhimeshwari, Manchanabele water reservoir, Chikmagalur. Coorg is another good spot for angling. It's most scenic and lush green hill station attracts many fishing enthusiasts to drop their hook.

Tourism, when uncontrolled, makes it challenging to adopt appropriate management strategies to secure aquatic resources sustainably. Hence, the fisheries managers need to conduct detailed surveys about the fishing tourism activities in order to set the conservation goals accordingly, thereby boosting fishing tourism.

Places like Dandeli, Kali River, Tungabhadra & Kabini Reservoirs can be developed into potential angling destinations. Angling Carnivals/Fests can be conducted at regular intervals to encourage angling among the masses.

3.6.5 Constraints and Recommendations to promote Coastal, Riverine and Estuarine Tourism

Beach tourism and coastal recreational activities provide huge economic returns and also generate employment. Worldwide, clean beaches, coastal, riverine and estuarine areas are attractive tourism spots. Karnataka is blessed with some of the most beautiful scenic coastline and pocket beaches interrupted by cliffs originating from Western Ghats and promontories in addition to breathtaking riverine and estuarine areas. However, the tourism potential in these areas has not been optimized fully. Hospitable homestays, houseboats, services and various eco-friendly water sports such as Kayaking, Surfing, Stand Up Paddling (SUP), adventure water sports such as parasailing, paragliding etc. are the various tourism activities and ventures that require serious inroads to maximize social benefits. Domestic as well as international marketing remains to be one of the biggest hurdles for the untapped blue tourism potential in Karnataka. Though some efforts have been seen in recent years, they have been sporadic and few and far between. There are also other numerous hurdles and lacunae to development of coastal, riverine and estuarine tourism that are cited by various stakeholders such as inadequacy of suitable sector and scale specific policy, paucity of information to getting prerequisite approvals, dearth of financial assistance schemes, lack of promotions etc. to name a few. Unless these grass root level problems are addressed, it would pose a barrier to harness the huge potential the state has in maximizing social benefits from blue economy resources. Serious concerted efforts need to be undertaken to address the gaps and market the serene natural beauty that the state is endowed with.

A robust, sector and activity specific policy framework and incentives as per the scale of the venture needs to be chalked out in consultation with relevant stakeholders to promote homestays, eco-friendly waters sports etc. near and around the beaches to attract domestic as well as international tourists.

Improvement/upgradation of basic infrastructure like roads, toilets, parking lots, etc. and yearly allocation of funds to maintain them are extremely crucial. Promoting specific beaches through international surf festivals, beach festivals, kite festivals, etc. will go a long way in maximizing the tourist potential of the state.

A comprehensive development of coastal tourism in the state should be undertaken in accordance with the “Karnataka Maritime Perspective Plan”. Additionally, support through Central Government schemes such as Swadesh Darshan and Sagarmala shall also be sought to develop tourism in coastal Karnataka. Karnataka Tourism shall seek to develop coastal Karnataka as a multi-product destination and develop facilities for leisure, recreation, and adventure activities. Coastal Tourism shall be taken up in conjunction with the development of Maritime Tourism and Inland Water Tourism. Towards its commitment for sustainable tourism development in coastal areas, Karnataka Tourism shall support relevant state agencies in obtaining Blue Flag certification for the State’s beaches⁵². There are many tourism spots and near-shore land destinations in the three maritime districts. The following are some of the recommendations to promote water-based tourism in coastal, riverine and estuarine areas in the state:

Beaches such as Gokarna, Murudeshwara, Malpe etc., are potential candidates for Blue Flag beach certification similar to Padubidri in Udupi district and Kasarkod in Uttara Kannada

⁵²Karnataka Tourism Policy 2020-2025, Department of Tourism, Government of Karnataka

district. The Government of Karnataka should initiate the process of Blue Flag Certification through the Environment and Tourism department and develop the beaches for obtaining the same.

1. Further, as a part of Swacch Bharat Abhiyan the State Government along with schools and colleges should undertake cleaning of beaches periodically through public participation, such as NGOs, local committees and organizations etc. This approach would lead to awareness of clean beaches.
2. The Hospitality and the Tourism sector in coastal areas have tremendous potential to provide alternative livelihood and income generation opportunities to the coastal community by means of eco-friendly water sports, homestays etc. It brings the communities together and helps to keep beaches clean.
3. An effort also needs to be made to organize frequent events such as surf festivals, beach festivals, food festivals on beaches and river banks. These events have to be widely marketed with Public Relation strategies internationally as well as all over India especially in metro cities like Mumbai, Delhi etc. to showcase the pristine natural beauty of Karnataka. This will ensure other alternative livelihoods gaining pace to drive socio-economic benefit.
4. The Government must promote sustainable beach tourism wherein dedicated infrastructure such as access roads, parking facilities, changing rooms, etc. need to be created and maintained. This will provide various kinds of job opportunities for local communities such as lifeguards, food stalls etc.
5. The Government should support beach side and river side resorts that are built with sustainable and eco-friendly building materials such as wooden cottages, bamboo cottages etc. that are easy to construct and dismantle. This would create more jobs to the local communities in the hospitality sector.
6. There is an urgency to promote alternative livelihood options for the fisher/coastal communities as they are solely dependent on fishing for their income which is all set for a downfall considering the unsustainable trends of fishing which is on the rise. Beach tourism should be promoted to develop local communities and safeguard their local culture. Promoting water sports such as surfing, kayaking, paddle sports and the like will boost income generating opportunities amongst the local community.
7. Creating good infrastructure such as Aquariums, near to coastal areas will automatically attract more tourists and open new avenues to boost other kinds of tourist activities such as homestays, water sports etc. Moreover, licensing for business opportunities such as homestays, water sports activities, land conversion formalities should be made convenient and hassle free to attract more start-ups and ventures.
8. Provide subsidies especially to Women Entrepreneurs to start up tourism activities such as houseboats to maximize social benefits to the local community from allied activities that would be generated by promoting tourism.
9. Identify areas of historical importance near coastal and backwater areas and promote these as heritage sites to attract more tourists. This will also attract more tourism avenues in and around those regions leading to socio-economic development.
10. Promote riverine tourism in line with Kerala model/strategy to tap the enormous potential that this sector offers for socio-economic development of adjoining

communities. The Government must encourage houseboat businesses and attract more investment in this sector by providing subsidies for running costs (subsidy for electricity, potable water, diesel etc.) rather than for the initial investment, provide good infrastructure support (jetties, dredging of channels etc.) and advertisement/marketing support. This would create a lot of alternate livelihoods to communities and job opportunities for the youth in the hospitality segment.

11. Training programs could be given to the locals especially youth to be self-employed and promote the tourism/hospitality sector in a sustainable manner i.e., lifeguard training, sustainable tourism, environmental management, adventure tourism and related safety skills, outdoor adventure guide, customer service skills, leadership skills, communication skills, generic management skills etc.
12. Promote coastal tourism and its potential by creating awareness on eco-friendly activities such as beach walks, beach tracks, enjoying non-motorized water sports such as kayaking, surfing, Stand-Up-Paddling (SUP) etc. which has no ecological impacts on fragile ecosystems.
13. Provide awareness on CRZ norms to locals and various tourism stakeholders as lack of awareness leads to violations. Create awareness on permissible and non-permissible activities in CRZ areas, along with providing alternative infrastructure (temporary) that is economical and could be utilized for various purposes such as storage of equipment for water sports etc. Make provision in CRZ regulations on such temporary dismantlable structures.
14. Formulate a strong policy for coastal tourism entailing eligibility criteria, minimum standard operating procedures required as per the scale and magnitude of the venture and detailed methodology for obtaining approvals for various tourism sectors such as hospitality (Homestays), services, different sports activities etc. Presently, there is no clarity on how various approvals need to be obtained and new players are often misguided and have to run from pillar to post in order to start up new ventures. Hence, provide the details on application procedure, documents required as well as incentives and support from the government for every activity (Homestays, watersports etc.) on the website of the Department of Tourism that should be clearly defined and followed.
15. Formulate thorough rules to be followed by each of the coastal, riverine and estuarine tourism stakeholders during operations of various tourism activities such as safety for tourists, waste management, precautions on tourism during monsoon, preventing any kind of damage to the coastal and estuarine ecology, following pandemic appropriate guidelines etc.
16. Provide financial assistance schemes, especially to young entrepreneurs and women thus empowering them, encouraging their innovative ideas for new start-ups in the riverine/coastal tourism sector that will also increase livelihood options for coastal communities.
17. Provide relief packages to riverine and coastal tourism stakeholders having valid registration during untoward incidents such as in Kerala for houseboats.
18. Carry out an annual assessment of infrastructure, facilities, equipment involved in coastal and riverine tourism activities to improve and maintain hygiene and safety standards including a check on various other relevant certifications etc. Advertise the registered coastal and riverine tourism providers on the Department of Tourism website who outperform their safety and quality standards to provide the best tourism

experiences to tourists. Ensure that expiry/failure to renew crucial certifications would result in cancellation of registrations from the Department of Tourism. A proper monitoring mechanism shall be established to maintain top notch quality tourism experiences to tourists.

19. Organize brush up trainings/coaching classes for new tourism stakeholders on lifesaving techniques, emergency response drills etc. during monsoon (Offseason) such that tourists feel safe. Presence of fire extinguishers and emergency response training to be provided in homestays etc. during unforeseen events in coastal and riverine areas.
20. Form a coastal and riverine tourism stakeholders committee which includes sub-committees for the hospitality, service and activities sector with pioneers/subject matter specialists on board who can guide on continuous improvement strategies, decision making etc. All stakeholder members including owners and care takers of ventures should be part of the committee.
21. Ensure all activities related to tourism should be undertaken only in areas not listed as Ecologically Important and with prior approval from local gram-panchayats, Fisheries society and MoEF&CC. An initial as well as annual Environment and Social Impact Assessment by an independent committee comprising Ecologists, Fisheries Scientists, Social Scientists and Hydrologists should be made mandatory for the application of permission or NOC for all tourism and allied projects. This is to ensure that the negative impacts of tourism and allied activities on ecology, biodiversity and local capture fisheries are minimized and mitigated. Experiences from the past have made us aware that tourism and allied activities have a potential to constrain land use activities of vulnerable fishing communities while being highly destructive of natural ecological processes. While promoting efforts to maximize social benefits we need to be mindful that these alternate efforts do not come in the way of current livelihoods and land use of the fishing community.
22. The current policies for water-based tourism activities, homestays, camping, agro-tourism etc. are vague, arbitrary and impractical. Moreover, there is a policy-culture conflict due to the disconnect between the policies and the ground reality thus hindering promotion of aquatic tourism and other allied activities. This results in illegal businesses being run across the state. Hence, these policies need to be revamped to make them practical, activity specific (depending on the Sport), simpler, friendlier, easy for implementation and ensure inclusiveness by consulting subject experts and social specialists. Policies would also have to consider the risks and amenities that would be required for handling different scale and magnitude of people as having a common policy would be impractical.

3.6.6 Ecotourism

Ecotourism is “responsible travel to natural areas that conserves the environment and improves the well-being of local people” (International Ecotourism Society, 1990). Ecotourism is about uniting conservation, communities, and sustainable travel. The very definition of ecotourism stresses on the improvement of the well-being of local people. Ecotourism has experienced arguably the fastest growth of all sub-sectors in the tourism industry; the popularity represents a change in tourist perceptions & preferences, increased environmental awareness, and a desire to explore natural environments. Providing financial benefits and empowering local people is one of the seven characteristics of ecotourism as per the TIES definition. Providing jobs to local populations and sharing of the socio – economic benefits with local communities and indigenous people, by having their informed consent and participation in the management of ecotourism enterprises are the other benefits. It is also

said that locals benefit from ecotourism economically more than what they would by other forms of tourism.

Promoting ecotourism through community participation will facilitate conservation of ecology and environment and improve the well-being of native individuals. There are many popular ecotourism destinations in Karnataka. They mainly cover hill stations, waterfalls, wildlife sanctuaries, bird sanctuaries, etc. Karnataka must also make the best use of its vast inland waterways by developing newer eco-tourism destinations. Promoting activities such as campfires, wildlife safaris, adventure sports, morning trails, rock climbing, zip lining, river crossing, Burma bridge, backwater cruises, water zorbing, nature camping, backwater boat safaris and such would make these spots more interesting for tourists while generating valuable revenue and livelihood opportunities.

Nirvana beach, near Kumta of Uttara Kannada, with a 5 km coastline with white sand and palm trees adjoining the coast, is an example of a beach that has been considered as a potential area to develop an ecotourism beach.

Jungle Lodges and Resorts Limited (JLR) is the nodal agency for the development and promotion of Ecotourism in Karnataka, which includes Nature Tourism and Wildlife Tourism. Ecotourism activities focus on increasing awareness towards conservation and sustainability of biodiversity and natural environments. The development and promotion of this form of tourism is carried out after careful consideration of the destination's carrying capacity and in adherence to the orders and guidelines issued by Government of Karnataka and relevant authorities. Ecotourism in Karnataka is encouraged in close collaboration with the Forest, Ecology and Environment Department and Karnataka Ecotourism Development Board.

The backwaters in Kerala and tapping of it to develop ecotourism can be taken as a model that could be emulated in Karnataka as it focuses on sustainable and eco-friendly development of tourism taking in not only the rich biodiversity and unmatched natural attractions but also the local and regional traditions of the state. Within this fold, a host of products have been developed with the active support and involvement of the local community. One such example is the Kudumbashree groups (women self-help groups), which are involved in producing many eco-friendly products such as paper and cloth bags, food items, and they are actively supported by the government. Kudumbashree groups also run canteens. This program is often cited as one that has achieved the dual objective of achieving women empowerment and poverty reduction.

Coastal Karnataka also has self-help groups, akin to Kudumbashree program, those started by the Government of Karnataka called the Streeshakthi groups and those supported by the NGOs- Navodaya and Shri Kshetra Dharmasthala Rural Development Project. Kudumbashree model can be adopted at places where ecotourism and allied activities would be implemented to enhance social benefits to the local community in the blue economy framework.

Tourism can strengthen communities. Events and festivals of the local communities where they are the primary stakeholders provide opportunities to showcase local skills and cuisine. Local employment opportunities would improve and ecotourism related activities could be imbibed with professional training and development of businesses and organizational skills.⁵³

⁵³Hongalad SM, Biradar SI. Ecotourism in Uttar Kannada district and its impact on the tourism industry. *International Journal of Research and Review*, 2019; 6(9):203-209.

Studies of ecotourism in Kerala have shown that the socio-cultural impact of this form of tourism has resulted in a marked increase in infrastructure, gender equity, better information access, and approach to tourists. The Ecotourism model of Kerala has been provided in Box 3.2 below.

Box 3. 2: Ecotourism model of Kerala

Ecotourism along with pilgrim, backwater, and village tourism has propelled Kerala's economy. Kerala has a protected area of 2,324 sq.km with two national parks and 12 wildlife sanctuaries. The development of Ecotourism in the Western Ghats of Kerala, with its tropical forest ecosystem, provides a natural advantage for the tourists. The number of domestic and foreign tourists have been on the increase over time and this has contributed to the foreign exchange earnings of the state.

The major ecotourism products are broadly classified as beaches, backwaters, hill stations, wildlife sanctuaries, etc. In Kerala, these are largely spread over the Western Ghats regions. The recorded forest area in Kerala is 11,12,559 sq.km. Forest, wetlands, mangroves, and aquatic ecosystems are the major types of ecosystems in Kerala.

Kerala has 41 west-flowing rivers and 3 east-flowing rivers. Unlike many other states in India, Kerala is rich with evergreen forests. It has over 25 percent of India's 15,000 plant species, where the majority of them grow in the Western Ghats. It includes 150 ferns, 4000 flowering plants, 600 fungi, 800 lichens, and 200 mosses. A large number of them are endemic to Kerala.

Fifty-six places have been identified for the development of ecotourism destinations that emphasize conservation, ecological sustainability, environmental education, and local community benefits. A separate ecotourism wing has been set up to give policy support for the development of the ecotourism destinations in the state.

Ecotourism spots in Kerala

Sixty ecotourism destinations are functioning in the State implemented through the forest department.

Ecotourism destinations in Kerala.

Sl. No.	District	No. of Destinations
1	Thiruvananthapuram	6
2	Kollam	3
3	Pathanamthitta	5
4	Alappuzha	0
5	Idukki	9
6	Kottayam	2
7	Ernakulam	3
8	Thrissur	2
9	Palakkad	6
10	Malappuram	3
11	Kozhikode	5
12	Wayanad	12
13	Kannur	3
14	Kasargod	1
TOTAL		60

Source: kerala.forest.gov.in⁵⁴

54 To Examine the Potential and Scope of Ecotourism in Kerala with a Special Focus on Tourists to Ecotourism Destinations in Trivandrum Meera Ranjith* Department of Geography, University of Mumbai, India, July 06, 2020

Another example of Eco-tourism development is Rajgir in Bihar where a glass skywalk bridge is set amid five hills that provides a breathtaking view of the area, nature safari that takes tourists on a journey through attractive forests of the region, adventure sports like air cycling, zip line that provides tourists a thrilling experience on their visit to the bridge etc. to attract more tourists. Such initiatives can be taken up at eco-tourism destinations in Karnataka.

Some of the popular Ecotourism destinations along the coast and rivers in Karnataka are as follows:

1. Hill stations

Agumbe, Biligiriranga Hills, Chikkamagaluru, Coorg, Horanadu, Kemmangundi, Kudremuk, Nandi Hills etc.

2. Waterfalls

Magod falls, Lalgulli falls, Sathodi falls, Unchalli falls, Lushington falls, Shivaganga falls, Ulavi falls, Iruppu falls, Shivasamudram falls, Balmuri falls, Gokak falls, Abbey Falls, Achakanya Falls, Chunchanakatte Falls, Hebbe falls, Kallathigiri falls, Varapoha Falls, Sogal falls, Godchinamalaki falls, Jog falls etc.

3. Wildlife/Bird Sanctuaries

Attiveri Bird Sanctuary, Bandipur National Park, Bankapura Peacock Sanctuary, Bannerghatta National Park, Bhadra Wildlife sanctuary, Bheemeshwari, B R Hills, Biligirirangan Hills, Brahmagiri wildlife sanctuary, Dandeli & Anshi National Park, Dandeli Sanctuary, Daroji Bear Sanctuary, Deva Raya Wildlife Sanctuary, Gudavi Bird Sanctuary, Kabini Wildlife sanctuary, Kudremukh National Park, Mandagadde Bird Sanctuary, Nagarhole National Park, Pushpagiri Wildlife Sanctuary, Ranebennur Blackbuck Sanctuary, Ranganathittu Bird Sanctuary & Sharavathi Sanctuary etc.

3.7 Conclusion and Recommendations

Karnataka is the sixth largest state in India and is one of the popular tourism destinations in India (Domestic: 4th, International: 11th). Tourism in Karnataka is dominated by cultural, natural and dharmic tourism sectors. Blue Tourism sectors such as Coastal/Beach tourism, Ecotourism and Adventure Tourism (Aquatic) contribute to a significantly lesser extent to the states' tourist footfall.

Though North Karnataka shares a similar coastal landscape with Goa, there is a stark contrast between it and Goa in terms of coastal tourism development. Tourism in Goa is a mature, well-developed industry and a primary contributor to the state's economy. This is primarily supported by the tourism friendly policies of the state government.

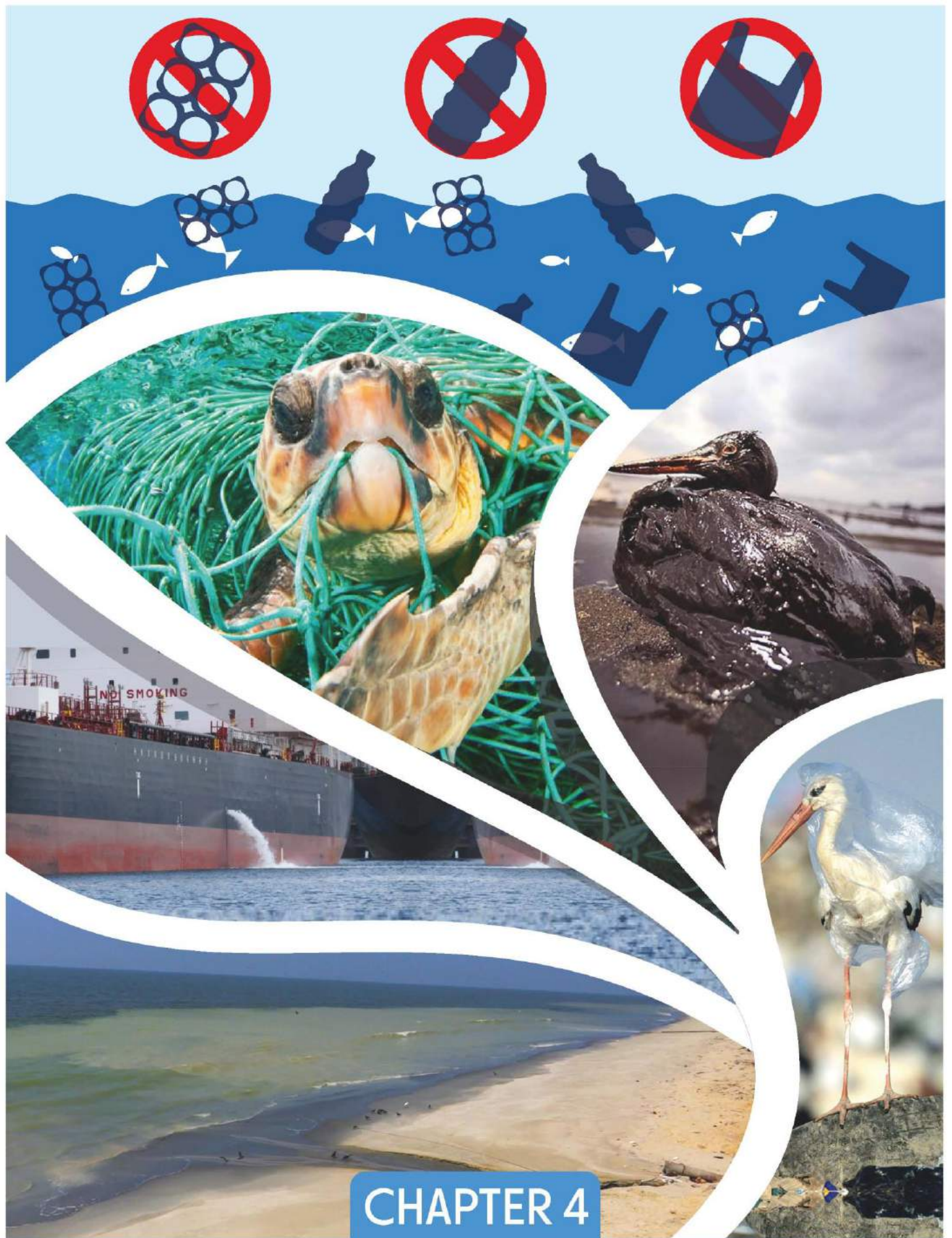
The current tourism policies in Karnataka are archaic, generic, and inapplicable to the ground realities without the requisite institutional arrangements in place for implementation. These issues coincidentally impede the growth of tourism in Karnataka.

Support policies (subsidy for running costs (fuel), provision of free water etc. for houseboats) in neighboring states such as Kerala encourage and provide the much-needed backing for sector development.

Lower tourist footfall in the blue economy sectors is also partly due to inadequate marketing. The cultural, natural and dharmic sectors are focused/projected while marketing tourism in Karnataka and blue tourism sectors such as coastal/beach tourism, ecotourism and adventure tourism (aquatic) take a backseat in the marketing portfolio.

Though Karnataka is endowed with several islands, tourism is mainly limited to a handful of islands and that too in a small way.

There is considerable scope for promoting blue tourism in Karnataka. This needs to be spearheaded by robust tourism-friendly and sustainable policies complemented by appropriate support through subsidies etc. The blue tourism sectors in Karnataka need to be aggressively marketed. Hitherto unexplored sectors such as island tourism, ecotourism etc. need to be actively pursued and promoted. Going forward, greater focus needs to be given to environmental sustainability and social equity in all the blue tourism sectors.



CHAPTER 4

Strategies for Pollution Management, Improved Resources Efficiencies, Recycling and Waste to Useful Products

Chapter 4: Strategies for Pollution Management, Improved Resources Efficiencies, Recycling and Waste-To-Useful Products

4.1 Introduction

To meet the growing demands of an ever-increasing population, rapid urbanization and industrialization has led to speedy resource depletion, increased waste generation and aggravated pollution. The ultimate sink or deposition points of most of the pollutants are water bodies, which include the coastal, marine as well as inland waters. It is estimated that a staggering 80 percent of marine pollution originates on land. Several point-source pollutants are large in volume and quantity, such as municipal sewage with high organic load or industrial effluents which carry toxic chemicals and heavy metals in high concentrations. Numerous non-point sources of pollutants such as the agricultural and municipal runoffs, also find their way into water bodies. In addition, water-based activities such as maritime transport, water-based tourism, fisheries, aquaculture, etc. have also resulted in additional pressure on the world's aquatic ecosystems and undermined their overall health.

The cumulative release of various pollutants such as nutrients, toxins, marine litter, etc. has caused the degradation of water quality thus disrupting the balance of the ecosystem, killing fish and other aquatic life besides being toxic to human beings. If these wide ranges of pollutants that end up in our planet's lakes, rivers, streams, groundwater and eventually the oceans are not managed appropriately, it would continue to have devastating consequences on marine life and their habitats. This would further render the water bodies unfit for use and pose a serious threat to the ocean-based economy and livelihoods of people.

An exponential rise in public awareness about water pollution has attracted international attention and stimulated scientific research geared to understanding its extent and reducing its impact. Countries have expressed a growing sense of urgency to tackle this issue, for example, member states have adopted resolutions on marine litter and marine plastic debris/micro plastics in UNEP (2014, 2016 and 2017). These resolutions build on the outcome document of the UN 2012 Conference on Sustainable Development, "The Future We Want" (UN, 2012), in which States committed to take action to reduce marine debris significantly by 2025. The same urgency is reiterated in Sustainable Development Goals (SDG) 14, particularly its target 14.1 (prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities, including marine debris and nutrient pollution by 2025).

With a population of just over 60 million, Karnataka is one of the most urbanized states in India. Karnataka is endowed with rich natural resources that make it one of the leading states in terms of industrial growth and urbanized culture. There are seven river systems in Karnataka, namely Godavari, Krishna, Cauvery, North Pennar, South Pennar, Palar and West flowing rivers, which along with their tributaries support the existence, growth and sustenance of a large number of industries as well as urban dwellers. The over-exploitation of these rivers and the long-term discharge of untreated urban and industrial effluents in them have led to substantial decrease in the quality of water thus rendering them unsuitable for human use. Moreover, high cost, energy intensive and sophisticated treatment systems are required to make the waters suitable for human/industrial use. In 2015, Karnataka generated over 3,700 MLD (million liters per day) of wastewater whereas the installed sewage treatment capacity of the state is only 1,300 MLD implying that nearly 65 percent of wastewater is discharged untreated into water bodies.

Improper solid waste management in industries as well as urban local bodies/municipal corporations has led to all kinds of littered wastes ending up in waterways and eventually in the oceans. This unethical management of waste and discharges has resulted in dire and detrimental damage to aquatic ecosystems and the aquatic life that these water bodies

support. It is therefore evident that if these devastating impacts continue, it will substantially hamper the state's potential to harness the blue resources sustainably.

Monitoring of water bodies is essential to detect the presence of pollutants such as heavy metals and pesticides in the biota so that suitable remedial actions can be taken up. Continuous monitoring will aid in maintaining the quality of water and preserve the health of aquatic ecosystems that support all forms of aquatic life.

To assess the impact of various anthropogenic activities on the coastal ecosystem, it is necessary to monitor long trends along the coastal waters for important environmental and biological parameters. To achieve this, the Ministry of Earth Sciences (MoES), has been implementing a nationally coordinated research program, namely 'Seawater Quality Monitoring (SWQM)' earlier known as 'Coastal Ocean Monitoring and Prediction System (COMAPS)', since 1990. The main objective of the program is to constantly assess the health of India's marine environment and indicate areas that need immediate and long-term remedial action. Under the program, data on more than 25 parameters on physico-chemical, biological and microbiological characteristics of seawater and sediment are being seasonally collected and analyzed at about 84 locations (number and locations vary periodically based on the trends of pollution) with the help of 121 R&D institutions in the 0-25 km sector of the coastline of the country. Under this program, the Water Quality Index (WQI) for coastal waters at Mangaluru in Karnataka showed 'Poor' status (Water Quality Index monitored from 2011-2015).

Similarly, to monitor the health of rivers and lakes, the Central Pollution Control Board (CPCB) is executing the National Water Quality Monitoring Program (NWQMP) in collaboration with Karnataka State Pollution Control Board (KSPCB). The NWQMP comprises 63 stations in the State and monitoring is carried out on a monthly basis in selected stretches of rivers. Presently the water quality monitoring network is operated under two programs, viz., Global Environment Monitoring System (GEMS - 5 locations) and Monitoring of Indian National Aquatic Resources System (MINARS - 58 locations). Water samples are being analyzed for 28 parameters, which includes 9 core parameters, 19 Physico-Chemical and Bacteriological parameters along with field observations. Besides this, 8 trace metals and 15 pesticides are analyzed once a year to assess the water quality.

Under this program, water resources are classified according to their uses for setting water quality objectives for different water bodies. The classifications are as follows:

Class 'A' – Drinking water source without conventional treatment but after disinfection.

Class 'B' – Outdoor bathing (organized).

Class 'C' – Drinking water source with conventional treatment followed by disinfection.

Class 'D' – Propagation of wild life, fisheries.

Class 'E' – Irrigation, industrial cooling, controlled waste disposal.

Below 'E' – Not meeting criteria A–E.

WQI - Water Quality Index: S- Satisfactory, US- Unsatisfactory

WQI - Water Quality Index: (Dissolved Oxygen ≥ 4 mg/L, BOD ≤ 3 mg/L, Fecal Coliform ≤ 2500 MPN/100 ml & Total Coliform ≤ 5000 MPN/100 ml).

The water quality of a stretch is evaluated based on the criteria of designated best use and activities in the river. The monitoring locations wherein one or more parameters are exceeded are identified as polluted and require action for restoration.

The water quality monitoring results are analyzed with respect to the indicator of oxygen consuming substances (BOD - Biochemical oxygen demand) and that of pathogenic bacteria (total coliform and fecal coliform). The presence of high coliform and excess BOD are indicators that the river/lake will not be able to support fisheries/aquatic life.

**CLASSIFICATION OF RIVER WATER QUALITY UNDER
NATIONAL WATER QUALITY MONITORING PROGRAMME
DURING THE YEAR 2017-18**

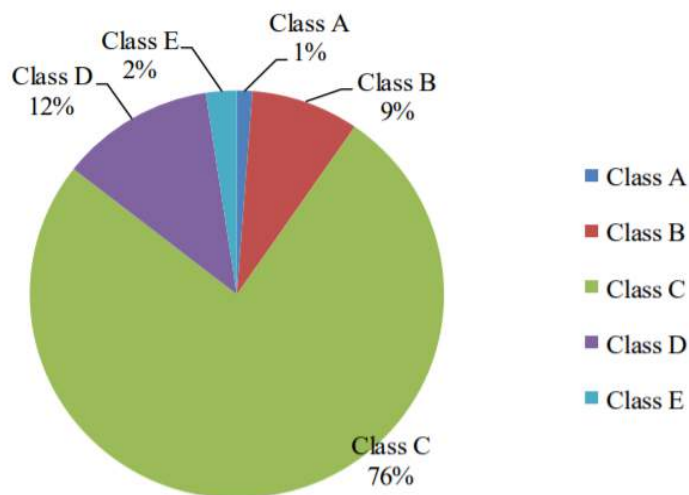


Figure 4. 1: Classification of river water quality under NWQMP during the year 2017-18

Results of the NWQMP carried out during the year 2017-18 are depicted in Figure 4.1. By and large most of the river stretches fall under "C" category (76 percent), which indicates that the water is fit for domestic use after physio-chemical treatment and disinfection.

The KSPCB is slated to monitor water quality in 120 lakes throughout the State. Out of 120 lakes, 30 lakes are not being monitored due to non-availability of water. Majority of the lake waters are classed low with 60 percent and 20 percent of the lakes classed D and E respectively. Only 1 percent each are classed as A and B with the remaining 8 percent classed as C.

**CLASSIFICATION OF LAKE WATER QUALITY UNDER NATIONAL WATER
QUALITY MONITORING PROGRAMME DURING THE YEAR 2017-18**

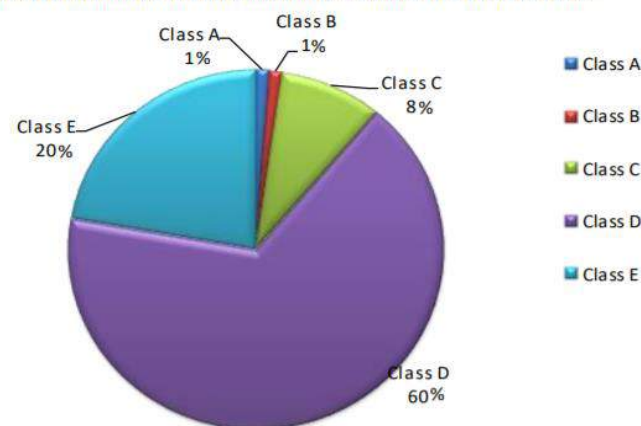


Figure 4. 2: Classification of lake water quality under NWQMP during the year 2017-18

A surge in economic ventures has not come without risks to the ocean, lake and river ecosystems. Once considered an inexhaustible source of food, the oceans and rivers have now become vulnerable to overexploitation, rising temperatures and pollution, which is adding stress on the ecologically sensitive and economically important ecosystems. For example, the effects of climate change have already caused damage to aquatic ecosystems. This is evident from the overall decline in fish catch in India as well as in Karnataka. As per data by Central Marine Fisheries Research Institute (CMFRI), Karnataka's production for the year 2018-19 (ending May 31) fell to 4,45,213 MT from 5,47,784 MT in 2017-18, a drop of 18 percent. The sharp fall in catch is attributed to climate change, i.e., the El Nino effect. The El Nino effect occurs when the surface temperature of the Pacific Ocean increases by over 0.5° Celsius above the average, for a prolonged period of time. Even a one-degree centigrade rise in sea temperature impacts breeding of some fish species and this phenomenon has had an adverse effect on fish production globally and in India, too. Higher atmospheric temperature has also led to higher carbon dioxide concentration making water acidic with lower dissolved oxygen levels thereby affecting primary productivity in the coastal waters

The CMFRI, Mangaluru research center had also issued a forecast over the decline of Indian oil sardine (IOS, *Sardinella longiceps*) because of El Nino. Indian oil sardine is the most abundant fish resource in the Indian seas and the catch of this variety often reflects total marine fish landing trends in the country. The 2018 annual fish landing data showed a 54 percent decline since 2017 of the Indian oil sardines. Kerala and Karnataka together saw a decline in sardine catch from 1,19,000 MT in 2018 to 74,000 MT in 2019. In Karnataka, there has been a decline in the catch of mackerel too as the climate cycle has a staggered effect on the reproductive biology of the fish.

In Karnataka, the landings during 2019 increased by 11 percent (5,01,331 MT) as compared to 2018. However, the increase was mainly due to very high landings (1,62,398 MT) of the red-toothed triggerfish (*O. niger*). It is not consumed by humans and has meagre commercial value and is generally relegated to producing fish meal. It is unfortunate that the changes in climatic conditions, including higher sea surface temperatures, have affected the quantity of popular fish species, including sardines and mackerels, while giving way for heavy landings of other non-dietary and commercially non-important fish species. The west coast region is also experiencing a high frequency of high intensity cyclones. Cyclonic conditions increase sea water turbulence leading to increased suspended solids in the sea water column thereby affecting primary production and a possible shift in the fish population and diversity.

Water pollution from point and nonpoint sources can harm aquatic life in various ways. When nutrient rich pollutants such as nitrogen and phosphorus from agricultural run-off and sewage outflows join the water bodies, it leads to eutrophication or nutrient induced excessive growth (or bloom) of algae and plankton. When this algae/plankton decay they further lower the oxygen levels in the water that fish need to survive resulting in 'dead zones'. There are now some 500 of these dead zones around the world. Algal blooms can be harmful to fish as toxins accumulate within the fish due to ingestion and move up the food chain resulting in bioaccumulation and biomagnification. Synthetic pesticides and heavy metals that enter water bodies are toxic even in small amounts. The presence of heavy metals in water can impair a fish's ability to smell, disrupting its ability to locate food and protect itself from predatory animals and fish.

Unsustainable use of oceans and rivers threatens the very wellbeing of mankind in the long run. Against this backdrop, sustainable development requires a responsible approach to reducing pollution and the negative impact of climate change. Implementing effective waste reduction initiatives, recycling and effective waste and sewage management is the key to improving the healthy longevity of our lakes, rivers and oceans. Pollution-free waters are an essential key to ensure their health and productivity. Hence, the blue economy initiative seeks to improve human well-being and social equity while addressing current

economic and environmental challenges of minimizing pollution and promoting sustainable practices.

To ensure sustainable blue economy in Karnataka, an integral part would be to manage the wastes arising from industries such as fisheries, aquaculture, allied supply and value chains, maritime, urban and municipal areas, etc. by giving emphasis to solutions based on the waste management hierarchy of reduce, reuse, recycle, recover and responsible disposal.

This status paper deals with strategies for pollution management from various sources such as aquaculture sludge, fish and shellfish waste, ship wastes/effluents, etc., improving resource efficiencies as well as strategies to reuse and recycle these wastes into useful products. Thus, responsible waste management would not only improve the quality of water in our water bodies but also enhance a sustainable blue economy that in turn will create more livelihood opportunities and boost the state and national economy.

4.2 Production of Organic Fertilizers from Aquaculture Sludge

Aquaculture is one of the fastest growing animal production sectors in the world. Aquaculture systems can range from ponds, flow-through, cage culture, or re-circulating systems and vary in the degree of water usage and in the characteristics of the “waste” byproducts. Estimates of waste produced per MT of fish produced vary considerably depending on the species, scale and intensity of production. Sediments and sludge generated from intensive aquaculture ponds are rich in organic matter (OM), nitrogen (N), phosphorus (P), macro and micronutrients that accumulate in pond sediments due to the significant discharges from feed waste and waste products that fish excrete by through their gills, urine and feces. When these untreated nutrient rich sediments are discharged in local water bodies, it can lead to environmental impacts such as eutrophication that cause algal blooms and threaten the survival of fish and other aquatic life. Fish farm waste affects not only the surrounding areas directly affected by the effluent, but can also alter a wider coastal zone at different ecosystem levels, thus reducing the biomass, density and diversity of the benthos, plankton and nekton, and modifying natural food webs (Gowen, 1991; Pillay, 1991). Hence, the increasing intensification of aquaculture systems requires effective strategies to reduce their environmental impacts. To reduce the environmental impact of aquaculture sludge, it can be converted into less harmful and/or more beneficial forms such as organic fertilizers which could enhance the soil environment for crop production.

The two most common methods used to reuse solid wastes from aquaculture facilities are land application of thickened sludge (>5 percent solids) and composting. Transportation from the point of generation to the application site can be a major challenge and incurs extra costs, as aquaculture sludge, even when thickened, is mostly water. The aquaculture sludge and effluent wastewater firstly needs to be transferred to a storage system for both sludge thickening and flow equalization. Controlled sludge thickening typically requires sludge storage structures such as anaerobic lagoons, earthen ponds, and tanks that are equipped with settling basins, reed beds, sand beds or wetlands, with an option for lime stabilization to kill sludge pathogens, reduce odor problems and improve solids thickening. Other sludge thickening methods include offline settling basins, wetlands, sand beds, wedge wire sieves, filter presses, centrifuges, vacuum filters, etc.

4.2.1 Land application of aquaculture sludge

Land application has become the easiest and most widely adopted technique to recycle solids from hatchery settling ponds. When properly applied, this technique safely disposes of waste while providing crop fertilization and improving or maintaining the soil structure. The nutrient characteristics and fertilizer value of fish manure have been found to depend on the source materials, the methods of collection and storage, and the methods of

land application⁵⁵. Settled fish waste is generally in the form of slurry that is about 95 percent water. While this high-water content can be beneficial for direct land application, dewatering of the sludge for further storage may be needed to reduce the amount of land/space required and to alleviate storage and handling costs.

Dewatering of fish production waste using a filter press system has been studied in the past⁵⁶. With the aid of fly ash, agricultural lime, diatomaceous earth, or perlite, the filter press reduced the moisture content and produced a filter cake material that retained 95 percent of the N, P, and BOD demand, while reducing the moisture content of the waste by about 35 percent.

A study showed that preliminary attempts to assess the value of the filter cake material as a fertilizer on the growth of *Impatiens walleriana* plant were not very promising⁵⁷. Smaller scaled alternatives may provide more appropriate “beneficial” uses. For smaller scale horticultural, landscape, or gardening applications, further processing and stabilization of raw waste by composting is justifiable for handling, storage, and marketing reasons.

To avoid environmental damage, land application of aquaculture waste slurry should take into account site conditions, timing of application, application rates, crop type, crop uptake capacity, crop rotation, and land availability for application⁵⁸. Most foreign countries have guidelines or regulations that govern land application of manure and other organic wastes to fertilize agricultural crops to limit nutrient loads and associated pathogens, heavy metals, and other contaminants. This is mainly to prevent runoff or groundwater contamination as well as odor problems that may have consequences to human and livestock health.

Currently in India, standards for land application of aquaculture-based organic fertilizers are not available. Hence, appropriate studies and regulations in this area are required.

4.2.2 Composting of aquaculture sludge

Composting offers an alternative to direct land application of thickened aquaculture sludge. Composting is an accelerated bio-oxidation of organic matter passing through a thermophilic stage (45–65°C) (113–149°F) where microorganisms (mainly bacteria, fungi, and actinomycetes) liberate heat, carbon dioxide, and water. Composting converts the sludge and other waste products from aquaculture into a stable organic product by converting nitrogen from the unstable ammonia to a more stable organic form. The end result is a product that is safer to use than the original sludge and when applied to land, will improve the soil fertility and water holding capacity. In addition, composting stabilizes the waste, reduces the bulk of material that needs to be spread, improves its handling properties, reduces BOD, reduces odor, fly and other vector problems and can destroy pathogens. The more stabilized the finished compost is, the easier it is to store and transport for use than raw waste. Composts have commercial value and can potentially be sold as a soil amendment. Furthermore, compost micro flora has also shown to have plant disease suppressive qualities⁵⁹.

Composting of aquaculture wastes requires the mixing in of amendments or bulking agents in proper proportions to promote aerobic microbial activity and growth and to achieve optimum temperatures. This mixture provides a source of energy and nutrients, moisture, and

⁵⁵Harris 1981; Mudrak 1981; Smith 1985; Willet and Jacobsen 1986; Olson 1992a, b; Westerman et al. 1993; Axler et al. 1997; Naylor et al. 1999

⁵⁶Williams and Starr (1990, 1995)

⁵⁷Williams and Starr 1995

⁵⁸IDEQ 1997

⁵⁹Adler et al. 1996f

oxygen for the bacteria. The composting amendment is added to the mixture to alter the moisture content, carbon to nitrogen (C:N) ratio, or pH. Many materials are suitable for use as composting amendments, including crop residues, leaves, grass, straw, hay, sawdust, wood chips or shredded paper, and cardboard. The bulking agent is used to improve the ability of the compost to be self-supporting and to increase porosity to allow internal air movement. Wood chips especially are an excellent bulking agent because they also alter the moisture content and C:N ratio. Composting methods include windrow, static pile, and in-vessel.

4.2.3 Case Studies-Composting aquaculture sludge

In a case study at Mekong Delta in Vietnam, researchers explored the possibility of composting as an effective approach to reuse Fish Pond Sediments (FPS) and agricultural residues such as rice straw (by-product of rice production) that is usually considered unsuitable for animal feed due to its low digestibility, low protein, high lignin, and high silica concentration, thereby converting them into a relatively valuable agronomic resource for use as organic fertilizers. Suitable mixtures of striped catfish (*Pangasianodon hypophthalmus*) pond sediment (PPS) and locally sourced organic amendments of rice straw (RS), or common water hyacinth (WH) (*Eichhornia crassipes*) were used to fertilize cucumber plants (*Cucumis sativus* L.) in an integrated cucumber–giant gourami fish (*Osphronemus goramy*) farming system. The highest nutrient concentrations were found when mixing 30 percent PPS with 70 percent RS or WH. When used in combination with chemical fertilizer, it was found that a 25 percent to 75 percent reduction in chemical fertilizer application could be achieved, while also increasing cucumber yields, with the highest yields found when rice straw was used in organic amendments. The nutrients contained in organic fertilizers produced from *Pangasius* catfish pond sediment (PPS) and locally sourced organic amendments can replace the inorganic fertilizers for cucumber vegetable production and potentially decrease production costs while also reducing the negative impact of aquaculture on the environment. The experiment concluded that an integrated cucumber–fish production system optimized the mutual benefits of growing fish and vegetables and could have both economic and environmental benefits greater than mono-production systems and increase both farm income and production diversity⁶⁰.

Another study was conducted at the laboratory of the Department of Environmental Engineering, Częstochowa University of Technology, Częstochowa, Poland. They investigated the potential of organic fish pond sediments to be managed through laboratory composting with selected waste materials such as wheat straw and green grass and evaluated the fertilizing potential of the obtained compost on the growth of *Phaseolus vulgaris* L. in pot experiments (Figure 4.3). It was found that, the addition of cardboard waste and woodchips derived biochar to the obtained compost significantly improved the growth of the roots of *Cardamine* L. Also, the content of carbon and nitrogen in the compost mixtures increased. The addition of compost from organic fish pond sediments and 1 percent of biochar to the soil had a significant impact on the growth of white beans⁶¹. Hence, fish manure can provide organic content to soil, which is beneficial to moisture retention.

However, the nitrogen levels (2–5 percent dry matter, Westermann et al. 1993) are not as high and readily available to the plants as is the case with inorganic soluble nutrients. Also, fish waste solids may not contain the proper balance of nutrients for plant growth, and further addition of nutrients may be required to sustain profitable growth.

⁶⁰Agronomy 2020, 10, 1025; doi:10.3390/agronomy10071025

⁶¹Potential of Fish Pond Sediments Composts as Organic Fertilizers, Waste and Biomass Valorization (2020) 11:5151–5163

Potential constraints on composting include storing wastes for considerable time and extra expense before they can be used. The conventional compost pile also requires considerable bulk in order to retain the heat required for the thermophilic reaction.



Figure 4. 3: Experiments on potential of fish pond sediment composts as organic fertilizer

Vermicomposting is an alternative to conventional composting that uses worms in the composting process⁶². Vermicomposting is also a bio-oxidation and stabilization process of organic material that, in contrast to conventional composting, involves the joint action of earthworms and microorganisms and is less dependent on a thermophilic stage. The earthworms are the agents of turning, fragmentation, and aeration, consequently avoiding some of the labor required for the turning of bulky conventional compost piles. The end products are the worms themselves, valuable either as bait or as live fish food, and a highly valued specialty organic soil amendment⁶³. Earthworms can break down a wide range of organic wastes and are commercially bred on a large scale in organic wastes for fish bait. Currently, other livestock manures are used as feedstock for worms, and there is reason to believe that either recovered aquaculture bio solids in the form of fish manure, unused feed, or fish processing waste could be effectively processed through vermicomposting. This technique is however still undergoing further testing.

It is estimated that on an average per kg of shrimp or fish production generates 8-10 kg of sludge. The chemical composition of the fish farm sludge from commercial farms averaged 2.83 percent nitrogen (N), 2.54 percent phosphorus (P), 0.10 percent potassium (K), 6.99 percent calcium (Ca), and 0.53 percent magnesium (Mg) on a dry-weight basis. The concentrations of the metals, arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), iron (Fe), mercury (Hg), manganese (Mn), nickel (Ni), lead (Pb), selenium (Se), and zinc (Zn) were also measured. Mean concentrations of these metals ranged from 0.05 mg/kg for Hg to 1,942 mg/kg for Fe. Fresh fish manure has similar levels of N, P, Ca, and Mg, and lower levels of K when compared to manure from beef, dairy cattle, poultry and swine. Fish manure tended to have a higher content of Mn, Cd, Cr, Pb, Fe, and Zn than most other livestock manures, but had lower levels of As, Se, Co, and Ni. The copper (Cu) content of fish manure was similar to all other livestock manures.

The total number of aquaculture farms in Karnataka are: Shivamogga (34); Mandya (31); Mysuru (37); Ballari (35); Raichur (65); and Koppal (57). Further, the brackish water farms in Dakshina Kannada (6), Udupi (200) and Uttara Kannada (156). The major species cultivated are Catla, Rohu, Mrigal, Common Carp, Amur Carp, Silver Carp, Magur, Vannamei

⁶²Edwards and Neuhauser 1988

⁶³Edwards and Burrows 1988

Shrimp. The fish production generated through aquaculture year wise in both marine and inland sector in Karnataka is as shown in Table 4.1;

Year	Marine (MT)	Inland (MT)	Total (MT)
2014-15	389822	223419	613241
2015-16	411762	168828	580590
2016-17	399000	158000	557000
2017-18	414348	188174	602522
2018-19	389491	197921	587412

Table 4. 1: Fish production generated through aquaculture in Karnataka

Depending upon the species culture, stocking density, feed type and feed provided to the fish, pond preparation method, and supplement added to the farms, the annual sludge generation is around 22.85 MT. To make the composting technically and economically viable, bulking agents like rice straw and such can be utilized. Further, Karnataka has cereals and nutri-cereals such as maize, ragi, sorghum, pulses, etc. Oil cakes from groundnut, soya bean, sunflower and safflower can be used as a fat supplement. These cereals and oil cakes along with bulking agents like straw or agro-waste can be used to produce fish feed. The major producers of these cereals/millets are located in Tumakuru, Ramanagara, Hassan, Bengaluru Rural, Chitradurga and Davanagere. Further, oil production from oil seeds is dominant in the districts of Bidar, Kalaburagi, Dharwad and Koppal.

4.2.4 Conclusion and Recommendations

Currently in India, the Coastal Aquaculture Authority has set standards for wastewater discharged from aquaculture farms, hatcheries, feed mills and processing units based on the final discharge point⁶⁴. However, the disposal of aquaculture sludge is unregulated and the conversion of aquaculture sludge into organic fertilizers is not explored in the state. Considering the substantial growth expected in the aquaculture sector, the conversion of aquaculture sludge to reusable materials should be evaluated and implemented to avoid its adverse impact on the environment and promote sustainable aquaculture management.

Aquaculture sludge can be transformed to organic fertilizers if they can be collected in sufficient quantities in a cost-effective manner. Composting of fish pond sediments mixed with locally sourced organic residues can offer both a solution to mitigate pollution in the region and an opportunity to improve agricultural soils. It is an economical and environmentally acceptable method that produces little odor and destroys harmful pathogens. The main constraints to use of aquaculture sludge would be the difficulty of matching available amounts with needs from both quantity and location perspectives to ensure cost-effectiveness of the intended use. There are many research examples of integrated aquaculture-agriculture farming systems that are environmentally sustainable, economically viable as well as practically applicable in a local context as discussed above. However, further studies near aquaculture facilities in Karnataka would be required to use land application and composting based on adequate supply of bulking agents available locally. On obtaining positive results from these studies, integrated farming systems can be supported to enable nearby farmer communities to produce fresh farm organic vegetables and fruits that have good demand. This

⁶⁴http://caa.gov.in/uploaded/doc/treatment_of_wastewater.pdf

would not only increase farmer income but also promote sustainable livelihoods, healthy lifestyles while also protecting the environment from careless disposal of aquaculture sludge.

4.3 Production of Feed/Compost from Fish and Shellfish Wastes

In fisheries and aquaculture, it is estimated that 35 percent of the global harvest is either lost or wasted every year. In most regions of the world, total fish loss and waste lies between 30 percent and 35 percent. Fish losses, both in quantity and quality, are driven by inefficiencies in value chains such as inadequate infrastructure, services and practices for adequate onboard and on-shore handling for preserving fish quality. Some of the key deficiencies relate to access to electricity, potable water, roads, ice, cold storage and refrigerated transport.

The quantities of wastes generated by the fish processing industry is around 50 percent-80 percent of the original raw material. Wastes are generated at different points in the value chain, viz. by-catch, on-board handling, landing centers, transportation, storage, retailers and consumers. These byproducts or wastes are in the form of non-edible tissues like bones, skin/scales, swim bladders, fins, intestines, blood, roes, liver, etc. that are a rich source of valuable components such as protein, lipid, enzymes, bioactive peptides, pigments, flavors, vitamins and minerals. Although fish wastes are a good source of protein, lipids and minerals, these wastes are often discarded unscientifically leading to loss of huge amounts of nutrients and also causing serious environmental pollution. Hence, converting fish and shellfish wastes into marketable products will not only add value to this waste but will also lead to significant reduction in wastes going to landfills and associated environmental impacts.

It is estimated that nearly one-third of the world's wild-caught fish are not consumed directly by humans but rather are "reduced" to fishmeal and fish oil and consumed in feed by farm raised animals, such as chickens, swine, and other fish generally from high grade pelagic fish waste and demersal fish processing waste. Globally, 20 million MT (approx. 12 percent of total fish production, 171 million MT) is used for non-food purposes. Out of this, 15 million MT is reduced to fishmeal and fish oil and the remaining 5 million MT is largely utilized as material for animal feed, as bait, in pharmaceutical uses and for ornamental purposes⁶⁵. In addition to fishmeal and oil production, there is potential in silage production, fertilizer, composting, fish protein hydrolysate and fish protein concentrate. Due to recent biotechnological advances and processing techniques, it is also possible to produce high value components such as collagen and gelatin, enzymes, etc. Some of the non-nutritional uses of fish wastes include chitin and chitosan, carotenoid pigments, enzyme extraction, leather, glue, pharmaceuticals, cosmetics, fine chemicals, collagen, gelatin and pearl essence.

Table 4.2 and 4.3 shows the waste generated during industrial processing of fish in India and the valuable components of fish by-products respectively.

Products	Waste Generated (percent; w/w)
Shrimp products	50
Fish fillets	70
Fish steaks	30
Whole and gutted fish	10
Surimi	70

⁶⁵Vikas Kumar et. al., *Utilization of Fish Processing Waste: A Waste to Wealth Approach*, ICAR-CIPHET, Punjab

Cuttlefish rings	50
Cuttlefish whole	30
Cuttlefish fillets	50
Squids whole cleaned	20
Squid tubes	50
Squid rings	55

Table 4. 2: Waste generation during industrial processing of fish in India

(Source: Anon (2005))

By-Product	Valuable Components	Utilized as
Heads	Proteins, peptides, lipids, collagen, gelatine, minerals including calcium, flavour	Food, fish meal, fish oil, food grade hydrolysates, animal grade hydrolysates, pet food, nutraceuticals, cosmetics
Frames (bones, flesh, fins)	Proteins, peptides, lipids, collagen, gelatine, minerals including calcium, flavour	Food, fish meal, fish oil, food grade hydrolysates, animal grade hydrolysates, pet food, nutraceuticals, cosmetics
Trimmings	Proteins, peptides, lipids	Food, fish meal, fish oil, food grade hydrolysates, animal grade hydrolysates, pet food
Viscera	Proteins, peptides, lipids, enzymes such as lipases	Food grade hydrolysates, animal grade hydrolysates, fishmeal, fish oil, fuel, fertilizers
Skin (with belly flap)	Collagen, gelatine, lipids, proteins, peptides, minerals, flavour	Fish meal, fish oil, cosmetics, food, fish meal, nutraceuticals, cosmetics, leather, fuel, fertilizers
Blood	Proteins, peptides, lipids, thrombin & fibrin	Fuel, fertilizer, therapeutants

Table 4. 3: Valuable components and the utilization of fish by-products

(Source: Vikas Kumar et. al., Utilization of Fish Processing Waste: A Waste to Wealth Approach, ICAR-CIPHET, Punjab)

This section entails the potential of maximizing the benefits from fish wastes into making various by-products that can be used by other industries for various applications such as production of fish feed, animal feed, fertilizers, compost, etc. from fish and shellfish wastes. This useful utilization of fish processing waste can enhance the productivity of the fishery sector to a great extent by meeting the demand of the aquaculture and animal feed industry that are already facing severe resource scarcity.

In Karnataka, there are 91 beach landing centers, 16 fish landing centers and 8 fishing harbors (Fishing Ports) falling in the 3 coastal districts of Karnataka namely, Dakshina Kannada, Udupi and Uttara Kannada which are located in the taluks of Mangaluru, Udupi,

Kundapur, Bhatkal, Honnavar, Kumta, Ankola and Karwar. The waste is generated in pre-processing centers, fish processing and exporting factories, fish markets and other handling premises. Karnataka's total trash fish production is around 32,000 MT/ year. To utilize the discarded by-catches and fish processing wastes, Fish Meal and Fish Oil (FMFO) industries were set up to make fish meal/fish oil, which are the major ingredients used for production of high-protein feed ingredients and palatability-enhancing agents for aquaculture and animal feed processing industries. In India, most of the FMFO industries are in Karnataka. At these FMFO plants, the putrid cargo is turned into powder (fish meal), packed in 10 kg, 50 kg and 100 kg sacks and dispatched to fish feed processing factories, mostly in coastal Andhra Pradesh and Tamil Nadu. The fish meal is mixed with wheat and vegetable proteins to make feed for shrimp, catfish and other aquaculture produce that is sent to the commercially run fish and shrimp farms dotting the Indian coastline, especially the east coast. The fish and crustaceans farmed using this feed are exported to countries such as the US, UAE, China and Japan⁶⁶.

The following sections describe the use of fish and shellfish wastes to produce organic fertilizers, fish meal/fish oil/fish silage, which in turn can be used for production of fish feed/animal feed.

4.3.1 Fish feed and animal feed from fish and shellfish waste

Rising demand in the animal husbandry sector has in turn driven the demand for fish/animal feed. Usually, fish meal, fish oil and fish silage are produced from juveniles, low value bycatches (LVB) and other fishes not used for human consumption. Fish meal, fish oil and fish silage can be either directly used as poultry feed or further processed into fish/animal feed. Utilizing fish and shellfish waste for production of fish/animal feed can reduce their costs and thereby significantly reduce operating costs of poultry and aquaculture activities. However, use of fish/shellfish wastes from processing plants/fish markets to manufacture fish meal/fish oil is rather rare since they are generally discarded. The following sections give a brief on the processes involved in production of fish meal/fish oil/fish silage and feeds.

4.3.1.1 Fish meal

Converting fish waste into fishmeal is a viable option for stabilizing the otherwise highly perishable waste. Fishmeal is a highly nutritious powder, produced by drying and grinding whole fish or processing waste. The type, nature and freshness quality of the raw material are extremely important in fishmeal production as they relate to the protein and ash content, and total volatile nitrogen (TVN) level of the finished product. These factors, and others such as histamine levels, digestibility, salt and moisture content, dictate the grade of the fishmeal produced and hence its value. Fishmeal can be made from almost any species of whole fish or their processing waste. The process of making fishmeal from waste is almost the same as that of making fishmeal from whole fish, except modulating the time and temperature of operation and pressing. The process of converting fish/fish waste into fish meal is shown in Figure 4.4.

⁶⁶<https://earthjournalism.net/stories/trawling-for-trouble-along-the-karnataka-coast>

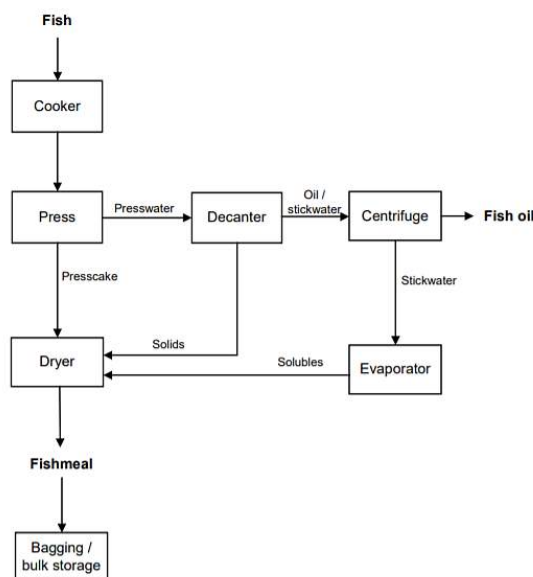


Figure 4. 4: Flow chart of fishmeal production

(Source: Fish Waste Production in the United Kingdom, Seafish Report Number SR537, November 2001)

Fishmeal is produced in a number of grades dependent on its composition. High-grade fishmeal is in demand from animal husbandry and aquaculture where it can be blended with fish oil to make a feed that provides the best possible source of digestible protein and essential vitamins and oils for the rapid growth of farmed fish, piglets and poultry. Fishmeal is considered an ideal ingredient in animal nutrition and is a highly concentrated nutritious feed supplement consisting of high-quality protein, minerals, vitamins and other unknown growth factors. The as yet unknown growth factors of the feed are thought to be responsible for the accelerated growth and improved resistance to disease shown by fish and animals reared on a fishmeal diet. The increased digestibility of high-grade feed not only improves growth, but it is estimated that a 1 percent increase in digestibility from 90 percent to 91 percent results in the reduction in the amount of waste discharged by farmed fish by 5 percent.

In India, the fishmeal production (65,000 MT/annum) is confined to the coastal states with Karnataka (58,000 MT) being the largest producer, followed by Kerala (6,000 MT) and Tamil Nadu (1,000 MT). Globally, India is ranked 8th in fishmeal production with a quantity of about 1.03 lakh MT.

4.3.1.2 Fish oils

The most significant use of fish oil is in aquaculture, which uses between 70-80 percent of all fish oil produced. Omega-3 fatty acids are found in relatively large amounts in all types of fish oil. Recent health and development studies have demonstrated the considerable benefits of Omega-3 long chain fatty acids in both humans and weaning animals. Recent studies have also shown the benefits of feeding fish oil to poultry, pigs and cows. A fish oil enriched diet is particularly beneficial for weaning and young animals. Not only do the animals show increased growth and resistance to disease, but the animals fed on a diet rich in Omega 3 fatty acids store these components in their flesh or eggs, resulting in the health benefits being passed on through the food chain. In humans, Omega 3 fatty acids reduce the risk of coronary heart disease and appear to reduce susceptibility to inflammatory, allergic and immune diseases, amongst other benefits.

As shown in Figure 4.4, crude fish oil is produced as part of the fishmeal process but this needs further processing before use, as shown in Figure 4.5. These processes are generally not undertaken at the fishmeal plant. If the crude oil is to be used for animal or fish feed, it is generally washed and centrifuged before use.

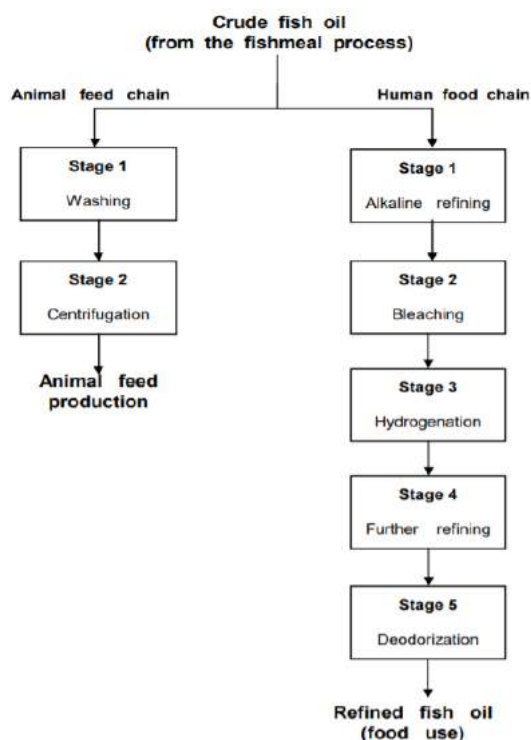


Figure 4. 5: Flow chart of fish oil production

(Source: Fish Waste Production in the United Kingdom, Seafish Report Number SR537, November 2001)

4.3.1.3 Fish silage

Fish silage is a product of fish liquefaction by using a wide variety of fish species either whole fish/parts of the fish/ fish waste by adding acid, enzymes, lactic acid producing bacteria or by naturally occurring enzymes in fish. Fish silage is a liquid product which has a high nutritional value similar to that of the fish itself. Silage is usually produced from pelagic fish which are relatively low in value and caught in large quantities. The product is a stable liquid with a malty odor which has very good storage characteristics and contains all the water present in the original material. It is a simple process and it requires little capital equipment, particularly if non-oily fish are used. In comparison to fishmeal, silage production is relatively simple and inexpensive with much lower capital equipment, production and labor costs. However, being in a relatively low concentration liquid form, the main disadvantages are transport costs. The protein digestibility, vitamin content and hence the quality of the silage is directly related to the quality of raw material, which should be processed as soon as possible after catching. Generally pelagic fish liquefy much faster than demersal fish and fresh fish liquefy quicker than stale fish.

Fish silage can be used the same way as fishmeal in animal feed; however, liquid feeding and handling systems are required. Like fish meal, fish silage is rich in protein and amino acids and can be used as a protein source for animal feed preparation to feed cattle, cow, swine, duck, sheep, mink and many other terrestrial animals. Fish silage can also be mixed with other ingredients such as grains and dry flour for livestock feed. Since fish silage contains hydrolyzed protein, it can be used as a protein source by replacing fishmeal at the level of 5-15 percent in fish feed preparation. Swine fed with fish silage showed higher growth

rates, improved health and reduced mortality. Protein rich fish silage can be used as a protein source for broiler chicks and as an alternative to fishmeal to achieve increased weight and feed conversion ratio. It is also used as a feed supplement in aquaculture.

The silage process is more likely to succeed in areas where fish waste is regularly available and where pig farms are located nearby. Production of a semi moist feed or paste product would reduce transport costs and open up new markets for silage products. Similarly, the application of new concentration techniques such as membrane filtration technology may further reduce drying costs. If the silage process uses pelagic fish as raw material, the fish oil recovered from the process can be sold as a product to offset drying costs. Figure 4.6 shows the basic stages of silage production using acid.

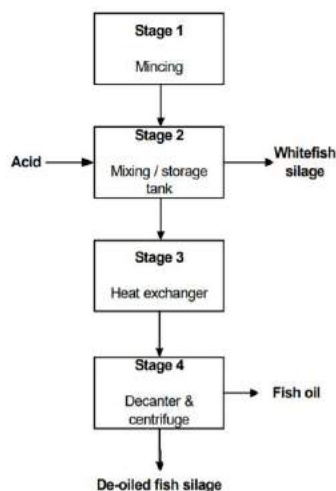


Figure 4. 6: Flow chart of the basic stages of silage production using acid

(Source: *Fish Waste Production in the United Kingdom*, Seafish Report Number SR537, November 2001)

4.3.1.4 Foliar spray

Foliar spray, which contains soluble protein and other micro and macro nutrients, is another option for fish waste utilization. Foliar spray is a technique of feeding plants by applying liquid fertilizer directly to their leaves by spraying. Plants are able to absorb essential elements and nutrients through their leaves and absorption takes place through the stomata of the leaves and also through the epidermis. Movement of elements is usually faster through the stomata and this results in faster growth and flowering. Some plants are also able to absorb nutrients through their bark.

Foliar spray is prepared by hydrolyzing the fishery waste either by adding acid directly as in case of silage or by in-situ production of lactic acid by microorganisms. The clear upper portion of acid silage is decanted and suitably diluted and used as spray. In the case of microbial process, the fish waste is mixed with a carbohydrate source like molasses and inoculated with lactic acid producing bacteria and the lactic acid produced will hydrolyze the protein partially. It will take 20-30 days for hydrolysis and the upper clear liquid can be used as foliar spray. It gives quick results by enhanced productivity in plants and also acts as a pest repellent.

ICAR-CIFT has been providing training on production of fish silage and foliar spray from different types of aquatic wastes including cephalopod waste. The incubatees of CIFT are

successfully marketing their products and it is a profitable venture⁶⁷.

4.3.1.5 Fish feed/Animal feed

There is a growing demand for pellet feeds due to the increase in aquaculture and poultry activities. A significant portion of costs in these sectors is directed towards the feed, which can be reduced by utilizing the waste generated from nearby fish markets and fish processing industries.



Figure 4. 7: Different kinds of fish feed pellets

The technology of feed processing has undergone substantial improvement in recent years from simple hand mixing to the nutritionally balanced pellet feeds available in the market today. This requires a considerable amount of specialized equipment and technical expertise. ICAR-CIFT has been working on technologies for production of low-cost alternatives to commercial feeds using locally available ingredients. The feed ingredients used are rice bran powder, soya powder, wheat powder, corn flour along with fish waste thus producing low-cost fish pellet feeds using small indigenous machinery like grinding/pasting machine, ingredient mixing machine, cooking device and pelletizer, etc. The feed developed is comparable to commercial feeds in terms of its quality. This model can be easily set up at the fish farm site itself and based on the fish age and species cultured, the ingredient mixture composition and pellet feed size can be changed considerably thus reducing the wastage.

An improved method in feed production from fish waste has been worked out by ICAR-CIFT which will reduce the cost of production, handling time and manpower requirement, when compared to conventional processes. Figure 4.8 shows the steps involved in fish feed production. Many farmers have taken up the technology and are producing their own feed as per CIFT guidance.

⁶⁷FishTech-19, *Fishery waste management: Challenges and Business Opportunities in Gujarat, Agricultural and Animal Farm Inputs from Fishery Waste*



Figure 4. 8: Flow chart of fish pellet feed production by ICAR-CIFT

(Source: Pellet Fish Feed, ICAR-CIFT, Kochi, 2019)

4.3.1.6 Economic analysis of the production of fish feed pellets from the fish waste

The annual investment is around INR 1.65 lakhs. Out of the total investment, machinery items such as grinder and pelletizer cost up to 42 percent of the total investment. The annual operating cost is around 8.7 lakhs, and the main components of the operating expenditure are the raw material cost, which includes fish waste as well as the ingredients constituting 70 percent of the cost. The annual fixed cost is INR 0.33 lakhs. A 100 kg fish contains roughly 80 percent moisture and 20 percent dry matter. 20 kg of this dry matter is mixed with 80kg of ingredients to produce 100 kg pellet feed per day. A break up of ingredient costs excluding fish cost is around INR 4.75 lakhs, out of which the cost of rice bran is 34 percent, the remaining, i.e., soya powder is 25 percent and corn flour 17 percent. The investment made is found profitable and the option for the fish farmer to start a unit locally is feasible, and this technology will act as a way to mitigate the rising cost of commercial feed. Even though the ingredient cost itself is about 54 percent of operating cost, this can be reduced by using locally available raw materials such as agricultural byproducts. Species specific feeds with improved nutritional profile can also be thought of while catering to the needs of the growing aquaculture industry. The technology will enable the development of rural enterprises in producing affordable fish feed and also generate local employment and economic participation of rural entrepreneurs, including women. The technology will improve fish waste management and address fish waste pollution related issues.

ICAR-CIFT has also developed technologies for the extraction, purification and characterization of high-end products from fishery discards. To name a few, chitin & chitosan, various derivatives from chitin, squalene, hydroxyapatite, fish calcium, fish protein hydrolysate, PUFA, etc., all have various industrial and pharma and nutraceutical applications. The conversion of waste material with its consequent reutilization can bring economic advantages for the industry, besides solving a great problem of the discharge of the waste into the environment.

4.3.2 Production of compost from fish and shellfish wastes

Fish-based fertilizer has been used to supply crops with a balanced source of nitrogen, phosphorus and potassium. Liquid fish fertilizer is produced by mixing whole fish or processing waste with sulphuric acid, which releases sulphates and phosphates and reduces fishy odors. Alternatively, the addition of urea solubilizes the fish proteins, which become available to plants after being broken down by bacteria in the soil. There are a number of advantages of using fish-based fertilizer that has been solubilized with urea: the resulting fertilizer does not readily leach out the soil and also it releases nutrients into the soil slowly unlike modern chemical fertilizers. Another source is the anaerobic digestion of fish waste which leads to the production of methane and sludge. The methane is generally recycled into the digestion process to generate electricity/heat whereas the sludge can be used as an organic fertilizer.

A biogas unit was installed in the premises of Mangaluru Research Centre of CMFRI during November 2016 in order to utilize the fish waste generated from the biological analysis done in the lab thereby solving the fish waste disposal problem. This biogas unit installed is the first of its kind in the state to utilize fish waste. The portable biogas unit has 2 MT capacity and when fully functional around 2 kg of gas is produced every day. In addition, the slurry collected from the unit is utilized for the production of manure by mixing it with coconut fronds, grass leaves, etc. The total expense incurred was about INR 35,000/- for installation of the unit. The LPG gas consumption is reduced to 25-30 percent and approximately 100-120 kg of vegetables per year is produced in the premises. This method is an efficient alternative technology that combines biofuel production with sustainable waste management. Biogas, being a renewable energy resource, has aided in reducing the usage of fossil fuel. Hence, installation of similar units in the fishmeal and fish processing plants would reduce their dependence on fossil fuels and address the issue of fish waste management to a great extent.

Composting uses microorganisms to convert the fish waste and plant material into a useful soil enhancer. Highly nitrogenous fish material is most suitable for composting. The most common materials used include aquaculture mortalities, viscera, frames, whole oily fish and shellfish waste. These materials are relatively rich in protein and putrefy rapidly. Composting relies on mixing proteinaceous and carbonaceous matter in the correct ratio. The biologically optimum ratio for carbon to nitrogen is 30:1. Typically, nitrogenous fish waste is mixed with a rich source of carbon such as wood waste (sawdust, peat, wood chippings, etc.). Composting usually takes about four to six weeks. Over this time, the waste is converted by micro-organisms into rich humus. Regular aeration is necessary to prevent overheating and the development of anaerobic 'pockets', both of which can destroy the useful bacteria. The heat generated by the microbial action pasteurizes the product, eliminating odors and destroying weed seeds and disease organisms. The final compost products are generally rich in organic matter (40-70 percent) and contain between 1-4 percent nitrogen. Compost is used as a soil enhancer to improve the nutrient content of the soil in order to favor growing conditions. This has mass potential for both domestic and commercial markets, particularly as it is an organic product. Fish-based compost can be commercially produced, particularly in areas with large quantities of fish and forestry waste. The heat produced during the process is used to heat commercial greenhouses. Given that composting is a process that can utilize all parts of fish and shellfish and there is a significant market for the end product, it has significant potential. However, the process does require a significant area of land, preferably remote because of the odors produced, with a ready bulk supply of carbonaceous material and fish waste.

4.3.3 Conclusion and Recommendations

An ever-increasing amount of fish and shellfish wastes are being generated in the state from low-value-bycatches (LVB)/ juveniles caught at sea, wastes in fish markets, fish processing industries, etc., which are usually discarded, and harmful to the environment.

Hence, appropriate management of these wastes is crucial in protecting the environment and aquatic life from long-term degradation.

Presently, the low-value-bycatches (LVB) are being used to produce fish meal and fish oil, which are subsequently sent to other states and/or exported for the manufacture of fish feed/animal feed. Although the state has many FMFO (Fish meal/fish oil) units which are well established there are no fish feed-making units. The export demand for processed products such as fish meal, fish oil, etc. has been steady for some years and has been a source of income and generator of valuable foreign exchange revenue for the state. All feed for aquaculture/poultry in the state is obtained from Andhra Pradesh and Tamil Nadu while for the ornamental fish culture the feed is obtained from abroad.

Demand for fish meal, which is the precursor to the manufacture of animal and fish feed, has increased over a period of time and is bound to increase further as more aquaculture farms, reservoir cages, etc. would come up with the implementation of PMMSY in India. In addition, with marine capture fisheries stagnating, more and more aquaculture farms are being set up worldwide to cater to the demand for fish and fish products in turn driving up the demand for fish meal/fish feed. With regard to cattle and poultry feed production there is already a deficit of 8-14 lakh MT. Although there is significant requirement and demand for fish meal and allied products, it would not be prudent to set-up more FMFO units as they are one of the main causes of overfishing and environmental degradation. Hence, it is recommended that up-gradation of existing fish meal plants for effective utilization of the raw materials/fishery wastes to produce fish feed and animal feed be encouraged rather than increasing the number of FMFO plants in the state. The use of fish/shellfish wastes to make high quality fish feed and animal feed will not only meet the demand, but also prevent fishery waste from landing up in the aquatic environment thus reducing pollution as well as the cost of fish farming. However, during the stakeholder consultation, it was suggested that instead of converting fish processing waste into aquaculture feed, it would be wise to convert fish processing waste into organic fertilizers, which is in great demand. The same has been presently carried out successfully by fish meal industries and is being marketed as a bio stimulant, giving excellent results.

Intervention of the government to utilize fish/shellfish wastes from fish markets and fish processing units to nearby FMFO plants are a key to successful seafood waste management. An effective way to implement this would be to create awareness and bring in appropriate policy interventions coupled with setting up of adequate infrastructure.

The state has not yet made serious inroads into converting fish/shellfish waste into other valuable products such as fish silage, fish feed/animal feed, fertilizer, and compost. These strategies also hold tremendous potential and can considerably reduce the amount of waste going for disposal. It will also encourage sustainable practices, reduce the adverse impacts on the environment while increasing foreign exchange earnings and job opportunities.

Fish/shellfish wastes are rich in several bioactive materials, such as proteins, enzymes, fatty acids, and biopolymers. Bioactive substances derived from seafood by-products/wastes have been used in various biotechnological, nutritional, pharmaceutical, and biomedical applications⁶⁸. Karnataka is yet to venture into the production of bioactive substances from fish and shellfish wastes. As the area holds immense promise, this needs to be actively pursued.

The fish processing industry and related stakeholders can intervene and make progress in the future in terms of resource mobilization, value addition, product diversification and sustainable growth. Suitable technology can be applied for easier processing and

⁶⁸Kim, S.-K. (Ed.), *Seafood Processing By-Products*, 2014

recovery of bioactive components and biomolecules from some of the prospective fish processing by-products or waste. However, the technical feasibility does not necessarily translate into economic feasibility and therefore, a fish processor should critically review by-product utilization options before committing to a specific process.

4.4 Desalination Plants – Strategic Deployment and Cost Reduction

Water is vital to life, society and the economy. Around 4 billion of the world's population face moderate to severe water scarcity, about 66 percent of which live under conditions of severe water scarcity for at least one month during a year. According to a study in 2014, one in four major cities in the world, constituting a USD 5 trillion economy, is already facing water stress⁶⁹. As the global population rises, increased urbanization, climate change and shifts in food consumption are likely to dramatically increase future demand for water. Under current trends i.e., without altering current levels of water consumption and pollution, demand for water will exceed supply by 40 percent and almost half of the world's population will suffer severe water stress by 2030, damaging the well-being of millions of people⁷⁰.

Fresh water and energy are essential commodities for the well-being of humankind. Due to the increasing population growth on one hand and rapid industrialization on the other, today's world is facing the unprecedented challenge of meeting the current needs for these two commodities as well as ensuring the needs of future generations.

4.4.1 Desalination as a solution to water crisis

In response to increasing water scarcity, over the last 30 years desalination has evolved into a viable alternate water supply. Desalination is the process which removes excess salts and minerals from sea water to obtain freshwater/potable water. Desalination can tap non-traditional water resources with great potential to provide a sustainable, drought-proof water supply. Currently, more than 150 countries in the world are already using desalination technologies, which account for about one percent of the world's drinking water⁷¹ but this is expected to grow year-on-year. An expected USD10 billion investments in the next five years would add 5.7 million cubic meters per day of new production capacity. This capacity is expected to double by 2030.

However, the energy requirements of desalination processes are high. Moreover, climate change and global warming are heralding the gradual demise of fossil fuels and the rise of less polluting renewable energies. Hence, a holistic, sustainable and environment friendly approach would be to couple renewable energy sources to innovative desalination technologies and meet the world's energy and water needs, thereby reducing desalination costs. Since many arid regions are coastal areas that have high renewable energy resources, the use of renewable energies in seawater desalination exhibits an interesting chance, or even the only way, to offer a secure source of freshwater⁷².

4.4.2 Use of OTEC to power desalination plants

In Karnataka, desalination plants may be more appropriate for Islands off Karnataka's coast which may be proposed to be developed as resorts/hotels/tourism facilities as well as in coastal areas that regularly face acute water stress. Since desalination is energy intensive,

⁶⁹McDonald and others 2014

⁷⁰Policy Options for Decoupling Economic Growth from Water Use and Water Pollution, United Nations International Resource Panel

⁷¹Sustainability 2020, 12, 5233; doi:10.3390/su12135233

⁷²García-Rodríguez, Lourdes. (2003). Renewable energy applications in desalination: state of the art. Solar Energy. 75. 381-393. 10.1016/j.solener.2003.08.005.

using OTEC to power the desalination process would result in significant cost reduction. Ocean Thermal Energy Conversion (OTEC) is a process that can produce electricity by using the temperature difference between deep cold ocean water and warm tropical surface waters. OTEC plants pump deep cold seawater and surface seawater to run a power cycle and produce electricity. OTEC is firm power (24/7), a clean energy source, environmentally sustainable and capable of providing massive levels of energy. Recently, higher electricity costs, increased concerns for global warming and a political commitment to energy security have made initial OTEC commercialization economically attractive in tropical island communities where a high percentage of electricity production is oil based.

A minimum temperature differential of 17-20°C between surface waters and those at 1 km depth is required for OTEC operations. Figure 4.9 shows the ongoing and proposed OTEC project on the world map while also showing realizable ocean thermal energy resources, with the greatest temperature gradients (from surface to water depths of 1 km) shown in red and the minimal possible realizable OTEC temperature gradient shown in blue. A temperature difference of 20-22 degrees Celsius is available for a depth greater than 100m along almost the entire Karnataka coast. Hence, OTEC for desalination plants can be explored in Karnataka subject to economic feasibility.

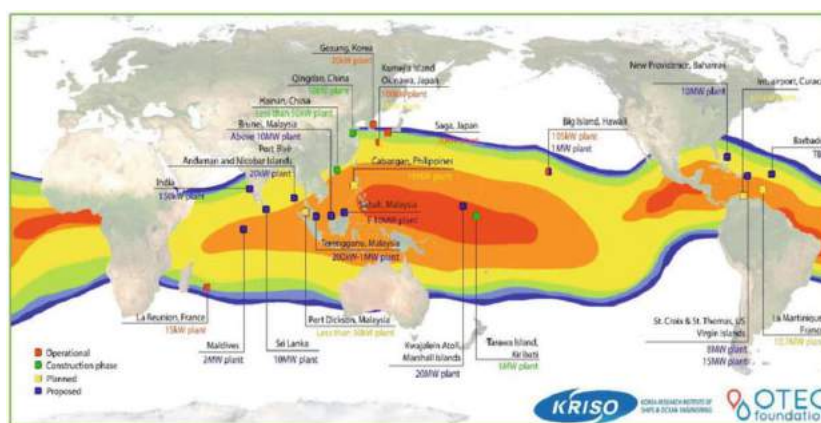


Figure 4. 9: Global map of OTEC activities and resources

4.4.3 Rain water storage systems

Desalinated water can be further supplemented by rainwater harvesting systems or vice versa as a sustainable water resources management tool especially in islands, densely populated regions and/or arid/semi-arid regions that face water scarcity. Rainwater harvesting (RWH) is a simple strategy by which rainfall is gathered and stored for future usage. It is one of the simplest and best measures to conserve water globally. For example, in cities, much of the rain that falls on natural or man-made catchment areas such as building roofs, roads, and other hard landscaping does not percolate into the soil but ends up in storm sewers. Hence, rainwater can be harvested rather than allowing them to run off. RWH process involves collection and storage of rainwater with the help of artificially designed systems and is diverted from roof-tops or surface run-offs to be filtered and stored in storage tanks for future use or used to recharge bore-wells, open-wells, etc. by artificial recharge techniques wherein water enters the aquifer. Thus, rainwater can be conserved in storage systems such as recharge pits, recharge wells, recharge trenches, tube wells, Gully Plugs, Contour Bunds, dug wells, percolation tanks, check dam/Cement Plug/Nala Bund, Recharge Shaft, etc. Typical direct uses of rainwater include landscape irrigation, wash applications, ornamental ponds, fountain filling, cooling tower make-up water, toilet and urinal flushing. With additional filtration and disinfection, harvested rainwater can also be treated to potable standards to supplement

municipal potable water supplies to facilities. The major components of a rainwater harvesting system are displayed in Figure 4.10.

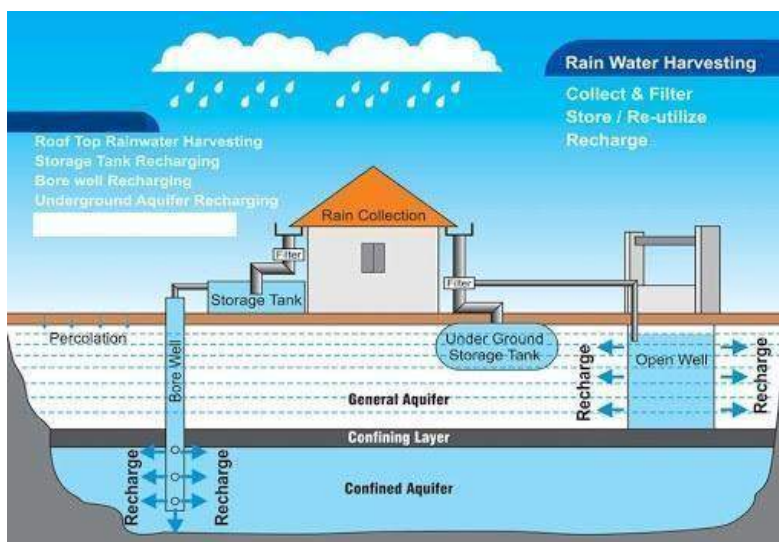


Figure 4. 10: Components of rainwater harvesting

Rainwater harvesting certainly depends on various factors which contribute to the amount of rain water harvested e.g., the frequency and the quantity of rainfall, catchments characteristics, water demands and the quantum of runoff and very importantly the volume & economics of artificial rain water storage tanks and also underground soil strata for ground water recharge of rain water.

Rainwater harvesting is unrestricted from any kind of impurity, with relatively less storage cost and no maintenance cost involved except for periodical cleaning. Hence, they are crucial for climate change adaptation in climates with a pronounced dry season especially under rain fed agricultural systems. Reserving rainwater can help recharge local aquifers, reduce urban flooding and most notably, ensure water availability in water-scarce zones. They can also supply households and businesses with water for use in dry seasons and lessen the demand on municipal systems along with protecting aquifers from overexploitation.

With depleting groundwater levels and fluctuating climate conditions, this measure can go a long way to help mitigate the adverse effects arising from water scarcity.

The average annual rainfall in Karnataka is 1248 mm. Coastal Karnataka, with an average annual rainfall of 3456 mm, is one of the rainiest regions in the country. In contrast, the region of South Interior Karnataka and North Interior Karnataka receive only 1286 and 731 mm of average annual rainfall. Rainfall distribution throughout the year in Karnataka (Table 4.4⁷³) is about 80 percent of the annual rainfall during the South-West monsoon period (June to September), 12 percent during the post-monsoon period (October to December), 7 percent during the summer season (March to May) and only 1 percent rainfall is received during the winter season (January to February). Average annual rainfall graph of Karnataka shows that in the year 2018 it was 850mm and 1100mm in the year 2019.

⁷³ <https://www.karnataka.com/profile/rainfall/>

District	Average Annual Rainfall in mm	District	Average Annual Rainfall in mm
Dakshina Kannada	3975	Ballari	636
Bengaluru rural	978	Bidar	847
Bengaluru urban	885	Kalaburagi	777
Chitradurga	573	Koppal	572
Davanagere	700	Raichur	621
Kolar	744	Chamarajanagar	751
Shivamogga	1813	Chikkamagaluru	1925
Tumakuru	688	Dakshina Kannada	3975
Bagalkote	562	Hassan	1031
Belagavi	808	Kodagu	2718
Vijayapura	578	Mandya	806
Dharwad	772	Mysuru	798
Gadag	612	Udupi	4119
Haveri	753	Uttara Kannada	2835

Table 4. 4: Average annual rainfall received by some districts of Karnataka

Although the humid Malnad region enjoys an annual rainfall of 1,000-3,800 mm, in the semi-arid regions of the state the intensity of rainfall decreases considerably. Karnataka has two major rainfall deficit areas within its territory. Both these areas are situated in the North Interior Karnataka. One covers east Belagavi, Vijayapura, the west Raichur districts and northeast Dharwad while the other covers east Ballari and Chitradurga district and a small region of Tumakuru district. These two areas receive annual rainfall of 500-600 mm only. Challekere in the district of Chitradurga receives the lowest rainfall in the state with less than 500 mm annual rainfall.

It is to be noted that although coastal Karnataka receives the highest rainfall in the state, most of the coastal areas face water shortages especially during peak summers (April-May). Hence, implementation of measures such as rain water harvesting, groundwater recharge systems, etc. throughout the state will alleviate the water shortage crisis in future.

4.4.4 Conclusion and Recommendation

Over the last 30 years desalination has evolved into a feasible alternative water supply. However, desalination plants are expensive to build due to the high infrastructure cost and expensive to operate mostly due to the high energy consumption. Owing to the above, they are more suited to offshore/nearshore islands as well as nearshore regions facing acute water scarcity. To offset the operation and maintenance cost, strategies such as use of renewable energy such as Ocean thermal energy conversion (OTEC) technology can be harnessed to reduce operating costs.

However, the impact on aquatic life due to the discharge of concentrated brackish water from desalination plants and blow down water of moderate temperature resulting from OTEC operations need to be evaluated and suitable mitigation measures to reduce these impacts have to be considered.

Rainwater harvesting and recharging underground aquifers have gained increasing importance over the years due to lack of freshwater availability even in areas receiving the heaviest rainfall in the state. They can not only be used to supplement desalinated water for providing fresh water supply but also as the sole means of potable water in remote areas that face acute water shortages. However, policy changes and stringent laws governing implementation of rainwater harvesting systems in domestic, institutional and industrial settings are to be introduced (wherever not available) and enforced.

4.5 Reuse of Decommissioned Ships

Ships transport up to 90 percent of the goods we buy. Our global economy relies heavily on ships to transport cargo, people, etc. When a ship becomes too expensive to maintain and/or repair, after about 25-30 years in service, the ship is decommissioned and scrapped for the valuable metals aboard. India is one of the leading ship recycling countries in the world with half of the total ships in the world being dismantled in the Alang-Sosiya (Gujarat) shipyard itself⁷⁴. The demolition of ships is a complicated and hazardous endeavor at the same time derelict, rusted-out hunks of steel floating in oceans can be hazardous, wreaking havoc on marine life and coastal habitats, ultimately disrupting the ecosystem and posing threats to natural resources. To avoid or reduce the hazardous wastes generated at ship breaking yards, the reuse of decommissioned ships can be well considered. Decommissioned ships can be reused for storage of desalinated water/harvested rainwater and supplying potable water in areas of water stress. These out-of-service vessels can also be repurposed and transformed to provide tourism services such as restaurants, hotels, museums and other waterfront attractions. There are many examples around the world of popular ships that are permanently docked and continue to serve a purpose beyond sailing the seven seas by providing modern-day amenities and unique experiences along the waterfront.

Decommissioned ships that have been repurposed are a win-win for the communities in which they are docked. Whether it is a restaurant or a floating hotel, having a nautical escape can boost a neighborhood's attractiveness by creating a vibrant maritime vibe. From offering top dining experiences as waterfront restaurants in the city, they can also serve as historical landmarks, entertainment venues, museums where tourists can partake in a variety of exhibits and activities while learning about the ship's history that provide a glimpse into the bygone era of maritime travel.

⁷⁴Vivek J.M., Singh R., Asolekar S.R. (2019) Hazardous Waste Generation and Management in Ship Recycling Yards in India: A Case Study. In: Ghosh S. (eds) *Waste Management and Resource Efficiency*. Springer, Singapore. https://doi.org/10.1007/978-981-10-7290-1_87



Figure 4. 11: The Queen Mary in Long Beach, California, USA
(Decommissioned ship serving as a full-service hotel and entertainment venue)



Figure 4. 12: Hikawa Maru in Yokohama, Japan
(Decommissioned ship moored at Yokohama Park is open to the public, serving as a museum)

Another potential reuse is for the decommissioned ships to be used for shore erosion protection wherein, the ships after being thoroughly cleaned to remove any toxic residues present can be sunk and well anchored in the near shore area more than 20m offshore to act as artificial reefs. This would promote sand accretion onshore creating a wide beach that can protect the shore from long-term erosion. Moreover, if the water visibility is good, artificial reef locations can also be used to attract tourists for activities such as scuba diving, snorkeling, etc. However, the economic feasibility, technical feasibility, short-term and long-term environment impact would have to be studied prior to implementation. Hazards to local fishermen using trawls and navigating vessels are also to be considered and prevented.

4.5.1 Reuse of decommissioned warships as warship museums

An excellent use of decommissioned warships is their conversion and re-use as warship museums. Some of the erstwhile warships have been converted as warship museums in India. Details are as follows:

1. **INS Chapal (K94):** A Chamak class Missile Boat of the Indian Navy and was decommissioned on 5 May 2005. Currently converted into a warship museum at Rabindranath Tagore beach in Karwar, Karnataka.
2. **INS Chamak (K95):** was a Chamak class Missile Boat of the Indian Navy and was decommissioned on 5 May 2005. Currently converted into a warship museum at Pune, Maharashtra.
3. **INS Kursura (S20):** was a Kalvari-class diesel-electric submarine of the Indian Navy and was decommissioned on 27 February 2001. Currently converted into a warship museum at RK Beach in Visakhapatnam, Andhra Pradesh.

Box 4. 1: Initiatives by College of Fisheries, Mangaluru

1. The College of Fisheries has established a Skill Development Centre costing INR 4.9 crores under Mangaluru Smart City Ltd. to provide skills such as aquarium fabrication, maintenance and propagation of ornamental fish; aquaponics/hydroponics integration with kitchen gardening; production of value-added fish products and promotion; advanced technology of fish preservation; utilization of fish wastes for manure, SCUBA diving and snorkeling; modernization and safeguarding of fishing boats and manual fish net making and mending - to fishing communities. At present 20 students per batch are proposed to be trained, comprising unemployed youth, school and college drop-outs and home-makers, primarily from the fishing and farming communities. Tie up with banks will also be established to provide loan facilities to trainees.
2. A meeting was held with the experts of the College of Fisheries and Fishermen Association on 19.07.2019. The areas that were discussed are as follows:

a. Explore the possibility of establishing a floating tourism hub in Mangaluru. It was indicated by the college that during the fishing ban period and in lean fishing periods the boats are idling at the ports. There is loss of income for the fishing families. In this context, it was suggested that these fishing boats can be temporarily converted into tourism facilities to provide for 2 to 3 beds, clean drinking water, toilets, large glass windows, glass top roofs, angling facilities, sit out, etc. and served with local cuisine made by the fishing communities. The port areas could be developed to provide entertainment and recreational facilities of local arts, dances, folk dances, Yakshagana, etc.

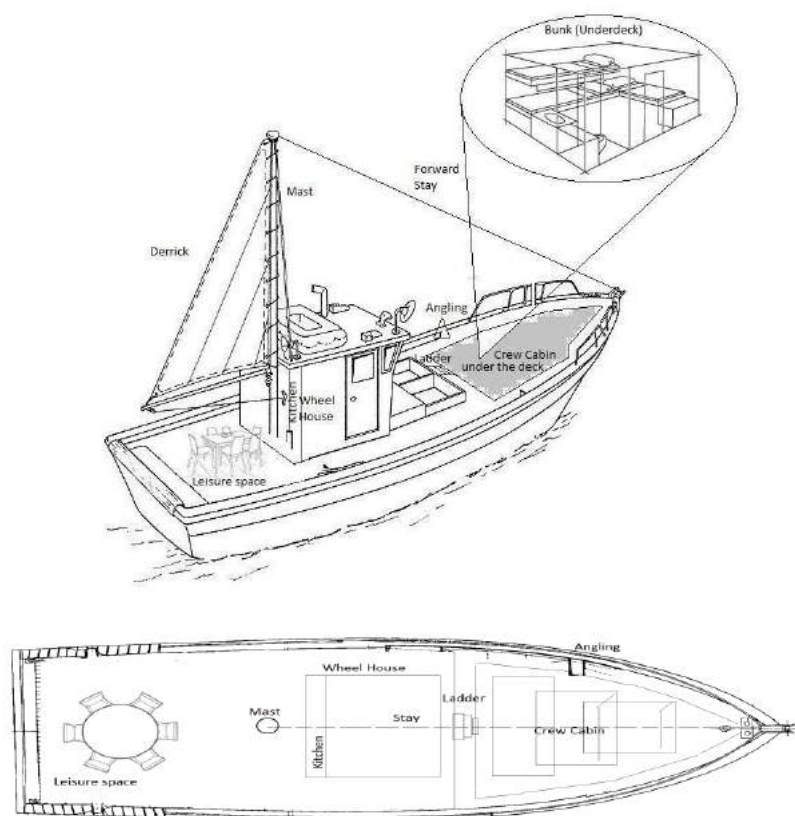
The above approach could enhance the income of the fishermen during such periods. The fishermen association agreed to the suggestions and welcomed it. They indicated that they will extend all cooperation in such economic development as it provides income and also promotes tourism in Mangaluru thereby promoting a chain of economic growth. But to promote such tourism it is essential that the port area, surroundings, etc. are kept clean as per international standards. Possibilities of merging such development with Smart City could be

explored as it benefits all communities while implementing Swachh Bharat Abhiyan.

b. It was suggested by the college that they will work out a prototype fishing vessel with a tourism facility that can be dismantled and stored in a warehouse and fitted back when required. Further it was also suggested that a course on coastal tourism could also be initiated to train the children of fishermen who can be employed in such tourism-cum- fishing boats. Further the old boats dumped along the coastal areas/port, which are an eyesore, can be refurbished into cafeterias, coffee shops, sales outlets, rain shelters, shops, etc. signifying a unique approach to resource management.

c. Due to the presence of a substantial amount of plastic in the sea, fishermen have reported they are now catching more plastics than fish in their trawlers. Further, micro-plastics have been noticed in the gut of several fishes in the college laboratory. Hence, the fishermen association proposed to bring back the plastics caught in their net for disposal at the shore. The college along with Municipal Authorities, port officers, etc. shall establish an outlet at the fishing port to collect all such plastic and other materials to be sold to authorized dealers or to be used as fuel in identified industrial units with the consent of the Pollution Control Board.

The fishermen association welcomed the initiative taken by the College of Fisheries and assured their full cooperation in the endeavor.



Prototype designed by Shri Bhavan Mendon: Retrofitting old fishing boat into boat house for tourism

4.5.2 Conclusions and Recommendations

Decommissioned ships and traditional fishing fleets can offer great value if repurposed and used for water storage and/or tourism prospects rather than being discarded or dismantled. Since Karnataka has a long coastline with several ports and harbors, there is a huge scope and potential for repurposing decommissioned ships for use as restaurants, museums, photo-shoot destinations as well as, wherever feasible, to supply desalinated potable water/harvested and filtered rainwater in water stressed areas/remote islands, etc.

Furthermore, decommissioned ships can also be used to provide shore protection services after carrying out technical feasibility studies as well as long-term and short-term ecology and environment impact studies.

4.6 Converting Select Reservoirs into Fish Sanctuaries and Aquaria

Karnataka has two main drainages, viz., the east-flowing large rivers such as Krishna and Cauvery with their tributaries and the west-flowing rivers having a short run. The Western Ghats, which remain as a wedge between the two major watersheds, feed both the east-flowing and west-flowing rivers with an impressive amount of water. The surface flow, in many rivers and their tributaries, has been interrupted for irrigation and power generation. While all the east-flowing drainages are harnessed mainly for irrigation, the west-flowing streams are impounded to tap their hydro-electric power potential. In the process, a large number of storage reservoirs have come up all over Karnataka. Today, Karnataka occupies a prominent position in the reservoir map of the country. Karnataka's total water area under man-made impoundments covers an area of 4,37,291 ha and is undoubtedly one of the largest in the country, holding tremendous potential for fisheries development and conservation in the state. With the aim to conserve the rich marine diversity, the Government has undertaken many initiatives, such as establishing aquaria and fish sanctuaries.

Fish sanctuaries are meant to establish and maintain a particular area in the water body as a permanent shelter for protection of fish for natural propagation. In other words, fish sanctuaries are a demarcated protected area where targeted fish will not be disturbed or captured. Establishment of aquatic sanctuary is one of the effective tools for conserving fish stock, preserving biodiversity and increasing fish production. The potential benefits of fish sanctuaries are that they protect aquatic habitats that provide nursery areas for juveniles and also protect a greater proportion of spawning fish, leading to an increase in the supply of juveniles to areas outside sanctuaries that remain open to fishing. They also ensure that the average size of spawning fish is achieved in sanctuaries to replenish the productivity. Hence, fish sanctuaries will presumably play their greatest role in conservation of fish biodiversity and sustaining catches.

Karnataka has the highest number of community fish sanctuaries in the Western Ghats. The Western Ghats portrays rich freshwater fish diversity with about 290 species belonging to 106 genera, 33 families and 11 orders. There are some community conservation initiatives which protect not only rare native fish species but the entire riverine habitats through simple, participatory measures, without any infrastructure development or external funding. Today, these community-conserved fish sanctuaries are some of the very few places where we can see native fish and undisturbed river stretches. These communities are the true custodians of riverine conservation. Most of them being temple sanctuaries, managed by the riparian temples and devotees for centuries⁷⁵. Some of the examples are the fish sanctuary at Sringeri wherein the endangered Sahyadri Mahseer fish (*Tor khudree*) is protected in a small river stretch of the river Tunga. Chippalgudde Matsya Dhama in Tunga River at Teerthahalli is also a 4 km stretch that protects more than 27 species of fish, the significant species of

⁷⁵www.indiawaterportal.org

which include the endangered Mahseer (*Tor khudree*) and *Puntius pulchellus*, the only indigenous herbivorous fish in our country. Shishisla Matsya Teertha, in Kumaradhara River in Dakshina Kannada is probably the first protected area for conservation and protection in the country established way back in 1930. The conservation area supports nearly 18 species with a predominance of *Tor khudree*. Some other examples include Bachananayakagundi and Dharmasthala at Dakshina Kannada, Jammatagi Agrahara at Chikkamagaluru, Ramanathapura at Hassan, Thingale on Seethanadi, etc.

These sanctuaries stand testimony to the fact that community conservation is one of the most sustainable and effective ways of protecting ecosystems. In addition to these there are also Wildlife Sanctuaries and National Parks (26 in total) that are protected under Law in Karnataka which harbor many wetlands/water bodies of importance including the conservation of fishes.

Aquaria are also an excellent way to conserve diverse marine creatures because they house and exhibit a variety of fish, indigenous as well as exotic. They also provide an opportunity to fascinate both children and adults alike to explore underwater world's varied aquatic life. These are very good tourist spots that serve the purpose of creating awareness to the masses and also conserve the diverse aquatic life. For example, the Bengaluru Aquarium also known as Government Aquarium is the second largest aquarium in India showcasing a variety of exotic cultivable and ornamental fish on display. The Karwar Marine Aquarium also houses different marine creatures like lobster, shark, eel, puffer fish, swordfish, catfish, crab, turtle and other sea creatures. There are 22 fish sanctuaries and 13 aquaria in Karnataka.

However, due to overexploitation and pollution, several valuable indigenous and endemic fishes in various fish sanctuaries have reached the status of threatened, endangered and extinct too. Due to high demand and pricing of many indigenous ornamental fishes, they are being harvested in greater volumes and sold at higher rates, which threatens the viability and sustainability of the resources. There are 289 types of fish, which are spotted in the fish sanctuaries of Karnataka, out of which 41 percent are extinct. The Nakur Gaya and Yenekkal fish sanctuaries that exist on the banks of Kumardhara in Dakshina Kannada are both threatened by the numerous mini hydel projects coming across the region (especially the 24.75 MW Kukke Mini Hydel Project near Hosmata). Karappura Fish Sanctuary in Mysuru was submerged by the Kabini reservoir while the Shivamogga Agrahara Sanctuary collapsed due to dwindling water levels which resulted after the construction of Tunga Anicut 12 km upstream.

Hence, there is an urgent need to protect the present fish sanctuaries and aqua-parks as well as find scope for new ones to be established (temple tanks and fort moats, stretches below dams, upper reaches of rivers, etc.) since they help to conserve resources, fish biodiversity and the habitat of the ecologically sensitive areas. Measures such as habitat protection, abating pollution, banning the introduction of exotic species for ornamental or culture purposes, etc. should be introduced for protecting the sanctity of fish sanctuaries.

4.6.1 Conclusion and Recommendations

There is an urgent need for establishing an increasing number of fish sanctuaries and aquaria in the state for protection of wild fish stock, conservation of fish species and their genetic diversity.

Setting up a dedicated institute and society on fish conservation can ensure that new fish sanctuaries are established and the present fish sanctuaries are protected from pollution, indiscriminate fishing practices and other pressures. In many parts of the world, anglers are the most prominent stakeholder group for aquatic ecosystem concerns. Employing anglers in

the long-term monitoring of fish populations can support the local economy and aquatic ecology by incentivizing new revenue streams and maintaining healthy lakes and rivers without incurring any significant monetary costs.

Fish sanctuaries can be established in different rivers, reservoirs, wetlands, floodplains, etc. through the government, or by direct participation of communities. Some of the locations that have a good scope for establishing fish sanctuaries in the state are temple ponds, Ranganathittu Bird Sanctuary in Mandya district, Karanji Lake in Mysuru, Pilikula Nisargadhama & Kadalakere Nisargadhama in Dakshina Kannada district, Yelahanka Lake & Hebbal Lake in Bengaluru, etc. Fishing and pollution are to be strictly prohibited in these stretches. Sanctuaries are relatively easy for user communities to implement and enforce and are a better management tool.

New aquaria can be established in urban areas with a high tourist footfall, for instance near parks, lakes etc. One such example is the Dr. Shivaram Karantha Pilikula Nisargadhama that has identified the potential to establish an aquarium to showcase the most diverse, yet the most neglected fishes of the region. The motto has been to conserve and exhibit the natural flora, fauna, aquatic fauna and cultural heritage of the Western Ghats and Coastal Karnataka. They have also initiated a Native Endemic Fish Conservation program that would be a part of the aquarium striving to conserve and foster the native species of the region which are sadly under threat of extinction. Among the 70 to 80 freshwater fish species in the Western Ghats, IUCN has listed about half of them under the “endangered” category. Pilikula Nisargadhama would conserve about 22 such species under the project initially. They collect threatened and endangered freshwater fish species of the Western Ghats in summer months from their natural habitat like rivers, streams, tanks and paddy fields, develop their progeny in the hatchery units at the park for about 2 months, and release the developed eggs of the species in their natural habitat.

There are facilities for display of marine and freshwater fish in natural habitats as well as in specially designed aquarium spaces serving as a valuable educational resource to provide insight into the aquatic ecosystems of the region. Some of the species displayed at fish display aquaria at the Nisargadhama included Hullu Gende (vulnerable), *Zeebra Lach* (endangered) found in Tunga River, Kempu Peruval (endangered) found in Netravati and Chandragiri rivers, Chameen (vulnerable) found in Netravati and Chandragiri rivers, Kajava (vulnerable) found in Sita and Swarna rivers.

4.7 Strategic Interventions to Reduce Marine Plastic Pollution

Though plastic has many valuable uses, humankind has become overly dependent on single-use or disposable plastics – with severe environmental consequences. Plastics are one of the biggest man-made pollutants in the marine environment, with an estimated 8 million MT of plastic waste finding its way into our oceans each year. Plastic production has increased exponentially since the early 1950s and reached 322 million MT in 2015, this figure does not include synthetic fibers which account for an additional 61 million MT in 2015. It is expected that production of plastics will continue to increase in the foreseeable future and production levels are likely to double by 2025. The build-up of plastic litter - bottles and cups, plastics found in cigarette filters, straws and other ‘macro plastics’ (those which are larger than 5mm) – in these urban coastal areas wash out to the sea in heavy rain, polluting coastal waters and eventually drifting out to sea, where it breaks down into even smaller pieces, eventually becoming micro plastics (<5mm). The harm caused by plastic pollution is wide ranging. It chokes wildlife above and below the waterline. An estimated one million sea birds and an unknown number of sea turtles die each year as a result of plastic debris clogging their digestive tracts, and marine animals of all sorts can become tangled and incapacitated by discarded fishing lines and plastic bags. Fish and other marine life ingest micro plastics which

in turn can find their way into the human food chain⁷⁶. Micro beads are another source of plastic pollution which are small, manufactured plastic beads used in health and beauty products. In the process of breaking down plastic debris, it releases toxic chemicals (additives that were used to shape and harden the plastic) which make their way into our food and water supply. These toxic chemicals can be found in our bloodstream and the latest research has linked them to cancer, infertility, birth defects, impaired immunity and many other ailments.



Figure 4. 13: Plastics in the ocean
(Source: <https://marinedebris.noaa.gov/>)



Figure 4. 14: Marine life surrounded by plastics in the ocean

Box 4. 2: Plastic pollution by numbers

1. More than 220 million MT of plastic are produced each year.
2. Recent research has suggested that the number of discarded plastics will outweigh the number of fish in our oceans by 2050.
3. 60-90 percent of marine pollution is made up of different types of plastic.
4. In 2006, the UN Environment Program estimated that every sq. mile of ocean contained 46,000 pieces of floating plastic.

⁷⁶<https://thecommonwealth.org/marine-pollution>

5. A plastic bottle can last up to 450 years in the marine environment.
6. A person uses a carrier bag for just 12 minutes on average which takes 500 years to decompose
7. 13 million MT of plastic leak into the ocean each year
8. We buy 1 million plastic bottles every minute
9. 100,000 marine animals killed by plastics each year
10. 90 percent of bottled water are found to contain plastic particles
11. 83 percent of tap water found to contain plastic particles
12. 50 percent of consumer plastics are single use
13. 10 percent of all human-generated waste is plastic
14. India generates 15,342 MT of plastic waste annually. Half of the total plastic used is single-use or disposable items such as grocery bags, cutlery and straws.
15. India's contribution to plastic dump into the world's oceans is 60 percent

From the fisheries and aquaculture perspective, two types of ocean pollution are of particular concern.

The first being “Ghost fishing” caused by abandoned, lost or otherwise discarded Fishing Gear (ALDFG) from capture fisheries. When old fishing gear is lost or abandoned at sea, they get dragged around the ocean by currents and storms, catching both target and non-target species, entangling/killing marine animals and damaging marine habitats. These “ghost gears” (ALDFG) keep on catching fish for years or even decades after it goes in the water. Every year, ghost gears kill over 136,000 sea mammals and clog sea grasses, causing a knock-on effect on anything that lives in the area, which is a huge threat to fisheries and ocean habitats worldwide⁷⁷. In the past, most equipment was made of materials like hemp or cotton that rot away underwater, but these days most of it is made of tough, synthetic nylon that can take centuries to break down. And when the plastics finally do break down, they leave toxic polyurethane chemicals behind.



Figure 4. 15: Sea turtle entangled into the discarded old net in the sea

⁷⁷<https://fishingbooker.com/blog/ghost-fishing-explained/>

The second is micro plastics, which are increasingly present in aquatic environments and are of concern for their impact on fish as food for human consumption and on the health of marine ecosystems. Micro plastics are the result of degradation and fragmentation of larger plastic items to sizes which measure less than 5 mm in their longest dimension, including nano-plastics (particles less than 100 nanometers (nm) in their longest dimension). Micro plastics may enter aquatic environments through different pathways and they have been reported in all environmental matrices such as beaches, sediments, surface waters and water column. Ingestion of micro plastics by aquatic organisms, including species of commercial importance for fisheries and aquaculture, has been well documented in laboratory and field studies. Micro plastics contain a mixture of chemicals added during manufacture, the so-called additives, that efficiently sorb (adsorb or absorb) persistent, bio accumulative and toxic contaminants (PBTs) from the environment. The ingestion of micro plastics by aquatic organisms and the accumulation of PBTs have been central to the perceived hazard and risk of micro plastics in the marine environment.

To reduce the stock of marine plastics and flow of solid waste into the oceans, the need of the hour is an integrated approach to reduce waste generation as well as to curb "improper and unscientific handling of waste" from homes, institutions, industries, hospitals, tourist destinations, fishing vessels, maritime transport, etc. as it can end up in the water bodies. Moreover, it is estimated that only 32 percent of the 10,000 MT of solid waste generated by the state of Karnataka every day was processed as of January 2019⁷⁸. This reflects the urgency to educate the public on solid waste management to alleviate the environmental and health impact from poor waste management. Understanding the grass root level problems and challenges faced to manage solid waste at the local level can help pave the way for strategic interventions to make our oceans plastic/debris free.

Some of the major issues concerning solid waste management are as follows:

1. Absence of segregation of waste at source thereby mixing of dry (non-biodegradable) and wet (biodegradable) waste
2. Lack of adequate infrastructure and funds for waste management at Panchayats, Urban Local Bodies, etc. leading to inadequate collection, transportation and storage of waste for further processing
3. Lack of technical expertise and appropriate institutional arrangement
4. Unwillingness of Urban Local Bodies to introduce proper collection, segregation, transportation and treatment/ disposal systems
5. Indifference of citizens towards waste management due to lack of awareness
6. Lack of community participation towards waste management and hygienic conditions
7. Illegal disposal and indiscriminate burning of solid waste

Unfortunately, these problems have led to most of the waste being littered which find their way to the oceans or dumped in landfills, which is no less harmful in terms of environmental problems they cause. Although various rules and regulations are in place such as Solid Waste Management Rules 2016; The Plastic Waste (Management and Handling) Rules, 2016; The Bio-Medical Waste (Management and Handling) Rules, 2016; The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 and The E-waste (Management and Handling) Rules 2016, there is a lag in proper implementation and enforcement of the rules at local levels. Illegal disposal of wastes such as plastics, bio-medical waste, poultry waste, E-waste and hazardous wastes have led to these wastes

⁷⁸<https://www.timesnownews.com/mirror-now/civic-issues/article/karnataka-bengaluru-bangalore-cpcb-solid-waste-garbage-management-disposal-landfills/365882>

eventually ending up in the rivers and eventually oceans wreaking havoc on aquatic life and their ecosystems.

To beat plastic pollution and reduce the flow of solid wastes in oceans we need to first and foremost rethink our approach to designing, producing, using and disposing of plastic products. The solutions hereunder are based on various levels at which control strategies and management initiatives are essential to achieve the goal of plastic-free oceans.

4.7.1 Upstream interventions

The solution to the plastic nuisance has to start with a sustainable behavior change because our plastic problem is one of design. Items are designed to be thrown away immediately after use, sometimes after just seconds. Hence, inspiring innovators, activists and leaders worldwide need to step in and do more than just clean up existing plastics, which is to focus our action 'upstream'. The private sector must innovate, adopting business models such as introducing eco-friendly products made out of plant biomass which are 100 percent biodegradable instead of single use plastic. These innovative changes upstream can go a long way in solving the plastic menace and thereby reducing its flow into oceans.

4.7.2 Government interventions

To stem the rising tide of single-use plastics and wastes entering oceans, we need strong intervention from the government. The plastic bag bans in more than nearly 100 countries prove just how powerful direct government action on plastics can be. Governments must lead, enacting strong policies that push for a more circular model of design and production of plastics.

In 2015, the Karnataka state government banned the use of all plastics below a thickness of forty microns. A year later, in March 2016, the government issued a notification banning the manufacture, sale and use of all plastics, thermocol products, and micro beads regardless of their thickness. However, the notification allowed for three exemptions. It allowed plastic to be used to package milk and milk products, to be used in nurseries and horticulture, and to be used for export purposes in Special Economic Zones. The Government has been enforcing the ban and imposing fines on offences such as manufacture, storage trading, retailing, selling and using banned plastic items. Shopping malls and supermarkets have switched over from providing free plastic bags to charging a fee for providing paper/cloth bags. This has encouraged customers to reuse bags thus resulting in a dramatic drop in the number of single-use plastic bags.

After the ban, around 1,000 units of single-use plastics have been closed down. Waste management centers confirmed that the number of single-used plastics coming into dry waste collection centers has reduced tenfold.

However, the circulation of chips and biscuit packets, shampoo sachets, PET bottles, carbonated drink bottles, and juice cartons have not been affected at all. These are a serious problem to the environment as they cannot be recycled and must be disposed of through incineration. It is now imperative that, just as the ban has been implemented in the case of single-use plastics, it must be strictly enforced and carried out with regard to multi-layered plastics as well.

Despite the ban, presently, the use of plastic bags continues to be rampant, right from the vendor, up till the individual consumer. The challenge of enforcement is further exacerbated by collusion between officials and the garbage mafia.

The following are some of the strategies the Government can initiate:

1. Create awareness among the public on the harm of littering and sustainable waste management practices such as avoid, reduce, reuse, recycle, recover, etc. through various media.
2. Ensure waste segregation occurs at source - in homes, educational institutions, commercial spaces, tourist spots and public places at the time of waste collection. Implement stricter fines for non-compliance.
3. Installing drainage nets/trash traps at outlets of drainage pipes to prevent plastic waste from being carried by storm water into water bodies. This has been successfully implemented in Kwinana in Australia where 370Kg of trash was collected in a period of 4 months.



Figure 4. 16: Drainage Nets/ Trash Traps

4. Clean up water bodies such as ponds, lakes, rivers and oceans.
5. Provide tax benefits for individuals, institutions, companies who fund clean-up/upcycle/recycle projects. In addition, it can also fund innovation for clean-up projects. For example, private companies or individuals could pay to adopt sections of the beach where they fund clean-up and maintenance efforts – much like the ‘adopt-a-highway’ scheme in the United States. In return, they generate tax benefits for themselves and are able to promote their commitment to the environment⁷⁹.
6. Encourage manufacture of plant-based plastic which are biodegradable, and other eco-friendly plastic alternatives by means of tax rebate or subsidies.
7. Implement the ‘polluter pays’ principle, which requires the waste generator to pay for the appropriate disposal of the waste.
8. Adopt new and upcoming technologies for waste management that are technically feasible, economically viable and environment friendly.
9. Promote the usage of biodegradable hemp or cotton fishing gears instead of plastic fishing gears.
10. Educate the fishing community about the effects of abandoned equipment and their impact on marine life.
11. Incentivize collection of ghost gears from boats/fishing vessels at ports and harbors and also provide incentives to organizations involved in safely disposing, recycling and producing energy from ghost gears.

⁷⁹<https://granthaminstitute.com/2017/09/19/when-it-rains-it-pours-how-can-cities-save-the-ocean-from-plastic-pollution-during-heavy-rainfall/>

4.7.3 Individual and community interventions

Regular beach cleanup activities can be organized by communities, educational institutions to create awareness among the general public and tourists on the effects of poor waste management on marine life.

Citizens must be educated and encouraged to act as responsible consumers and informed citizens, demanding sustainable products and refusing single-use plastics like plastic straws, cutlery, etc. Small lifestyle changes such as using reusable water bottles and shopping bags, taking along reusable plates, spoons on excursions, etc. can go a long way in reducing the plastic menace.

4.7.4 India's commitment to reduce pollution from ship generated single-use plastics

It is predicted that by 2050, the quantity of plastics in the oceans will outweigh fish. To address this issue, The Directorate General of Shipping, Mumbai vide its Order No. 05 of 2019 dated 16th October 2019 imposed a prohibition/ban on use of Single Use Plastics on Indian ships and foreign ships while in Indian waters.

The single-use plastic items prohibited with immediate effect from date of issued order include cutlery- plates and cups; up-to 10 liters bottles for water and other drinks; garbage and shopping bags, and dispensing containers for cleaning fluids that are less than 10 liters volume.

The single-use plastics prohibited with effect from 01-01-2020 include bags, trays, containers, food packaging film, ice cream containers, bottles for water and other drinks, biscuit trays, insulated food packaging, protective packaging for fragile items such as microwave dishes, dispensing containers for cleaning fluids, freezer bags, shampoo bottles, etc.

4.7.5 Conclusion and Recommendations

The first and foremost intervention to minimize the stock of marine plastics is to reduce/eliminate the flow of plastics into the ocean. This can be achieved by effective segregation and management of waste at source and implementation of innovative methods such as usage of garbage nets at the outlet of storm water drains to trap litter that would otherwise land up in the oceans. Regular clean-up of water bodies will also keep litter out of the oceans. The use of biodegradable plastics, which have been manufactured from sustainable sources like fish waste and algae, mushroom, plant sugars, sunflower hulls, olive pits, etc. can reduce the dependency on petroleum-based plastics. Incentivizing the on-shore collection of worn-out fishing nets/gears, marine plastics, etc. will discourage the fishing community and from discarding the same into the oceans. Creation of adequate on-shore facilities for segregation and collection of ghost gears and marine plastics will ensure their responsible management. The marine plastics/ghost gears, etc. can be reused/recycled into various consumer products such as bags, t-shirts, sun-glasses, footwear, swimsuits, skateboards, etc. and can also be used to make plastic roads and generate fuel. Moreover, use of traditional fishing gears such as cotton, manila, jute, coir, etc., which are biodegradable, should be encouraged among the fishing community thereby leading to the reduction of ALDFG.

Hence, the driving force to reduce marine plastics is a collective effort from manufacturers, governments as well as individuals. Implementing sustainable waste management practices in all districts/city municipal corporations/urban local bodies in Karnataka will help to meet the goal of plastic-free oceans. In addition, it will create jobs and provide better quality of life for local populations by improving hygiene conditions and reducing

health risks related to illegal dumping and inadequate garbage collection, which is a major concern otherwise.

Keeping our oceans free from wastes/plastics can go a long way in ensuring a sustainable blue economy for the state as, after all, clean and healthy marine ecosystems will ensure a healthy economy.

4.8 Effective Integrated Coastal Zone Management (ICZM) Strategy for the State

In India, activities in the coastal areas are regulated by the Coastal Regulation Zone (CRZ) notification issued by the Ministry of Environment, Forest and Climate Change (MoEF&CC) to govern human and industrial activity close to the coastline, in order to protect the fragile ecosystems near the sea.

The CRZ notification was first promulgated in 1991 for the protection of the coast. Over the years, this notification has undergone several reviews and amendments and the original CRZ notification of 1991 was replaced by notifications released in 2011 and 2019. These revisions indicate that the Coastal area management cannot be controlled or regulated based on a uniform provision for the entire country. To take into consideration the diversity, complexities of socio-economic, environmental and natural events of the coast, a holistic approach for integrated management of the coast is required to achieve sustainability. To address this, the Society of Integrated Coastal Management (SICOM) has been established under the aegis of the MoEF&CC with a vision for a vibrant, healthy and resilient Coastal and Marine Environment for continuous and enhanced outflow of benefits to the Country and the Coastal Community.

The World Bank-funded Integrated Coastal Zone Management Project (ICZMP) has been expanded and termed as “Enhancing Coastal and Ocean Resource Efficiency (ENCORE)” Project. The project will work at national, state, and community levels to enhance capacity for the ecosystem and community-based approaches to adaptation. Towards the development and implementation of State Level approach to ICZM, in the first phase, three pilot states of Gujarat, Odisha, West Bengal, were selected under the ICZM with the objective to develop and empower state-level authorities to adopt appropriate ICZM approaches consistent with national strategies. Based on the success of the Phase-I of the ICZM project, the ICZM Phase-II/ ENCORE project is being extended to all the 13 Coastal States/UTs (Maharashtra, Gujarat, Odisha, West Bengal, Andhra Pradesh, Tamil Nadu, Goa, Puducherry, Kerala, Karnataka, Daman and Diu, Andaman and Nicobar Island, Lakshadweep). Preparatory activities for the Phase-II are in progress.

The project activities in the identified coastal stretches of the respective States/UTs are grouped under the following broad themes: -

1. Conservation of coastal & marine ecological resources.
2. Coastal pollution management and related infrastructure upgrade.
3. Livelihood security and sustainable development of coastal communities.
4. Capacity building & implementation of ICZM plans.

The SICOM has prepared the final Environmental and Social Management Framework (ESMF) (Volume I and II) to guide the preparation of an Integrated Coastal Zone Management Project (ICZMP). This ESMF document provides guidance for management of environmental and social aspects and safeguards management for all components of the project. It provides guidance on a host of issues like project screening, project assessment, project approval, project regulation, site specific measures, environmental codes of practice to minimize and avoid adverse impact, labor management frameworks, resettlement and rehabilitation action

plans, indigenous peoples plan, and setting up a grievance redressal mechanism. The objective is to enhance the resilience of the lives and livelihoods of the most vulnerable populations, particularly women, in the coastal areas of India.

The Phase-II of the ICZM project i.e., the ENCORE project is being implemented in Karnataka. Karnataka State Project Management Unit (SPMU) is the state agency for implementing the Phase-II of the ICZM/ENCORE project. The objective is better coordination among implementing agencies for development along the coastal stretch of Karnataka, targeted at socio-economic improvement of the people while keeping natural resources and the environment healthy and capable of sustaining future generations.

In the following sections, an attempt is made to provide the activities to be undertaken while preparing the ICZM Plan, in a stepwise manner.

ICZM should be seen as a multi-sectoral process created to improve development planning and resource conservation through integration and cooperation. It should not be seen as a substitute for uni-sectoral programs such as coastal protection, fisheries, tourism or ports, nor as a substitute for coastal area development or agriculture programs. Because of the nature of the coastal zone, resources and geographical circumstances, the main issues faced are multi-sectoral activities and geographical boundaries. The natural resources of coastal areas are so different from their terrestrial counterparts as to require different and special forms of management. Success in creating ICZM may come more easily if the zone for management is well understood and defined.

4.8.1 Zoning of Marine Protected Areas

There is no single description of “coastal area” or “coastal zone” for the ICZM process; boundaries are delineated on the basis of the particular problems that ICZM attempts to solve. The boundaries must be adaptive to the goals and objectives. Because there is a broad array of possible coastal issues, there is an equally broad array of possible ICZM management boundaries. Some boundaries are quite narrow, and are best suited to deal with use conflicts occurring at the immediate shoreline.

The most certain way to conserve biodiversity and protect critical areas is to acquire ownership, or just assert ownership as the areas are already owned by the government. Marine protected areas complement and make possible other objectives of ICZM by conserving nursery areas for fisheries production, enhancing tourism revenues and recreational benefits, preserving wilderness values, promoting baseline scientific and management studies, and so forth. At the same time, marine protected areas gain from the ICZM program important protection from external impacts. Thus, ICZM and zoning of marine protected areas can be mutually beneficial. Together they ensure the maintenance of a healthy resource base upon which to build sustainable development.

A possible approach for management of marine protected areas appears to be the establishment of designated marine protected areas with joint authority between the local administration and the state government. With the traditional conservation area set aside as a protected area, rules of access and resource use can be formulated to give priority to the traditional users. In this situation, where the traditional group has exclusive, or priority, access to the resource, more care may be exercised in the quantity of fish or shellfish removed, self-discipline may be practiced during spawning periods, and less destructive fishing methods may be used. In some cases, this will provide for better conservation of fishery resources than a nationwide, centrally operated, management approach. Alternatively, “regulatory” approach by designating the marine protected area as an ICZM regional unit to protect its resources through regulations and guidelines would be appropriate.

4.8.2 Zoning of beaches

Beaches can have several uses, including, recreation and leisure; coastal protection; sporting activities; educational, socio-cultural, religious events; nature conservation; fishing and collecting shellfish; military activities, etc. There should be specific zoning to ensure the harmonious coexistence of different user groups within a confined area. Every beach is unique and has its own characteristics. A particular beach could be defined as a low activity beach for the majority of the year, but classified as high activity beach for a short period, thus requiring a different management approach to be adopted and temporary features to be added. The sustainability of the beach can also be influenced by environmental and building regulations relating to any events and/or the construction of facilities on the beach.

Beaches are being lost at a rapid rate and serious socio-economic situations may arise with coastal erosion, risk to life and property, loss of livelihood activities and tourism revenue. The problem will exacerbate with climate change and sea level rise. Beach management is an important element of the ICZM with the goal of maintaining the beach by protecting both the natural processes that supply the sand and the sand-storage capacity of the beach. Meeting this goal will require careful examination of conservation needs, natural processes, building practices, and corrective engineering proposals that affect whole beach systems. This process can best be developed through an ICZM program.

4.8.3 Traditional livelihood activities

Coastal communities often depend on natural resources in the sea for their livelihood on a day-to-day basis. Any restriction on their fishing or other resource extraction activities for conservation or resource rehabilitation purposes could be disastrous for people living so close to the coast. ICZM should recognize that often the most socially desirable and efficient approach to resource management is allocation according to traditional approaches worked out for specific coastal locations. When coastal projects or developments attempt to reassign these areas from communal to private use, the traditional users can become very disturbed. So, there is a need for continuation of traditional methods through ICZM including the protection of the community's rights to exclusive use of its traditional fishing areas.

The primary interest of coastal fishermen in ICZM is its potential role in the conservation of critical habitats and protection of water quality. There will be a much closer connection between ICZM programs and the small-scale, artisanal, fisheries than with the more industrialized offshore fisheries, because the artisanal fisheries are conducted in near-coastal and estuarine waters where the ICZM program would be most relevant. In aquaculture, the role of ICZM is more direct because aquaculture usually requires the conversion of land and water areas.

4.8.4 Economic activities

The purpose of ICZM should be to coordinate the initiatives of the various coastal economic sectors toward long-term optimal socio-economic outcomes, including resolution of use conflicts and beneficial trade-off. This integrated, multiple-sector approach is to be designed to interrelate and jointly guide the activities of two or more economic sectors in planning and management. This supports a programmatic goal to optimize resource conservation, public use, and economic development.

Implementing an ICZM-type program should have definite economic benefits. The values that developed nations put on biological diversity, saving endangered species, and protecting environmental quality are not so fully embraced by many coastal communities unless they provide financial benefits. Of the greatest economic importance in coastal marine areas is maintaining the productivity of fisheries and aquaculture. Continued fish production

means continued livelihood for fishermen and for others in the fishing industry, including boat builders, owners, net makers, packers, distributors, and retailers - all of which enhances social and economic stability. Of particular importance is the fact that a strong domestic fishery promotes self-sufficiency. Compatible aquaculture can also improve the jobs and foreign exchange situation. Because numerous economic sectors are influencing the coastal area, the ICZM process should examine the effects of externalities of any one sector on other sectors, most importantly the effects of land side activities, upon the common resources of the coastal area.

4.8.5 Developing coastal natural reserves and parks

Coastal and marine nature reserves should form a complementary and integral part of ICZM programs. Such reserves are a necessary component of coastal resource stewardship. While the primary ICZM program achieves resource conservation by controlling activities in the coastal marine area through its regulatory powers, it accomplishes only a part of the job. More focused natural area conservation can only be accomplished by declaration of protected areas - resource reserves, natural areas, and/or national parks.

It will be most helpful in the ICZM program development to identify special coastal habitats that should be given a high degree of protection. Detailed information on them should be available to all, particularly to resource users like fishermen, the public and the private development community. ICZM could provide an appropriate framework for integration of protected areas into a larger system of protection and a method of consensus building for their support.

4.8.6 Enhancing tourism and recreational opportunities

Tourism is the world's third largest industry and the primary economic sector in many regions. As a result, there is increasing competition for the use of resources in coastal waters and beach areas. For tourism, the environment is itself a significant part of the product which a destination has to offer. Beaches are the focal point for coastal recreation and tourism and are a major source of revenue for many coastal states. Good beaches attract tourists and liberal spending. Degraded beaches and poor water quality discourage tourism.

Coasts around the world face increasing demands to cater for a wide range of recreational activities, with millions of tourists visiting coastal areas each year. Beach activities are becoming more varied, ranging from parasailing to power boating; swimming to sailing and from horse riding to beach barbecuing. Many activities, particularly those involving more active participation, require some form of zoning and management to reduce potential conflict between different user groups, and trying to cater for such a diverse range of activities can cause difficulties. Not only do conflicts need to be resolved between different users, but differences between locals and tourists also need to be considered. The requirements of local residents differ from those of tourists, and balancing their respective needs is a major contributory factor in successful beach use and management.

4.8.7 Natural hazard prevention and protection of beach-dune systems

Reducing risk to life and property from natural hazards such as monsoon storms, cyclones, and tsunamis should be a major element of the ICZM program. In addition, climate change impact (over and above the wave, wind, and physical coastal dynamics) threatens all essential sectors, which are already subjected to numerous direct and indirect pressures. Substantial anthropogenic and environmental pressures have contributed to sediment deficits, excessive erosion, increased sedimentation, and decreased water and environmental quality. The rivers play an important ecological role, nourishing the beaches with sand and building complex sedimentary systems, sculpted by physical coastal dynamics. Unregulated sand

mining activities, primarily for construction purposes in the river mouths and beaches, has resulted in severe environmental degradation and has negatively impacted the ecological integrity of these coastal systems. The scientific audit of the Indian coast conducted during this study highlighted that nationwide strategies, research and evidence-based decisions and better planning is urgently needed to protect India's coastline⁸⁰. Coastal remediation is expensive and requires regular maintenance. Industrialization and urbanization of the coast creates further demand for well-planned coastal management. However, emergency responses are still common during a hazard event. These ad-hoc and to a certain extent unplanned approaches cannot initiate the required strategic management, particularly when confronting climate change impact. Moreover, piecemeal solutions may lead to endless downdrift problems.

Aspects/measures of disaster risk reduction can be readily combined with resource conservation, thus simplifying the management of coastal development and leading to more balanced decisions. For example, the CRZ setback requirement that protects coastal structures from erosion and storm waves can also preserve ecologically sensitive areas. Similarly, a coastal dune will both maintain a physical barrier against wave run-ups and flooding, while providing an environment for ecology enhancement. Natural hazards would usually be addressed in sectoral plans for public health and safety. But natural disasters cut across all sectors. Wind damage from a cyclone, inundation by a tsunami, or coastal erosion can affect tourism, fishing industry, port operations, public works, transportation, coastal housing and industry. It is critically important to include natural hazards prevention in the ICZM program.

The recommendation provided in the recently (March 2019) published "Reference Manual on Climate Change Adaptation Guidelines for Coastal Protection and Management" is that "the beach is the best form of coastal protection". However, harder solutions may be required in some locations based on the assets to be protected and site conditions. Hybrid management systems using a combination of hard structures with beach nourishment are viable under different climate change scenarios, but structures designed to capture natural sand from the beach are no longer feasible. Nourishment will be needed.

Mining of beach sand has been identified as a major coastal problem by the Karnataka Shoreline Management Plan 2020. Obviously, beach sand mining should be stopped, but unless an alternative can be offered at a reasonable cost, this is not feasible. Hence, viable alternatives for beach sand should be actively sought.

At many coastal areas in Karnataka, particularly Dakshina Kannada and Udupi Districts, buildings and roadways have been placed too close to the water's edge and are being undermined or threatened by storm induced erosion. In such cases, the beach is often "armored", using hard coastal protection options such as seawalls to protect the threatened properties or breakwaters are built to keep river mouths open. Less expensive alternative soft solutions such as dunes or beach nourishment can be considered, wherever feasible. However, such alternatives should consider availability of sand for nourishment and present-day beach elevation. Constraints in Karnataka are: limited sand resources for nourishment and low beach elevations of Uttara Kannada beaches.

ICZM should consider the coastal protection guidelines provided in the "Reference Manual on Climate Change Adaptation Guidelines for Coastal Protection and Management". The primary goal of the Guidelines is the development and fostering of sustainable methods to protect coasts in India, which can be adapted to climate change impact through the

⁸⁰Black K.P., Baba M., Mathew J., Chandra, S., Singh S.S., Shankar R., Kurian N.P., Ulrich P., Narayan B., Stanley D.O., Parsons, S., and Ray, G. (2019) 'Climate Change Adaptation Guidelines for Coastal Protection and Management in India' (Eds: K.P. Black, M. Baba and J. Mathew), prepared by FCGANZDEC (New Zealand) for the Global Environment Facility and Asian Development Bank, Volumes 1 (72p) and 2 (335p).

engagement of decision makers, implementing agencies, coastal scientists, communities and the civil society. The concept of the sediment cell is an important part of the Guidelines. A sediment cell is defined as a stretch of coastline where the inputs of sand from outside and losses to adjacent beaches are small. Common examples of morphological features which bound sediment cells are large headlands and/or major shifts in coastal orientation. The volume of sand in a sediment cell is essentially fixed, notwithstanding new deliveries from rivers or losses due to dredging/mining. Works within a sediment cell have only a small influence on adjacent cells. Thus, the sediment cell is generally a convenient method to subdivide the coast into zones which are essentially independent.

The Guidelines also assist the coastal states to proactively plan for erosion management under climate change, which is critically important for the future. Key elements of the Guidelines include overview of the physical coastal processes, evaluation of the protection measures, involvement of the community and role of the agencies responsible for coastal protection. The Guidelines are practical, relevant, achievable, easy to use, and acceptable to the decision makers and implementing agencies.

4.8.8 Strengthening institutional capacities in coastal planning and enhancing the governance mechanisms

ICZM includes policy-making, enforcement, boundary definition, zoning, monitoring, development of guidelines/standards and appropriate control measures, incentives and disincentives. Further, ICZM should relate to the broader national planning process through components on resources planning, land-use planning, and economic planning. Advice should be available from ICZM for government agencies, developers and other stakeholders and to the general public regarding economic development options. The ICZM entity should also transmit to the national planners any coastal needs for legislation; new programs, improved policy base, and interagency coordination.

Natural hazards prevention and mitigation should be integrated into the ICZM program, including adaptation to sea level rise caused by global warming. Regarding environmental restoration, current rehabilitation techniques require research and careful evaluation. The research should include prediction of the effects of environmental change (including climate change) on critical coastal habitats and on the living resources they support.

At present, the Coastal Regulation Zone Notification is being used for the management of coastal zones, and is primarily managed by the Department of Forest, Ecology and Environment. However, involvement by all levels of government will be required for an integrated coastal management program i.e, ICZM. The state government is involved because they govern where development takes place, where resources are found, and where the benefits are mainly to be felt. On the other hand, the Central Government has to be involved because responsibility and authority for marine affairs inevitably rests with them - navigation, national security, migratory fish, international relations, etc. At the intermediate level, district administrations are involved because they also often have administrative responsibility in the coastal area.

It may be advisable to prepare a Coastal Master Plan as the final product of the basic ICZM planning activity and to provide a detailed representation of the coastal zone and an inventory of the resources, an identification of critical areas, specifying those in need of special attention and those offering potential for development. The Master Plan should identify the permissible type of uses and the standards for these uses, the procedure for permit approval processes and/or monitoring of activities and enforcement of compliance. It should indicate options for human progress in the coastal areas. The objectives of the Master Plan could include the following:

1. Maintain a high-quality coastal environment
2. Identify and protect valuable species (and their intraspecific variations)
3. Identify and conserve critical coastal habitats and identify lands that are particularly suitable for development
4. Resolve conflicts among incompatible activities affecting coastal and ocean resources and the use of space
5. Identify and control activities that have an adverse impact upon the coastal and marine environment
6. Control pollution from “point sources” and from land runoff as well as accidental spills of pollutants
7. Restore damaged ecosystems
8. Coordinate governmental efforts to promote the sustainable development of coastal and marine resources
9. Balance economic and environmental pressures as they affect development and conservation of coastal and marine resources
10. Provide guidance for coastal development planning to reduce inadvertent side effects
11. Analyze and prepare safer options for coastal development
12. Raise public awareness.

The ICZM office should be trained, mandated, staffed, and budgeted to accomplish tasks such as inter institutional coordination on coastal resource conservation matters, review and comment on all major coastal developments, and compliance with ICZM rules and decisions. Implementation of the ICZM program should not be an entirely governmental responsibility. Resource management objectives can be pursued by local communities, resource user groups, schools, and other formal or informal collectives. Therefore, awareness must be raised among the public, the managers and the developers concerning the integrated nature of the problem, the consequences of resource mismanagement, and the importance of the maritime dimension in national planning and development strategies.

4.9 Strategies for Control and Management of Pollution from Ships

Almost two thirds of traded goods worldwide are transported by shipping⁸¹. Maritime transport is considered the backbone of the increasingly globalized economy and the international trade system. More than 53,000 commercial vessels—tankers, bulk carriers, container ships, barges, and passenger ships—travel the oceans and other waters of the world, carrying cargo and passengers for commerce, transport, and recreation.

A bulk of India’s trade is through sea and amounts to 95 percent of trade by volume and 70 percent by value. India has 13 major and 205 notified minor and intermediate ports. Under the National Perspective Plan for Sagarmala, six new mega ports will be developed in the country. The average throughput across the ports of India was about 100 million MT/month wherein a major part was imports of crude oil and LNG, to meet the energy needs of the nation.

Indian shipping, ports and supporting industries therefore play a pivotal role in India’s future economic growth. But the downside is the pollution from ship-generated wastes such as oil residues (sludge), slops (oil tank washings), sewage, food waste, garbage and other solid and hazardous waste, marine machinery exhaust, etc. Besides these wastes, ships use ballast water that needs to be taken up and discharged from time to time during its voyage.

⁸¹Kumar and Hoffmann, 2002

Unsafe management and disposal of ship wastes can pose a threat to marine organisms, humans, coastal communities, and industries that utilize marine waters. In addition, inadequate treatment of ballast water prior to discharge can result in the release of invasive species which can disastrously affect the native ecosystem. However, information on marine invasive species from Indian maritime system is very meager. During the last one decade, around 31 crustacean species have been reported as 'introduced' to Indian waters by ballast water⁸². This consists of 4 species of decapods, 6 species of isopods, 9 species of amphipods, 7 species of cirripedes and 5 species of copepods. Only one species of decapod, namely, *Litopenaeus vannamei* has been introduced to Indian waters for aquaculture purposes. The invasive statuses of some of these species, however, are yet to be determined. So far, no ecological impact of these species to native ecosystems is ascertained. However, the possibility that they could be undergoing a lag phase cannot be ruled out.

The conservation of the marine ecosystems is largely linked to regulation of coastal zone management activities and ship generated wastes. To govern, regulate and prevent pollution of oceans and seas from ships, the International Convention for the Prevention of Pollution from Ships (MARPOL) was adopted on 2 November 1973 at the International Maritime Organization (IMO). The Protocol of 1978 was adopted in response to a spate of tanker accidents in 1976-1977. MARPOL has been updated by amendments through the years.

The Convention includes regulations aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations - and currently includes six technical Annexes⁸³.

1. Annex I - Regulations for the Prevention of Pollution by Oil
2. Annex II - Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk
3. Annex III- Prevention of Pollution by Harmful Substances Carried by Sea in Packaged form
4. Annex IV- Prevention of Pollution by Sewage from Ships
5. Annex V- Prevention of Pollution by Garbage from Ships
6. Annex VI Prevention of Air Pollution from Ships

The Karnataka State has a maritime coastline of 155 nautical miles (300 km), studded with one major port and twelve minor ports (from Karwar in the North to Mangaluru in the south) situated in the three Coastal Districts of Uttara Kannada, Udupi and Dakshina Kannada. The twelve minor ports of the State from the North to the South are Karwar, Belekeri, Tadri, Pavinakurve, Honnavar, Manki, Bhatkal, Kundapur, Hangarkatta, Malpe, Padubidri & Old Mangaluru Port. The major port is New Mangalore Port (NMPT) and is situated at Panambur in Dakshina Kannada district. Under the Sagarmala project, the increase in maritime transport, expansion and development of ports and harbors will make the coastal and marine waters along the Karnataka coast more prone to invasive alien species and pollution impact from ship-generated wastes. Hence, this calls for a serious look into monitoring the discharges of these wastes and the efficacy of waste management strategies.

⁸²Roy MKD, Nandi NC (2017) Marine Invasive Alien Crustaceans of India. *J Aquac Mar Biol* 5(2): 00115

⁸³[http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-\(MARPOL\).aspx](http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx)

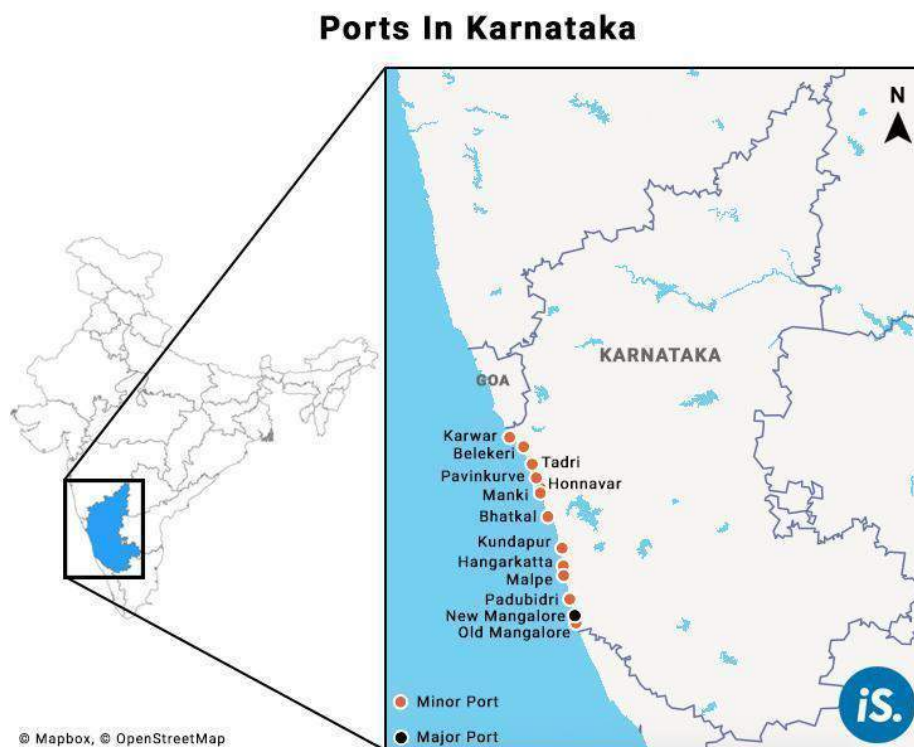


Figure 4. 17: Major and Minor ports in Karnataka

New Mangalore Port Trust (NMPT)

NMPT is a fast-growing port in the west coast of India. The year 2018-19 has witnessed several achievements with a high traffic throughput of 42.51 million MT with 1.08 percent growth over the previous year. Presently, the port is equipped with 14 meters draft, 16 berths, 68.90 million MT capacity as well as excellent road and rail connectivity.

The Port Reception Facility (PRF) at NMPT is well equipped with dedicated facilities for the receipt and management of shipboard residues and mixtures containing oil, noxious liquids, garbage and other wastes identified in MARPOL Annexes. The port has a Port Reception Plan that entails various Standard Operating Procedures (SOPs) for managing the waste reception facility. The port has detailed SOPs and procedures for reception and disposal of Slop/Bilge, Oily Water/Ballast water containing oil, Sludge/Waste oil, noxious liquid substances / liquid chemicals, sewage, garbage, cooking oil, fishing gear, expired medicine, waste, used batteries from coastal as well as foreign vessels approved by the KSPCB (Karnataka State Pollution Control Board) and customs.

The port has totally two tanks, one of which is a 5000 KL tank for receiving slop oil/ bilge water/ waste oil/ dirty ballast containing oil from foreign vessels and the other is a 500 KL tank for receiving slop oil/ bilge water/ waste oil/ dirty ballast containing oil from coastal vessels. The tanks are used for physical separation of oil and water by gravity settlement. Once separated, the waste oil is loaded into an empty authorized road truck and sent to KSPCB (Karnataka State Pollution Control Board) authorized recycling plant. The settled water containing traces of oil are treated in ETP (Effluent Treatment Plant) and the treated water is discharged after meeting the standards specified by KSPCB.

As yet, Karwar port does not have any infrastructure for receipt and management of ballast water, bilge water and slop. As part of the Sagarmala project, expansion and

modernization of Karwar port along with construction of infrastructure facilities in compliance with MARPOL requirements is also planned. However, the project is currently under hold.

Minor ports in Karnataka do not have any infrastructure for receipt and management of ballast water, bilge water, slop, etc.

The following sections include specific strategies for control and management of ballast water, ship wastes/effluents and oil and chemical spills.

4.9.1 Control and Management of Ballast Water and Invasion of Alien Species

Ballast water is carried by cruise ships, large tankers, and bulk cargo carriers to acquire the optimum operating depth of the propeller and to ensure ship buoyancy, maintain maneuverability and stability⁸⁴. Ballast water is released when the cargo is loaded onto the ship. It is estimated that for every MT of cargo, 0.33 MT of ballast water is discharged into the ocean. Ballast water is a major vector for the introduction and spread of non-native species into aquatic ecosystems. Ballast water can contain thousands of aquatic microbes, algae and animals, which are then carried across the world's oceans and if untreated get released into ecosystems where they are not native. These organisms under favorable conditions can become invasive⁸⁵.

An invasive species is one which has been introduced from one geographical location to another through human agency and upon establishment has a tendency to spread (invade), causing damage to the environment, aquatic life, man-made structures, human health or economy. Also, an introduced (also referred to as alien, exotic, non-indigenous or non-native) species becomes invasive when it out-competes native species for various resources such as space, light, water or food. The new environment may offer fewer able competitors, thereby allowing the invader species to multiply quickly.

The introduction of invasive aquatic species into new environments has been identified as one of the four greatest threats to the world's oceans. The invasive species are considered to be the second major cause of extinction of native and endemic species around the world⁸⁶. When including terrestrial species, invasive species were identified as key factor in 54 percent of all known species extinctions⁸⁷. Aquatic invasions are virtually irreversible and, once the newcomers are established, their impacts may also increase in severity over time. Invasive aquatic species can result in ecosystem changes and disruptions of ecosystem services.

For example, the North American comb jelly (*Mnemiopsis leidyi*) travelled in ships' ballast water from the Americas to the Black, Azov and Caspian Seas. It resulted in depletion of zooplankton stocks thereby altering the food web and the ecosystem function that led to the significant collapse of Azov Sea, Black Sea and Caspian Sea fisheries in the 1990s and 2000s, with massive economic and social impact. The Zebra Mussel (*Dreissena polymorpha*) native to the lakes of southern Russia and Ukraine has been transported in larval form in ballast water, and upon release, reproduced rapidly in North America with no natural predators. Displacing the native aquatic life, it altered habitat, ecosystem and the food web and caused severe fouling of infrastructure and vessels such as ships and boats. There have been high economic costs involved in unblocking water intake pipes, sluices and irrigation ditches.

⁸⁴Jing, Liang (Liam) & Chen, Bing & Zhang, Baiyu & Peng, Hongxuan. (2012). A review of ballast water management practices and challenges in harsh and arctic environments. *Environmental Reviews*. 20. 83-108. 10.1139/a2012-002.

⁸⁵Carlton, 1985, Williams et al., 1988

⁸⁶Wilcove et al

⁸⁷Red List database, International Union for Conservation of Nature (Clavero and Garcia-Berthou, 2005)

Another aspect of species transfer by ballast water concerns the spreading of organisms with potentially harmful effects on human health, such as toxin-releasing algae⁸⁸ or pathogenic bacteria⁸⁹. In 1991, the microbe *Vibrio Cholera* was released, which infected the drinking water in Peru. One million people were infected with cholera and more than 10,000 died.

The transfer of invasive species does not occur only over larger distances, between continents, but also as a secondary spread in regional seas. According to an estimate in 2001, the economic loss caused by invasive species to agriculture and forestry in India is nearly 91 billion dollars per year⁹⁰. The magnitude of invasions may be apparently local, but the drivers of bio-invasion are global. Direct economic impacts due to currently known aquatic invasions, including costs from reductions in fisheries and aquaculture production, physical impacts on coastal infrastructure, loss of income for the shipping industry, and impacts on recreational areas and tourism, are estimated to exceed US\$ 100 billion per year. Additional costs will be incurred by response measures, such as prevention, control and eradication of pests, research and monitoring, education and communication, compliance monitoring and enforcement, as well as costs of the development and onboard installation of ballast water treatment technologies⁹¹.

Management of invasive species in marine and coastal environments is a major challenge. IMO (International Maritime Organization) has been addressing the issue of invasive species in ships' ballast water since the 1980s. Guidelines to address the issue were adopted in 1991 and IMO then worked to develop the Ballast Water Management Convention, which was adopted in 2004.

The Ballast Water Management Convention (BWMC) requires ships to manage their ballast water to remove, render harmless, or avoid the uptake or discharge of aquatic organisms and pathogens within ballast water and sediments. The BWMC requires all ships in international trade to manage their ballast water and sediment discharge to a certain standard, according to a ship-specific ballast water management plan. All ships must carry a ballast water record book and an International Ballast Water Management Certificate. All ships engaged in international trade are required to manage their ballast water so as to avoid the introduction of alien species into coastal areas, including exchanging their ballast water or treating it by using an approved ballast water management system.

The ballast water management plan is designed to meet the requirements for compliance with the Convention and the G4 Guidelines produced by the IMO. It includes standard operational guidance, planning and management, sampling points and systems. Under the Convention, ships are required, according to a timetable of implementation, to comply with the D1 (Ballast Water Exchange Standard) or D2 (Ballast Water Performance Standard) standards. The D1 standard requires ships to exchange a minimum of 95 percent ballast water volume at least 50 nautical miles from the nearest shore and in waters of 200 m depth or more. The D2 standard is more stringent and requires the use of an approved ballast water treatment system. The system must ensure that the discharged ballast water contains viable organisms only in numbers below specified limits after treatment so as to minimize the environmental impact of shipping.

The technologies currently available in Ballast Water Management Systems (BWMS) can generally be grouped under three broad categories, i.e., Mechanical, Physical and

⁸⁸Baldwin, 1992, Doblin et al., 2004, Hallegraeff and Bolch, 1991, Lilly et al., 2002

⁸⁹Ruiz et al., 2000

⁹⁰Hiremath AJ Krishnan S (2016) India knows its invasive species problem but this is why nobody can deal with it properly. *The Wire: Environment*. Convention on Biological Diversity.

⁹¹Hassell, 2003, GEF-UNDP-IMO GloBallast Partnerships Program and IUCN, 2010

Chemical based on their primary mechanism for rendering the organisms inactive. Practically all identified BWMS employ a combination of two or more different processes. In most cases, mechanical separation of larger particles by filters or hydro-cyclones constitutes the first treatment step. Automatic, self-cleaning filter systems with mesh sizes of about 40 µm are frequently employed, leaving smaller organisms in the water. Other physical measures are application of ultrasound and cavitations, which lead to the mechanical destruction of particles and organisms, high energy techniques, such as heating, or UV irradiation.

Hence, appropriate treatment of ballast water prior to its discharge is essential to ensure that the receiving aquatic environment does not suffer the effects of these harmful agents that can lead to extinctions of native species and also result in severe social and economic losses. Currently Karwar port and other minor ports in Karnataka do not have dedicated facilities for the receipt and management of ballast water. Adequate infrastructure facilities shall be constructed for the receipt and management of the same. Moreover, suitable SOPs (Standard Operating Procedures) need to be formulated for the reception and disposal of slop oil/ bilge water/ waste oil/ dirty ballast containing oil/sludge from foreign and coastal vessels, which are approved by the KSPCB and customs.

4.9.2 Strategies for control and management of ship wastes/effluents

Increased maritime transport leads to increased amount of ship-generated waste (SGW) on-board depending on the type of ship and number of crew members and/or passengers. Waste streams on ships include sewage, grey water and garbage, as well as effluent from oil/water separators, cooling water, boiler and steam generator blow-down, medical wastes (e.g. health-care wastes, laboratory wastes and veterinary-care wastes) and hazardous waste (radioactive, chemical and biological wastes and unwanted pharmaceuticals). Cruise ships generate, on average, 8.4 gallons/day/person of sewage and a large cruise ship (3,000 passengers and crew) can generate an estimated 15,000 to 30,000 gallons of sewage per day. Waste can contain hazardous microbial, chemical, physical agents and toxic substances. For example, used syringes can transmit disease-causing agents such as hepatitis C virus and human immunodeficiency virus (HIV).

Restrictions on depositing hazardous wastes into water bodies mean that ships need to capture and retain those wastes on board for long periods of time. The process of packaging and storing hazardous wastes is in itself hazardous to the crew and leads to the risk of harm arising should spills or leaks occur. The management of ship wastes must follow the waste management hierarchy, that is, the priority order that ranks “waste prevention” as the most desirable option followed by preparation for re-use, recycling, other recovery operations and final disposal.

Outbreaks and harm associated with waste from ships have been linked to poor storage and disposal practices. In some cases, waste management systems have failed to perform as required, resulting in unsafe situations. Hence, it is necessary to ensure that the systems for collecting and storing waste are adequate given the extent and nature of waste generated on-board the ship. Staff at ports and ship crew involved in the collection, handling and disposal of wastes need to be adequately trained and skilled in the safe operations and relevant legislations.

4.9.2.1 Ship Effluents: Components, Treatment and Disposal

The wastewater generated on-board comprises black water and greywater. Black water consists of sewage, wastewater from toilets and medical facilities, which can contain harmful bacteria, pathogens, viruses, parasites and harmful nutrients. Grey water is wastewater from the sinks, showers, galleys, laundry, and cleaning activities aboard a ship and can contain faecal coliform bacteria, detergents, oil and grease,

metals, organics, petroleum hydrocarbons, nutrients, food waste, and medical and dental waste. Grey water is typically the largest source of liquid waste generated by cruise ships (90 percent-95 percent of the total).

It is generally considered that on the high seas, the oceans are capable of assimilating and dealing with raw sewage through natural bacterial action. Therefore, the regulations in Annex IV of MARPOL prohibit the discharge of sewage into the sea within a specified distance from the nearest land, unless otherwise provided.

Regulation for the prevention of pollution by sewage can be found in Annex IV of MARPOL (IMO, 2016). The revised Annex applies to new ships engaged in international voyages of 400 gross tonnage and above or which are certified to carry more than 15 persons and includes the following requirements:

1. Ships to be equipped with an approved sewage treatment plant/ sewage comminuting and disinfecting system or a sewage holding tank.
2. The discharge of sewage into the sea is prohibited, except when the ship has in operation an approved sewage treatment plant or when the ship is discharging comminuted and disinfected sewage using an approved system at a distance of more than 3 nautical miles from the nearest land.
3. Sewage that is not comminuted or disinfected may be discharged at a distance of more than 12 nautical miles from the nearest land, and the rate of discharge of untreated sewage shall be approved by the Administration
4. It is allowed to discharge at sea in case of securing the safety of a ship and those on-board and to save a life at sea. It is also allowed to discharge in case of discharge as a result of damage to a ship provided all precautions have been taken.

There are several modern types of equipment for treating black water and grey water separately or by using the same equipment to process both.

In most of the cargo and cruise ships with traditional Type II Marine Sanitation Devices (MSD), sewage is treated using biological treatment and chlorination. The treatment system typically includes a screen to remove grit and debris, followed by aerobic biological treatment to remove the biochemical oxygen demand and some nutrients, followed by clarification and filtration to remove solids, and finally chlorine disinfection to destroy pathogens.

To improve environmental performance, cruise lines use advanced onboard wastewater treatment systems that are designed to obtain effluent discharges that are of a high quality and purity; for example, meeting or surpassing standards for secondary and tertiary effluents and reclaimed water.

Advanced treatment systems utilize enhanced aerobic digestion with physical filtration to clean shipboard waste water. On some cruise vessels, sewage and often greywater are treated using AWTs. AWTs generally provide improved screening, biological treatment, solids separation (using ultra-filtration, reverse osmosis, or flotation), and disinfection (using ultraviolet light) as compared to traditional Type II MSDs.

4.9.2.2 Garbage: Components, Treatment and Disposal

Garbage generated on ship includes all kind of victual, domestic and operational waste excluding fish and parts thereof, food waste generated during the normal operations of the ship and liable to be disposed of continuously or periodically except those substances which are listed in other Annexes of MARPOL convention. It comprises glass, paper, cardboard boxes, plastics, aluminium, steel cans, etc. that can be either non-hazardous or hazardous in nature. Solid waste that enters the ocean may become marine debris, and it can then pose a threat to marine organisms, humans, coastal communities, and industries that utilize marine waters.

Marine mammals, fish, sea turtles, and birds can be injured or killed from entanglement with plastics and other solid waste that may be released or disposed of by cruise ships. Ships typically manage solid waste by a combination of source reduction, waste minimization, and recycling. However, as much as 75 percent of solid waste is incinerated on board, and the ash typically is discharged at sea, although some is landed ashore for disposal or recycling. On average, each cruise ship passenger generates at least two pounds of non-hazardous solid waste per day and disposes of two bottles and two cans. With large cruise ships carrying several thousand passengers, the amount of waste generated in a day can be massive. For a large cruise ship, about 8 MT of solid waste is generated during a one-week cruise. It has been estimated that 24 percent of the solid waste generated by vessels worldwide (by weight) comes from cruise ships. Most cruise ship garbage is treated on board (incinerated, pulped, or ground up) for discharge overboard.

An approved garbage management plan must consist of details of the ships, overview of Annex V of MARPOL, list of equipment for garbage handling on ship, disposal criteria, possible local recycling arrangements, written procedures for garbage collection, description for garbage segregation, garbage processing methods available on the ship, garbage storing methods, garbage disposal methods, garbage record book, emergency and accidental discharge criteria. It also identifies the available operating & maintenance procedures of collecting equipment on board, location of each collection point and describes the training or education programs to facilitate the processing of garbage.

New generation of incinerators are designed to burn solid waste, waste oil, according to IMO standards. The system is designed for continuous use, with automatic ash removal. Ash is discharged into the reservoir which is subsequently stored on board until the disposal at land.

Currently ship garbage handling facility is available only at New Mangalore Port. The port has Standard Operating Procedure in line with MARPOL Annex V, for the reception and disposal of garbage. The port has an approved agency in place for the collection and disposal of garbage.

Collection and segregation of garbage is undertaken by the Municipality authorized trucks at berths directly from vessels at pre-notified schedule. The garbage taken out from the port is transported directly and disposed of in the designated garbage dump area of the city corporation.

4.9.2.3 Bilge Water Management

On a ship, oil often leaks from engine and machinery spaces or from engine maintenance activities and mixes with water in the bilge, the lowest part of the hull of the ship. A typical large cruise ship will generate an average of 8 MT of oily bilge water for each 24 hours of operation. To maintain ship stability and eliminate potentially hazardous conditions from oil vapors in these areas, the bilge spaces need to be flushed and periodically pumped dry. However, before a bilge can be cleared out and the water discharged, the oil that has been accumulated needs to be extracted from the bilge water, after which the extracted oil can be reused, incinerated, and/or off-loaded in port. If a separator, which is normally used to extract the oil, is faulty or is deliberately bypassed, untreated oily bilge water could be discharged directly into the ocean, where it can damage marine life. Oil, gasoline, and byproducts from the biological breakdown of petroleum products can harm fish and wildlife and pose threats to human health if ingested. Oil, even in minute concentrations, can kill fish or have various sub-lethal chronic effects. According to EPA, bilge water is the most common source of oil pollution from cruise ships⁹². Bilge water also may contain solid wastes and pollutants containing high

⁹²EPA Discharge Assessment Report, p. 4-11.

amounts of oxygen-demanding material, oil, and other chemicals, as well as soaps, detergents, and degreasers used to clean the engine room. Annex I - Regulations for the Prevention of Pollution by Oil - covers prevention of pollution by oil from operational measures as well as from accidental discharges; the 1992 amendments to Annex I made it mandatory for new oil tankers to have double hulls and brought in a phase-in schedule for existing tankers to fit double hulls.

4.9.2.4 Hazardous Water Management on Ships

Cruise ships generate hazardous wastes from a number of on-board activities and processes, including photo processing, dry-cleaning, and equipment cleaning. Types of waste include discarded and expired chemicals, medical waste, batteries, fluorescent lights, and spent paints and thinners, among others. These materials contain a wide range of substances such as hydrocarbons, chlorinated hydrocarbons, heavy metals, paint waste, solvents, fluorescent and mercury vapour light bulbs, various types of batteries, and unused or outdated pharmaceuticals. Although the quantities of hazardous waste generated on cruise ships are relatively small, their toxicity to sensitive marine organisms can be significant. Without careful management, these wastes can find their way into grey water, bilge water, or the solid waste stream. All hazardous wastes generated by ships are to be well segregated, labelled, stored safely to be handed over at port reception facilities for further treatment and disposal by 3rd party authorized by Pollution Control Board in a Treatment, Storage and Disposal Facility (TSDF) site. This will ensure hazardous wastes are disposed off “in a safe and environmentally sound manner”.

India is also a party to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, which was adopted in 1989, and it came into force on March 22nd, 1992. It is the most comprehensive global environmental agreement on hazardous wastes and other wastes. With 175 Parties (as at 31 March 2011), it has nearly universal membership. The Convention aims to protect human health and the environment against the adverse effects resulting from the generation, transboundary movements and management of hazardous wastes and other wastes. The Basel Convention regulates the transboundary movements of hazardous wastes and other wastes and obliges its Parties to ensure that such wastes are managed and disposed of in an environmentally sound manner. The Convention covers toxic, poisonous, explosive, corrosive, flammable, ecotoxic and infectious wastes. Parties also have an obligation to minimize the quantities that are transported, to treat and dispose of wastes as close as possible to their place of generation and to prevent or minimize the generation of wastes at source.

4.9.2.5 Strategies for control and management of oil and chemical spills in the oceans

Each year, there are thousands of oil and chemical spills in coastal waters around the world. These spills range from small ship collisions to fuel transfer mishaps to massive oil spill events like the Exxon Valdez in 1989, the Prestige in 2002, and the Deepwater Horizon in 2010. Oil spills will continue to be a pressing problem and source of pollution as long as maritime transport around the world and exploration of oil from oceanic resources continues. Oil spill impact depends on the quantity of spilled oil, oil heaviness, spill site, sensitivity of the area, and weather at sea. Oil spills can have long-term impact on their surroundings and persist for decades⁹³.

The release of oil and chemicals into our coastal waterways can kill wildlife, destroy habitat, and contaminate critical resources in the food chain. They affect the environment, ecosystem, tourism and socio-economic factors directly. Spilled oil interferes with activities like fishing, swimming, sailing and diving. Fishing and other aquaculture practices are affected

⁹³Kingston, 2002; Bhagwan, and Chandrasaya, 2015

by oil spills and the existence of oil in fish and other edible products directly affect the livelihood of the local communities.

The impact of spilled oil on marine life depends on many physical and biological aspects. Phytoplanktons - primary producers of aquatic ecosystems are destroyed by oil spill. The entire ecosystem would be affected by any changes in density or pattern of phytoplankton. Oil enters into the plumage of birds and the fur of mammals, reducing their insulating capacity and making them vulnerable. Because of the oil scent on the animals, babies reject their mothers and die due to starvation. Some birds and animals exposed to oil spill also experience internal organ failure and metabolic imbalance. Oil can smother small species of fishes and invertebrates. Recreational beaches, ports, harbors, fisheries and all other allied activities are affected by oil spills resulting in severe economic loss.

Hence, the primary goal would be to reduce the occurrence of oil/chemical spills to the maximum extent possible. Both government and industries have to work together to reduce the risk of oil spills, with the introduction of strict new legislation and stringent operating codes. Industries have invoked many operating and maintenance procedures to reduce accidents that could lead to spills. In fact, the rate of spillage has decreased in the past 20 years. This is especially true for tanker accidents at sea. Intensive training programs have been developed to reduce the potential for human error. Despite these efforts, spill experts estimate that 30–50 percent of oil spills are either directly or indirectly caused by human error, with 20–40 percent of all spills caused by equipment failure or malfunction⁹⁴.

Equipment, procedures, and worker training are the three key components of oil spill prevention systems that will ensure spill prevention, control, and countermeasure plans to prevent oil discharges into navigable waters and adjoining shorelines. Such plans require operators to identify and analyze potential spill hazards, identify and ensure availability of resources to remove, to the maximum extent practicable, a worst-case discharge.

Double hull tankers offer a higher level of oil spill prevention since both hulls must be penetrated to cause a release of cargo. Use of single-hull tankers for the transport of oil was phased out worldwide as of 2010 under regulations of the International Maritime Organization. The risks of deep-water oil and gas exploration and development were demonstrated by the Deepwater Horizon oil spill in 2010, where an estimated 800 million L of oil was released into the Gulf of Mexico during the well blowout. Thus, industry has developed new technologies in blowout prevention systems along with a focus on safe operating processes, training, and drills.

The key to appropriate mitigation measures is to rapidly analyze spills, their projected damage, as well as environmental factors such as winds and tides. Once the properties (physical and chemical) and the likely behavior of a spilled substance is analyzed, a suitable response can be considered based on its potential impacts to human health and marine resources. However, the response strategy eventually implemented will also be largely dependent on the specific circumstances of the incident. The treatments follow a general rule: (All distances measured from the shoreline)

1. 200 nautical miles and beyond – No treatment is used, unless the case is very severe
2. Between 20 and 200 nautical miles, booms and skimmers may be used
3. Between 20 and 10 nautical miles, dispersants are used
4. For areas very close to the shoreline, biological agents are used

⁹⁴Michel, J., &Fingas, M. (2016). *Oil Spills: Causes, Consequences, Prevention, and Countermeasures. Fossil Fuels*, 159–201

These are only general rules and can be altered based on the type of oil that has been spilt and the prevailing weather conditions. No two oil spill cases are the same, so each one is evaluated individually based on its own merit. Since the density of oil is less than water, it floats on the water surface in the event of a leak or spill and hence it is much easier to clean up an oil spill. Depending on the scenario, some of the strategies and equipment that can be used to mitigate oil spills are use of oil booms, dispersants, skimmers, sorbents, burning In-situ, hot water & high-pressure washing, using Manual Labor, bioremediation etc.

Maintaining adequate health and safety for vessel crew, responders and the public is also a key factor when dealing with HNS (Hazardous and Noxious Substances) spills. In any HNS response the responders must wear the appropriate Personal Protective Equipment (PPE) and response / monitoring vessels must be adequately designed for entering a hazardous atmosphere. Lastly, effective training to the crew pertaining to prevention, control and management of oil/chemical spills will go a long way to ensure minimum damage from spills/leaks to the environment, marine life and their habitats.

In the Indian context, there have been a total of 79 minor and major oil spills from 1970 up to 2010⁹⁵. Most of the oil affecting the marine ecosystem is derived from tanker operations and accidents. However, compared to the decrease in oil spills incidents globally, the number of tanker spills/accidents has increased along the Indian coast. Of the total observed spills, 70 percent were reported from the west coast of India. Moreover, data has revealed that the majority of the spills occurred during the South-West (SW) monsoon period. Model studies, based on historical data of winds and surface currents, indicate that during the SW monsoon, the along-shore surface currents developed an easterly shoreward component resulting in rough weather conditions. This makes the west coast vulnerable to any oil spills in the Arabian Sea during the SW monsoon⁹⁶.

The Government of India vide a Gazette notification dated 12 December 2002 has designated the Indian Coast Guard as the Central Coordinating Authority for combating oil spills in Indian waters and to undertake oil spill prevention and control.

The National Oil Spill Disaster Contingency Plan (NOS-DCP) was originally promulgated in July 1996. It allocates the functional responsibilities to the various Ministries and Departments of the Government of India for oil spill response in the maritime zones of India. The NOS-DCP was subsequently updated in 1998, 1999, 2000, 2002, 2006 and 2014 to include additional information, international norms and best practices, key relevant national regulations, experience gained since publication of the first edition and valuable inputs received from stakeholders to the national plan.

The NOS-DCP was released with the following objectives:

1. Establish an effective system for detection and reporting of spills.
2. Establish adequate measures for preparedness for oil and chemical pollution.
3. Facilitate rapid and effective response to oil pollution.
4. Establish adequate measures for crew, responders, and public health and safety, and protection of the marine environment.
5. Establish appropriate response techniques to prevent, control, and combat oil and chemical pollution, and dispose of recovered material in an environmentally sound manner.

⁹⁵<https://www.indiancoastguard.gov.in/WriteReadData/Bulletin/201512290521575317057Spillssince1982.pdf>

⁹⁶Sivadas, Sanitha & George, A. & Ingole, BABAN. (2008). How vulnerable is Indian coast to oil spills? Impact of MV Ocean Seraya oil spill. *Current Science*. 95.

6. Establish record-keeping procedures to facilitate recovery of costs.
7. Maintain the evidence for the purpose of identifying the polluter and taking suitable administrative, civil or criminal action against the polluter.

The NOS-DCP was originally designed for responding to oil spill disasters in Indian waters. However, in view of India being in the process of acceding to the Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, 2000, the 2014 edition of the NOS-DCP has been revised in a manner such as to facilitate national preparedness and response to Hazardous and Noxious Substances (HNS) incidents also and thereby fulfill India's obligation to have in place a national plan to respond to HNS incidents, as a State party to the Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, 2000.

In line with the NOS-DCP, Dakshina Kannada district administration has prepared and released the District Oil Spill Disaster Contingency Plan or DOS-DCP 2019-20 in September 2019. The plan has been formulated with the intent to develop/enhance the district's capabilities to respond to oil spills. The plan provides the necessary instructions to the various stakeholders such as Revenue authorities, Pollution Control Board, Coast Guard, Fisheries Department, Forest Department, Ports, etc. regarding their involvement in the event of an oil spill in the coastal areas so that the spill is mitigated at the earliest causing minimum disruption and damage to local population, flora, fauna, the fishermen and other economic activities in the affected coastal area.

Udupi and Uttara Kannada Districts currently have a District Disaster Management Plan. However, they do not have a separate District Oil Spill Disaster Contingency Plan.

4.9.3 Conclusion and Recommendations

Maritime transport operations form the backbone of India's marine economy. Increased trade not only increases vessel traffic and revenue, but also drastically affects the coastal and marine ecosystems due to vessel sourced pollution in various forms.

The illegal discharge of ship-generated garbage and effluents from merchant ships present a significant threat to the environment and marine biodiversity. Often prosecutions are very rare as the exact source of pollution is difficult to identify⁹⁷. Hence, it is important that pollution by ships' garbage and effluents need to be properly controlled.

With the increase in the number of ships visiting ports, the on-board waste production is also on rise. By implementing the objectives set out in Annexes IV and V of MARPOL 73/78, i.e., by reducing on-board ship-generated waste, improving the availability of port reception facilities and by punishing the defaulters, the potential discharges of garbage and effluents from ships into the ocean can be greatly reduced and will facilitate the protection of the marine environment.

Unfortunately, waters of developing countries like India are highly susceptible to the non-compliance and illegal discharging or rather improper disposal of ship-generated wastes because of the lack of proper laws and poor enforcement regime. In India, ships continue to discharge vast amounts of plastics and sewage illegally into the oceans, which shows gross neglect of the provisions of Annexure IV and V.

The Indian government has a legal and constitutional obligation to safeguard the interests of the nation, its people and to maintain friendly relations with the international

⁹⁷ Jose G.B. Derrai, "The pollution of the marine environment by plastic debris: a review", 44 *Marine Pollution Bulletin* 842 (2002)

community. The policies of the government should strike a balance between the economic interests and preservation of the coastal and marine ecosystems. In order to achieve these objectives, there should be strong legal back up. The environmental laws should clearly address the legal, financial and practical responsibilities of all concerned in the operations of delivery and disposal of ship-generated wastes in ports. The government should also encourage research and development of technology for the compliance of MARPOL Annex IV and V for ships and ports. When amending the domestic legislation, the voluntary practices adopted by the shipping industry to comply with Annex IV and V may also to be considered⁹⁸.

Oil and chemical spills from marine vessels have the potential to cause significant adverse impact on the marine ecosystem. Considerable efforts have been made by the industries to reduce oil/chemical spills through the implementation of revised operating and maintenance procedures and through intensive training programs developed to reduce the potential for human error. However, in spite of all these efforts, oil/chemical spills still continue to occur, though at a lower rate.

In the unfortunate event of an oil spill, it is imperative to have in place a robust plan of action to mitigate the disastrous effects of oil spills. In this regard, The Government of India has developed the National Oil Spill Disaster Contingency Plan (NOS-DCP) and the 2014 edition is currently in force.

In line with the NOS-DCP, the Dakshina Kannada district administration has formulated a District Oil Spill Disaster Contingency Plan (DOS-DCP) 2019-20. The districts of Udupi and Uttara Kannada are yet to formulate a similar plan. As the majority of the marine traffic of India occurs in the western marine waters of India, it is prudent and imperative that a specific oil spill disaster contingency plan be available. Hence, it is recommended to formulate a District Oil Spill Disaster Contingency Plan for Udupi and Uttara Kannada districts as well.

⁹⁸<http://hdl.handle.net/10603/25497>



CHAPTER 5

Rehabilitation, Conservation and Protection of Priority Ecological Resources

Chapter 5: Rehabilitation, Conservation and Protection of Priority Ecological Resources

5.1 Introduction and Overview

Ecosystem services are the benefits to humans provided by the natural environment from healthy ecosystems either directly or indirectly. Aquatic bodies too play a key role in ecosystem services. They can be classified into three general categories:

1. **Provisioning services:** benefits obtained directly from the ecosystem (e.g., food, water, raw materials, medicinal resources etc.);
2. **Regulating services:** benefits obtained from the regulation of ecosystem processes (e.g., climate regulation, prevention of erosion, waste-water treatment etc.);
3. **Cultural services:** non-material benefits obtained directly from the ecosystem (e.g., aesthetic, tourism, recreation, etc.).

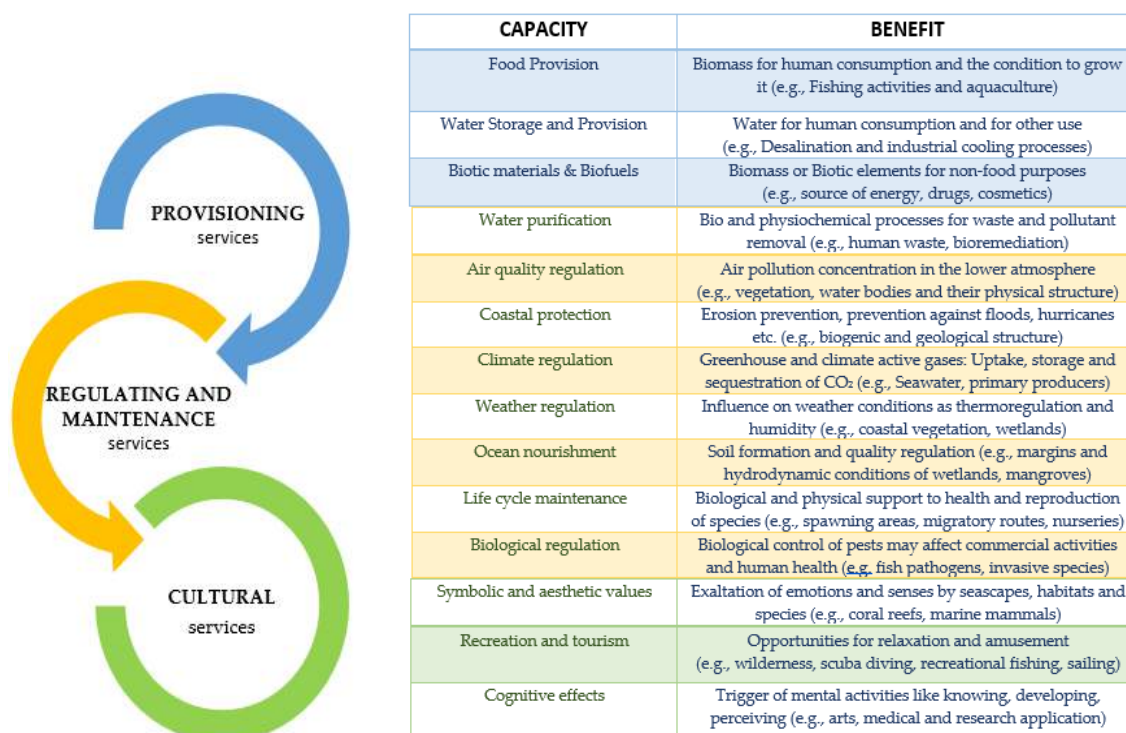


Figure 5. 1: Ecosystem services and their benefits

(Source: Own elaboration from Lique et al. 2013⁹⁹)

It is important to evaluate nature's contributions to societies, economies, and sustainable development, and hence the term "natural capital" was coined to define the stock of renewable and non-renewable resources, including biodiversity (e.g., plants, animals, air, water, soils, and minerals), that combine to yield a flow of benefits (ecosystem goods and services) to people. This evaluation and accounting of ecosystem services and natural capital

⁹⁹Perspectives on the link between ecosystem services and biodiversity: The assessment of the nursery function
Camino Lique et al., Núria Cid, Denis Lanza Nova, Bruna Grizzetti, Arnaud Reynaud European Commission, Joint Research Centre (JRC), Institute for Environment and Sustainability (IES), Via Enrico Fermi 2749, 21027 Ispra, VA, Italy

is important to identify, measure, and value natural capital, including biodiversity, to further integrate the understanding of this value into decision making and policy instruments. This would contribute to mitigation & elimination of harmful impacts that are resulting in degradation of natural capital assets and to further restore, maintain/enhance the value of these assets through public & private financial flows and policy initiatives.

The aggregated value of world's ecosystem services was roughly estimated at \$150 trillion per year in 1997¹⁰⁰. More than 60 percent of the total economic value of the world's ecosystem services is contributed by the oceans (especially coastal zones). Marine ecosystems not only provide goods but positively affect services (employment rates and business opportunities) contributing further to the overall human welfare.

While the value of ecosystem services can be very difficult to quantify, it is important to measure or estimate how sustainably people are using the ocean over time through human-ecosystem interactions. This is precisely the goal of the Ocean Health Index (OHI), scientific framework used to measure how healthy oceans are. Understanding the state of our oceans is a first step towards ensuring they can continue providing humans benefits now and in the future. The OHI, compares and combines key elements from all dimensions of the ocean's health i.e., biological, physical, economic and social¹⁰¹ to guide decision makers toward the sustainable use of the ocean. The OHI is a synthetic index based on the following dimensions¹⁰²:

1. **Food provision:** Harvesting and producing seafood sustainably.
2. **Artisanal Fishing Opportunities:** Ensuring access to artisanal fishing for local communities.
3. **Natural Products:** Harvesting non-food ocean resources sustainably.
4. **Carbon storage:** Preserving natural coastal ecosystems and habitats that sequester large amounts of carbon such as seagrasses, tidal marshes and mangroves.
5. **Coastal protection:** Persevering the habitats that safeguard shores against storm waves and flooding such as mangrove forests, seagrass meadows, salt marshes, and coral reefs.
6. **Livelihoods and economies:** Sustaining jobs, wages and revenues and thriving coastal economies through indirect effects such as identity, tax revenue and other related economic and social aspects.
7. **Tourism and recreation:** Maintaining the attraction of coastal destinations factoring in unemployment and sustainability.
8. **Sense of place:** Protecting iconic species and special places that people value as part of their cultural identity.
9. **Clean waters:** Minimizing pollution from chemicals, excessive nutrients (eutrophication), human pathogens and trash.
10. **Biodiversity:** Supporting the health of marine ecosystems and species by maintaining the richness and variety of marine life.

¹⁰⁰Changes in the global value of ecosystem services, Robert Costanza, Rudolf de Groot, Paul Sutton, Sander van der Ploeg, Sharolyn J. Anderson, Ida Kubiszewski, Stephen Farber, R. Kerry Turner

¹⁰¹<https://ohi-science.org/>

¹⁰²<https://sustainabledevelopment.un.org/>: DESA

This Chapter emphasizes on the status of biodiversity in Karnataka and the strategies to rehabilitate, conserve and protect priority ecological resources in the state such as mangroves, coastal wetlands and parts of Western Ghats. It also outlines conservation recommendations for protection of endangered species such as turtles, dolphins, whales, sharks and migratory birds.

5.2 Biodiversity in Karnataka

Karnataka is one of the richly biodiverse states in India, endowed with diverse climate, topography and soils. The seacoast is spanned with rich aquatic biodiversity and mangrove swamps. The hills of the Western Ghats are flanked with tropical evergreen forests, paddy fields, and coconut and areca nut orchards. The diverse environmental regimes support their own characteristic set of vegetation and animals. The aquatic biodiversity in Karnataka is also very rich harboring endemic species.

The Karnataka coast is also one of the richest marine biodiversity sites, contributing nearly 15.3 percent of marine biodiversity of the Indian coast. The Central Marine Fisheries Research Institute (CMFRI) in 2005 has developed a database of marine and coastal aquatic biodiversity. The economic richness of the sector is represented by a rich diversity of living resources (fish and plants) and services which provide human protein and feed for other species, medicines, coastal protection, carbon storage and livelihoods of coastal communities including socio-economic development.

Based on catch landings, occurrences of over 524 species of marine fish have been reported for the state (Zacharia et al., 2011). Due to increasing demand of fish for domestic consumption and export market, the state has witnessed enhanced exploitation of marine fisheries resources. The advancement in fishing technology has supported the sector activities and led to serious pressures on marine living resources.

In the coastal resources of the state, a total of 62 phytoplankton species were observed out of which 5 species were toxic i.e., they are capable of producing paralytic shellfish poisoning if they bloom. The other living resources contributing to biodiversity are 6 species of Demospongiae sponges, 25 species of sea anemones, 3 species of bryozoans, nearly 143 species of polychaetes (benthic), 4 species of nematodes and 1 species nemertean. Moreover, there are 234 molluscan species, 145 gastropods species, 70 bivalve's species, 16 cephalopods species, a single species of polyplacophores and 2 species of scaphopods.

Gastropoda accounted for 62 percent of the molluscan diversity followed by Bivalvia (30 percent); Cephalopoda (7 percent) and Amphineura & Scaphopoda (1 percent). Crustacean biodiversity comprised 19 species of shrimps, 13 species of brachyuran crabs, one hermit crab species. Penaeidae was the largest family with 16 species; 5 species of starfishes, 2 species of Sea urchins, 1 species of sea cucumber (*Holothuria leucospilota*). A total of 78 species of seaweeds and 2 species of sea grasses are reported, and the Intertidal rocks along the Islands registered fairly good flora of brown seaweeds dominated by *Sargassum ilicifolium*, having economic importance for extracting algin.

In the state, fish diversity is represented by 40 elasmobranch species (sharks, rays and skates) and 350 bony fishes. Three elasmobranchs, one fin fish and one turtle are declared endangered and listed under IUCN Red list categories. Five species of elasmobranchs are declared as vulnerable, nine spp. of elasmobranchs as lower risk/conservation dependent, three species of elasmobranchs are protected under Indian Wild life (Protection) Act, 1972 Schedules. Similarly, three species of mollusk, one species of sea cucumber, fourteen species of corals and four species of sponges are protected (source: MRC of CMFRI).

Sharks, one of the protected species under the Wildlife Protection Act 1972 is still being harvested by the fishers since some of its sub categories coming under the sharks and rays were exempted under Schedule I of the Wildlife Protection Act. Molluskan species that occur along the Karnataka coast which are included in the Schedule 1 of the Wildlife Protection Act of India (1972) are *Tridacna maxima* (giant clam), in Schedule IV are *Lambis chiragra* (spider conch) and *Placenta placenta* (windowpane oyster). Also included are 25 species of sea anemones, bivalve 15 species, gastropod 48 species and 8 nudibranch species. The other living resources are jellyfish, sea fans, sea feathers, sea pens.

The coral ecosystem of Netrani island supports biodiversity of Corals, Giant clam, Napoleon wrasse, Angelfish, Turtles, Barracuda, Moray Eels etc. Out of nine grouper fish species identified from this island, two species such as *Cheilinus undulatus* (endangered) and *Rhincodon typus* (vulnerable) are included in the IUCN red list. Several small giant clams (*Tridacna maxima*) which are protected under the Indian Wildlife (Protection) Act and included in the IUCN Invertebrate Red Data Book as 'Lower Risk: Conservation Dependent' species are also reported from this area.

Elsewhere on the Karnataka coast, a rare octopus species, a rare lingula species, a species of hermit crab, five species of starfish, two species of sea urchins, one species of sea cucumber, a sun fish species (called *Mola mola*), three species of endangered sea turtles, three species of sea snakes are reported. The mammal biodiversity is represented by three species of dolphins, one sp. of porpoise and four species of whales.

5.2.1 Status of Biodiversity in Karnataka

The biodiversity of Karnataka is under pressure in all the ecosystems-coastal and marine tracts, all the water bodies (rivers, streams, lakes and reservoirs), protected and non-protected forests, agro and urban ecosystems. The erosion of the ecosystems could be traced to the below reasons in the order of the impact that it causes.

1. **Direct exploitation or unsustainable harvesting of the resources:** Poaching, use of resources by pharmaceutical and allied industry, illegal harvesting of wood.
2. **Fragmentation or declining quality of habitat:** Urbanization projects, Monoculture plantations, commercialization of agriculture (use of pesticides and loss of traditional agricultural landscape).
3. **Invasive alien species:** short lifespan, high reproduction capacity (large number of eggs), survive in hostile environment - caused due to globalization
4. **Impacts of pollutants and climate change:** Industrial effluents, untreated sewage, bio-medical wastes, use and bioaccumulation of pesticides etc.

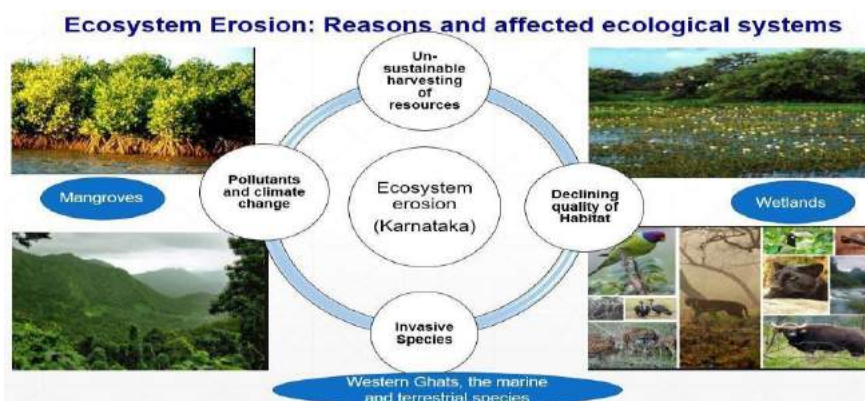


Figure 5. 2: Reasons for Ecosystem erosion and affected ecological systems

The Biodiversity in Karnataka is following a downward trend. The above reasons exploit one or more areas of biodiversity necessitating the need to conserve the unique biodiversity in Karnataka a primary objective- Mangroves, wetlands, the Western Ghats and the native coastal species and migratory bird species.

5.2.2 Biodiversity conservation challenges in Karnataka

Some of the challenges faced towards biodiversity conservation are as follows:

1. The rising sea level has resulted in natural shoreline erosion increasing the salinity of estuarine systems, displacing the existing coastal plant and animal communities.
2. The lack of basic data related to diversity of species and their distribution makes implementation of measures for ecological resilience complex.
3. Dwindling of diversity and fish stocks due to uncontrolled fishing, habitat degradation, pollution, etc., adds to the constraints in maintaining biodiversity
4. Bio-invasion threat due to accidental release of certain species of exotic plankton through ballast water
5. Scientific capacity challenges, including a lack of expertise in taxonomy, limited research facilities and financial resources

5.2.3 Recommendations for Biodiversity conservation

1. An ecosystem health card (based on (a) water quality index, (b) habitat index, (c) living resources index) can be prepared for the major river stretches, reservoirs, lakes and wetlands. Plans must be developed to restore the affected stretches of rivers and lakes through existing National River and lake conservation programs.¹⁰³
2. Maintaining environmental flow must be made mandatory as a part of Environmental Impact Assessments (EIA) while providing approvals for river valley projects as a major cause of biodiversity loss is the diminishing/impaired flows of water in rivers and associated wetlands due to various water abstraction projects.
3. Hill streams above 3000 m Mean Sea Level (MSL) must be declared as ecological sensitive zones in which developmental activities (including water abstraction) must be avoided.
4. Changes in coastal ecosystems need to be studied periodically through the use of technology, remote sensing data etc. for taking informed actions on their protection and conservation.
5. An annual monitoring of coastal and estuarine ecosystems, especially mangroves, using remote sensing is to be undertaken.
6. Restrict tapping of wild marine seed resources and develop new and more sustainable capacities across activities of fisheries.
7. Effectively implement sustainable management measures including control of fishing effort to avoid over exploitation .
8. Establish of Marine Protected Area (MPA) as ecosystem restorative measures for protection of sensitive habitats in support of conservation.
9. Stock enhancement programs to restore the severely depleted stock and sea ranching with robust ESIA studies.

¹⁰³Mainstreaming Biodiversity Inland Fisheries and Aquaculture – Centre for Biodiversity Policy and Law, National Biodiversity Authority -2019

10. Declaring “No-Go zones” to trawlers and other intensive gear in the fishing grounds which are habitats for threatened species
11. Conservation action plans must be prepared by the States or Union Territories (UTs) for all open water resources where fisheries resources are threatened.
12. Promotion of community-based fish protection zones and harvesting zones along inland and estuarine waters. This helps the local fishing communities to be given a stronger stake in sustainable management of wild fish stocks utilized in capture fisheries and increasing the responsibility of fishers towards the environment. This can be done by incorporating the guiding principles provided by the FAO's Voluntary Guidelines on Small Scale Fisheries (2014) and the FAO Code of Conduct for Responsible Governance of Fisheries (2012) into the present proposal.

5.3 Mangroves

A Mangrove Forest is defined as a salt-tolerant marine ecosystem with halophytic species of trees and shrubs representing wetland ecosystems. They normally occur above mean sea level and are known as the roots of the sea. The resources, though fragile, are highly productive, supporting a genetically diverse community of terrestrial and aquatic flora and fauna. The state has nearly 2 sq.km moderately dense mangrove, and over 8 sq.km of open mangrove (Source: India State of Forest Report 2019) and account for only 0.2 percent of the total country resources. The resource is spread over in all the three coastal districts. However, as per India State of Forest Report 2019, the district wise mangrove cover in Karnataka state is tabulated in Table 5.1.

State/ UT's and District	Very Dense Mangrove (sq. km)	Moderately Dense Mangrove (sq. km)	Open Mangrove (sq. km)	Total (sq. km)	Change w.r.t 2017 Assessment (sq. km)
Uttara Kannada	0.00	0.28	8.22	8.50	0.00
Udupi	0.00	1.54	0.00	1.54	0.00
Total	0.00	1.82	8.22	10.04	0.00

Table 5. 1: District wise mangrove cover in Karnataka state
(Source: India State of Forest Report 2019)

5.3.1 General uses of Mangroves

Mangrove ecosystem is one of the most productive natural ecosystems on the earth not only providing habitat to many diverse species of birds, mammals, fish and shellfish but also of great ecological, biodiversity and socio- economic importance.

Ecological uses	Economical uses	Social uses
Erosion control	Fishing	Education
Protection from damage	Shrimp and crab industries	Ecotourism
Indicator of climate change	Charcoal Production	Food
Habitat provision	Timber production	Local employment
Water quality management	Firewood	Agriculture
Carbon Sequestration		Traditional medicine

Table 5. 2: General uses of Mangroves
(Source: Conservation and Management of Mangroves in Uttara Kannada, Central Western G)

The mangrove ecosystems are associated with rich diversity of organisms and are also the nursery and breeding ground of several marine fauna-like prawns, crabs, fishes and mollusks¹⁰⁴.

They enhance the fishery production of nearby coastal waters by storing nutrients and detritus. The shed leaves of mangroves turn into detritus, which is colonized by fungi and bacteria and this detritus turns into a valuable pool of nutrients. This detritus is consumed by a variety of bivalves, shrimps and fishes, many of which migrate into the mangrove areas for better feeding and protection.

They perform many ecological functions like maintenance of water quality, fixation of carbon dioxide, pollution reduction by filtering suspended material and assimilating dissolved nutrients and they are the source of salt resistant genes, medicine, dyes, fodder, timber and firewood, paper pulp, seed oil for lighting and as fuel, manure, fiber, mat and basket weaving, groundwater protection from salinity, perfumes, tannin, fish food, study, recreation and tourism and potential donors of genes for salt resistance.

Furthermore, the mangrove forests play a major role in reducing the severity of tsunami waves, cyclones, sea currents and wind erosion. The mangroves of Bhitarkanika in Odisha, India have greatly reduced the impact of the 'super cyclone' that had struck in October 1999. There was little human casualty and less economic damage in the dense mangrove cover areas of Parangipettai, Tamil Nadu, and India during the 2004 tsunami.

5.3.2 Distribution of Mangroves

According to the Forest Survey of India 2019, India has 2.66 percent of the world's mangrove covering an estimated area of 4975 Sq. km, which is 0.15 percent of the total country's geographical area (32,87,469 sq. km). As per the assessment, very dense mangroves comprise 1476 sq. km (29.66 percent), moderately dense mangrove is 1479 sq. km (29.73 percent) and open mangroves constitute an area of 2020 sq. km (40.61 percent). About 57 percent of the mangroves are found on the East Coast, 23 percent on the West Coast and remaining 20 percent on the Andaman and Nicobar Islands. Thus, the mangrove cover in India during the last three decades has shown an increase in extent of 21.6 percent.

Along the west coast of India, mangroves are found growing on the banks of estuaries, deltas, backwaters, creeks and other protected areas. In all 34 species, 25 genera and 21 families have been reported from the west coast of India.

Karnataka has 10 sq. km (FSI, 2019) of mangrove area along the coastline of 320 km. The saltwater tides from the seas flow towards the delta several miles inland providing suitable habitats for mangroves. Most mangroves are of the fringing type (classic zonation pattern) in linear formations along the river or estuarine banks. Where the estuaries are wider, especially in Swarna-Sita-Kodi, Gangoli (towards the mouth of Haladi-Chakra-Kollur Rivers), Aghanashini and Kali, there are remarkable locations of mangrove. About 18 species have been reported and the dominant species are in the table below:

Family	Species
Acanthaceae	<i>Acanthus ilicifolius</i> (Kannada: Holechudi),

¹⁰⁴[http://wgbis.ces.iisc.ernet.in/Mangroves in general-CES \(IISc\)](http://wgbis.ces.iisc.ernet.in/Mangroves%20in%20general-CES%20(IISc))

Rhizophoraceae	<i>Bruguiera gymnorrhiza</i> <i>Bruguiera cylindrica</i> <i>Kandelia candel</i> <i>Rhizophora mucronata</i> , <i>Rhizophora apiculata</i> ,
myrsinaceae	<i>Aegiceras corniculatum</i>
Euphorbiaceae	<i>Excoecaria agallocha</i> ,
Sonneratiaceae	<i>Sonneratia alba</i> , <i>Sonneratia caseolaris</i>
Poaceae	<i>Porteresia coarctata</i>
Verbenaceae	<i>Avicennia marina</i> , <i>Avicennia alba</i> , <i>Avicennia officinalis</i>
Combretaceae	<i>Lumnitzera racemosa</i>
Pteridaceae	<i>Acrostichum aureum</i> .

Table 5. 3: Mangroves of different estuarine complex of Karnataka

A few other Mangrove vegetations are:

Barringtonia racemosa (Kannada: Samudra Phal), *Caesalpinia crista*, *Caesalpinia bonducella* (Kannaada: Gajakakayi), *Calophyllum inophyllum* (Kannada: Honne), *Morinda citrifolia* (Kannada: Ainshe, Tagase), *Phyllanthus reticulatus*, *Salvadora persica*, *Sonneratia caseolaris*, *Thespesia populnea*, *Vitex negundo*. This vegetation is rich source of chemicals with insecticidal and bactericidal properties, novel agrochemicals, gums and glues, alkaloids, saponins, phenolics, steroids, terpenoids, amino acids, carbohydrates, proteins, fatty acids, alkaloids, carotenoids, various mineral combinations etc. They also have potential medical, agricultural, industrial, and scientific importance. With the advent of biotechnology, it has opened up new opportunities for innovation, business models and could stimulate conservation and enrichment of mangrove vegetation in years to come.

Mangroves are extremely important bio-resources which are crucial to the coastal environment. Mangroves are declining rapidly as they are getting degraded for agriculture, aquaculture, tourism, urban development, industrialization and over-exploitation.

Sn	Mangrove species	Name of estuary										
		NG	MP	UD	SS	HC	BA	VE	SH	AG	GA	KA
1	<i>Acanthus ilicifolius</i>	P	P	P	P	P	P	P	P	P	P	P
2	<i>Lumnitzera racemosa</i>	-	-	-	-	P	-	-	-	-	-	P
3	<i>Excoecaria agallocha</i>	P	P	P	P	P	P	P	P	P	P	P
4	<i>Aegiceras corniculatum</i>	-	P	P	P	P	-	-	P	P	P	P
5	<i>Bruguiera cylindrica</i>	-	-	-	-	-	P	-	-	-	-	P
6	<i>B. gymnorhiza</i>	-	P	P	P	P	-	P	-	-	-	P
7	<i>Kandelia candel</i>	P	P	P	P	P	-	P	P	P	P	P
8	<i>Rhizophora apiculata</i>	-	-	-	-	-	-	-	-	P	P	P
9	<i>R. mucronata</i>	P	P	P	P	P	P	P	P	P	P	P
10	<i>Sonneratia alba</i>	-	P	P	P	P	P	P	P	P	P	P
11	<i>S. caseolaris</i>	P	P	-	P	P	-	P	P	P	-	P
12	<i>Avicennia marina</i>	-	P	P	P	P	-	P	-	P	P	P
13	<i>A. officinalis</i>	P	P	P	P	P	-	P	P	P	P	P
14	<i>Acrostichum aureum</i>	P	P	P	P	P	-	P	P	P	P	P
Total		7	11	10	11	12	5	10	9	11	10	14

Dakshina Kannada: 1. NG: Netravati-Gurpur; 2. MP: Mulki-Pavanje.

Udupi: UD: 1. Udyavara; 2. SS: Sita-Swarna-Kodi; 3. HC: Haladi-Chakra-Kollur; 4. BA: Baindur.

Uttara Kannada VE: Venktapur; SH: Sharavati; AG: Aghanashini; GA: Gangavali; KA: Kali

Table 5. 4: Estuary-wise Mangrove Distribution in Karnataka

(Source: Conservation and Management of Mangroves in Uttara Kannada, Central Western Ghats)

This is one of the highly stressed estuarine complexes with an area of about 1920 ha. Diversity indices calculation showed comparatively high diversity and richness of mangroves in Gurupura estuary. *Avicennia officinalis*, *Rhizophora mucronata*, *Kandelia candel* and *Rhizophora apiculata* are dominant due to their tolerance to the wide range of physico-chemical properties fluctuations than the other species of mangroves.

- Mulki-Pavanje Estuaries:** Twelve of the 15 mangrove species of Karnataka are found here. Pavanje village itself and Chitrapu have 11 species each. Of the mangrove associates, the rare tree *Morinda citrifolia* and *Thespesia populnea*, rare for the Karnataka coast occur at Haleangadi. *Cerbera manghas* is sparingly present.
- Udyavara Estuary:** The estuary has 11 species of true mangroves. *Acanthus ilicifolius* is more dominant followed by *Acrostichum aureum* and *Excoecaria agallocha*. Katapadi and Jarukudru.
- Estuarine complex of Swarna-Sita-Kodi Rivers:** There is considerable distribution of the mangroves in this estuarine complex. About 11 species of mangroves are found. Hangarkatta is a promising locality. Important mangrove associates are *Cyperus malaccensis*, *Cerbera manghas*, *Derris trifoliata*, and *Caesalpinia crista*.
- Estuarine Complex of Haladi-Chakra-Kollur Rivers:** The combined estuary of these three rivers is spread over an area of 2550 ha in the Kundapur taluk. Shrimp culture is quite widespread. There are 13 species of mangroves dominated by *Rhizophora mucronata*. *Lumnitzera racemosa* was found only at Hangallur. Some shrimp farmers also have raised mangroves around their prawn farm, particularly to protect the bunds, with promising results. Upstream death of mangroves has been observed following construction of barrages for fresh water storage.

5. **Baindur Estuary:** The estuary is notable for the rare presence of *Bruguiera cylindrica*, perhaps the only location for the species in the State. Other mangroves include *Avicennia officinalis*, *A. marina*, *Sonneratia alba* and *Rhizophora mucronata*.
6. **Venkatapur Estuary:** A lone tree of the species *Bruguiera gymnorrhiza* and a few seedlings were present at Heble. This is the only tree of the species in the Honavar Forest Division, the territory of which covers 3 more estuaries (Sharavathi, Aghanashini, and Gangavali).
7. **Sharavathi Estuary:** It is a fine estuary, although it has only 8 species of mangroves. *Sonneratia alba* and *Rhizophora mucronata* are sparingly present only towards the river mouth, obviously because of more salinity. The major reason for the absence or rarity of true mangroves could be the constant release of fresh water from the various hydel projects of the river. The estuary is most remarkable along the coast for the fairly good growth of the low salinity preferring *Sonneratia caseolaris*. The largest population of *Cerbera manghas* is found alongside this estuary.
8. **Kali Estuary:** One of the best natural mangrove areas of Karnataka are found in this estuary. It has 14 of the mangrove species listed under this survey, the exception being *Bruguiera cylindrica*. This is the only estuary in Uttara Kannada having *Lumnitzera racemosa* (at Kanasgeri) and practically, the entire population of *Bruguiera gymnorrhiza* (at Kanasgeri and Sadashivgad). Notable of the mangrove associates are *Barringtonia racemosa*, *B. acutangula*, *Hibiscus tiliaceus*, *Salvadora persica* and *Thespesia populnea*.
9. **Aghanashini Estuary:** This is one of the largest estuaries of the State. It has 12 species of mangroves, including *Rhizophora apiculata* and *Avicennia marina*. There is a small sacred grove dominated by *Avicennia officinalis* alongside Masurkurve Island. Rampant conversion of estuarine rice fields (Gazanis) into shrimp aquaculture has destroyed most of the old mangroves.
10. **Gangavali Estuary:** Gangavali estuary, situated towards the south of the Ankola town, is home for 12 species of mangroves. Though mangrove habitats are few, all along the edge of the river a linear strip is found. Some small good patches occur at Bilihonge and Agragone. The river mouth has a good patch dominated by coppicing *Sonneratia alba*. Notable of the mangrove associates are *Hibiscus tiliaceus* and *Ficus racemosa*.

5.3.3 Contribution of Mangroves to Fisheries

The mangrove ecosystems consist of rich diversity of fauna and flora, that provides a wide range of services as habitats, nurseries, nutrients, and spawning grounds for several marine fauna viz. prawns, crabs, fishes and mollusks. The fringe area of mangrove forests typically serves as a breeding ground and nursery habitat for marine life contributing for stock enhancement, production of commercially important marine fisheries and add incremental value to marine fisheries. It is estimated that about 33 percent of total marine fish catch in 2014 was mangrove dependent (FSI, 2015). The various activities of this ecosystem are directly or indirectly supporting the livelihood community living in or around the mangrove habitat.

The predominant species of mangrove ecosystem are demersal fishes, crustaceans and mollusks. Demersals include sharks, skates, rays, eels, catfishes, cods, snappers, breams, perches, goatfishes, threadfins, croakers, silver bellies, big-jawed jumper, pomfrets, and soles; Crustaceans include penaeid and non-penaeid prawns, lobsters, crabs and stomatopods; mollusks include mussel, oysters and clams, other bivalves, gastropods,

squids, cuttlefish and octopus (CMFRI data – <http://www.cmfri.org.in/fish-catch-estimates.html>).

Based on economic analysis of mangrove and marine fishery linkages, annual per hectare contribution of mangroves to total marine fish production is estimated at 1.86 MT (Lavanya Ravikanth Anneboina and Kavi Kumar, 2017).

5.3.4 Mangrove afforestation in Karnataka

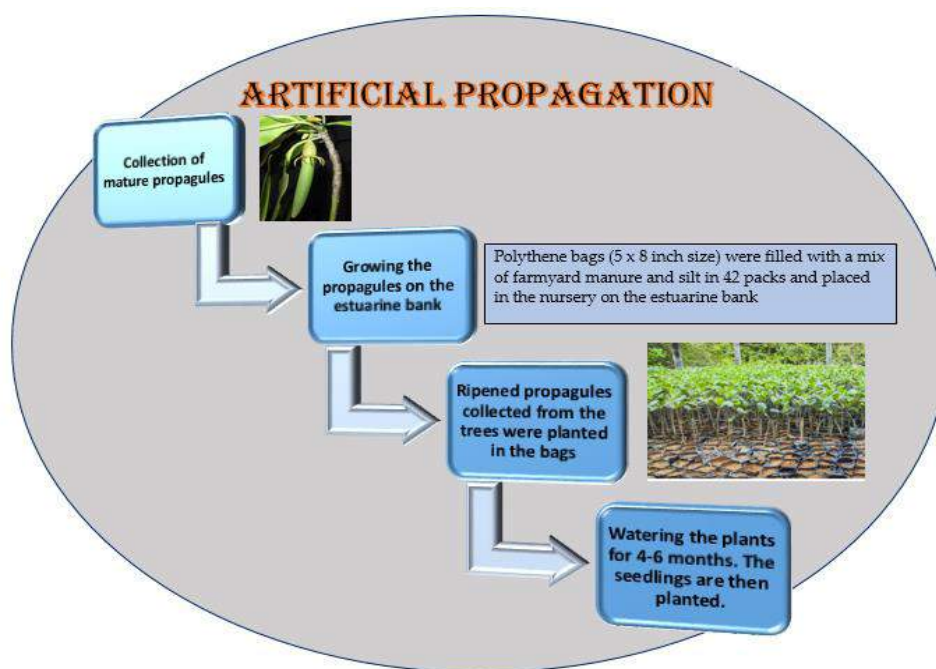


Figure 5. 3: The brief process of artificial propagation

To protect this coastal treasure, mangrove restoration works gathered pace after the Coastal Regulation Zone Act of 1991, when several awareness campaigns on the importance of mangroves were conducted and projects were implemented by governments and not-for-profit organizations for planting mangroves. The government further renewed its efforts after the tsunami in 2004, when there were reports of mangroves acting as bio shields and lessening damage in some coastal areas.

The rejuvenation was carried out by involvement of different department officials and local communities. Several mangrove afforestation programs were carried out with people's participation in different parts along coastal Karnataka. Village forest communities were formed in estuarine villages, through which awareness programs were held and local fishermen were informed regarding the economic benefits of conserving the mangroves, and other income generating activities such as honey cultivation and mangrove tourism that could be pursued.

For reforestation, the propagules (mangrove seeds) are taken and planted in empty areas. In some cases, the seedlings are raised outside the mangrove and then planted. Almost 2500 propagules were planted every year alongside Masurkurve as well as in Masur-Lukkeri areas. In the Gangavali estuarine region, mangroves went up from 48.77 to 51.59 percent after reforestation programs. Two other estuaries - Sharavathi and Venkatapura — showed a similar rejuvenation of mangrove species. Plant species such as *Rhizophora mucronata*,

Sonneratia caseolaris, *Avicennia officinalis*, *Sonneratia alba*, and *Kandelia candel* representing both high salinity and low salinity tolerant shrubs were assessed in these estuaries.

Mangrove restoration programs in Karnataka			
Area (Location)	Year	Total area	Success rate
Udupi (Parampally & Kodi Kanyana)	2005 -2019	15 ha	70 percent
Uttara Kannada (Karwar & Honnavar)	2010-2019	600 ha	70 percent

Table 5. 5: Mangrove restoration programs in Karnataka

A recent study published in the International Research Journal of Engineering and Technology also indicated that in the Aghanashini estuary alone, there has been a significant improvement in the mangrove areas from 1% to 18% between 1990 and 2019 by afforestation in abandoned salt pans and rice fields within the river. The improved mangroves along this estuary have stabilized the river bank, reducing erosion from 43% in 1990 to 4% in 2019.

5.3.5 Conservation recommendations for Mangroves

1. Ensure protection of existing mangrove ecosystems and removal of deleterious impacts. Protection of mangrove flora and fauna by banning the extraction of mangrove wood; address the issue of encroachment, destruction and reclamation of mangrove areas with a legal enforcement of protection rules against exploitation of mangroves for fuel wood, timber, paper, charcoal etc. that violates Coastal Zone Regulation Notification, 2011 and 2019.
2. Degraded mangrove areas to be identified and intensive measures undertaken to restore degraded/destroyed mangroves.
3. Avoid monoculture of mangroves species during afforestation measures, giving importance to *Avicennia* spp. and *Sonneratia* spp.
4. Mangrove planting and maintenance should be undertaken as per natural zonation in mangrove ecosystem
5. Carry out awareness campaigns on Mangroves to coastal communities. Training to be provided to local communities on management and restoration of mangroves
6. Annual monitoring of mangroves using remote sensing in coastal and estuarine ecosystems to be undertaken
7. Promote mangrove management and reforestation activities by adequate funding to Panchayats, Village Self-Help-Groups and Village level organizations. Under the coordination of different departments, set up Mangrove Co-management Committees and Mangrove Protection and Employment Generation Scheme as done in Maharashtra to make people's livelihood dependent on and linked to the mangrove cover so that people will voluntarily come forward to save the mangrove cover
8. Identification of potential mangrove areas for declaration as national parks and sanctuaries
9. The rare population of *Bruguiera gymnorrhiza* in Venkatapur estuary to be protected
10. Promote mangrove plantation in abandoned aquaculture ponds

5.4 Status of Coral Reef Ecosystem

The state has Coral and coral associated biodiversity in St. Mary's Island, Netrani Island, Mugali to Apsarakonda rocky shore and Devgad Island. Netrani is an uninhabited island located nearly 18 km off Murdeshwar (Karnataka State) in the southwest coast of India that is an internationally recognized underwater diving destination for tourists. It is a home to coral reefs which harbor 14 coral species belonging to 11 genera and several other flora and fauna comprising of fishes (92), seaweeds (7), sponges (6), jellyfish (2), holothuria (1), nudibranchs (7), zooplankton (25), bivalves (15), phytoplankton (16), gastropods (48), cephalopods (3), crabs (17), shrimps (2), lobsters (4), etc. Moreover, 26 new fish species belonging to four genera and other IUCN red listed species are found here that are very significant. The two IUCN Red Listed fish species recorded from the island area are the humphead wrasse (*Cheilinus undulatus*) and the whale shark (*Rhincodon typus*). Another IUCN red listed mollusk, the giant clam (*Tridacna maxima*) was also found inhabiting this reef and this is a first report on the occurrence of this species from the mainland Indian waters¹⁰⁵. The fish species from the Chaetodontidae family are also present within the corals which are a bio indicator of the health of coral reefs (Thomas et al., 2011).

However, several anthropogenic activities can result in the damage of coral reefs such as overfishing, use of destructive fishing practices, extraction of live corals and coral biodiversity for aquarium trade, marine litter, sediment/nutrient/chemical/oil pollution from land/ships, overexploitation for bioprospecting, global warming and climate change, sea level rise, ocean acidification etc. The Indian Navy based at Karwar were known to use the Netrani Island for target shooting and shelling practice as several naval artillery shells and torpedo cases were found scattered during the underwater survey around the Island by CMFRI (P. U. Zacharia et al., 2008).

From stringent regulations on overfishing, prohibiting illegal ornamental trade, encouraging responsible eco-tourism, curtailing marine litter, steps towards reducing global warming etc. can go a long way in safeguarding this unique and biodiverse ecosystem. Hence a coordinated effort by various stakeholders including general public is essential in conserving coral reef ecosystems as every action counts.

5.4.1 Conservation of Coral Reefs

1. Control and regulate commercial fisheries, underwater diving and amateur collection of corals around coral reef ecosystems especially around Netrani Island.
2. Ensure safe and responsible diving and snorkeling activities is practiced to protect the fragile coral ecosystems such as by instructing tourists to avoid touching reefs and avoiding anchoring boats on reefs.

Moreover, tourists need to be informed on reef-friendly approach to sun protection as some ingredients in sunscreen can be harmful to or even kill corals.

3. Protect and conserve the Netrani Island and other coral reef ecosystems by declaring them as a Marine Protected Areas (MPA) under the Biodiversity Act 2002.
4. Prohibit sale of living coral and collection of fishes from these ecosystems for ornamental purposes.
5. Create awareness on importance of Coral ecosystems on marine capture fisheries, coastal protection etc. and the ways to protect them such as curtailing marine litter, steps towards reducing global warming etc.

¹⁰⁵J. Mar. Biol. Ass. India, 50 (1): 87 - 97, January - June 2008

6. Carry out regular assessment to evaluate the trends and patterns of use and health of coral reefs as it is an essential tool for the development of effective management strategies.

5.5 Coastal Wetlands in Karnataka

Wetlands are the areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters.

5.5.1 Uses of Coastal wetlands

Below is the pictorial representation of the benefits or uses of the coastal wetlands. They are key drivers of reducing pollution, drainage, land conversion and climate changes.



Figure 5. 4: Brief description of the uses/benefits of wetlands
(Source: Two oceans Aquarium)

5.5.2 Geographical distribution of Wetlands in Karnataka

In Karnataka's total geographical area, wetlands cover 2.72 million ha and out of which the inland wetlands cover 2.54 million ha and coastal wetlands 0.18 million ha. The 682 wetlands in the State come under inland-natural (7), Inland man-made (615), coastal-natural (56) and coastal man-made (4). Inland wetlands dominate in Karnataka, which account for 93.44 percent while coastal wetlands account for 6.56 percent. Out of the 682 wetlands, 622 are inland while 60 are coastal wetlands.¹⁰⁶

¹⁰⁶Wetlands of Karnataka- Ahalya, N. and Ramachandra T.V. Energy & Wetlands Research Group-CES (IISc)

Wetlands	Area (ha)	Percent Area	Number
Inland			
Natural	581.25	0.21	7
Man-made	253433.75	93.22	615
Total	254014	93.43	622
Coastal			
Natural	16643.75	6.13	56
Man-made	1181.75	0.44	4
Total	17825.5	6.57	60
Total wetlands			
< 56.2 ha	278310.5	100	682
> 56.2 ha.			171

Table 5. 6: Area under Inland and Coastal Wetlands of Karnataka

5.5.3 Conservation recommendations for Coastal Wetlands

1. Wetlands, salt marsh areas are eco sensitive coastal areas as mapped in the CZMP and declared as CRZ IA should be protected in line with CRZ notification 2019
2. Carry out studies to map wetlands (coastal and inland), low lying coastal areas, and potential coastal stretches that are prone for inundation during monsoon/cyclones/sea level rise
3. Develop guidance for the wise use of wetlands in relation to coastal and inland aquaculture to prevent direct (habitat loss, wild harvest of species) and indirect (pollution, contamination of wetlands, impact of novel compounds, genetic modification) impacts of aquaculture. Build on aspects of COP9 Resolution IX.4 (2005): productive and sustainable use of fisheries resources
4. Ensure agriculture in coastal wetlands are sustainably managed as poorly managed agriculture can negatively impact wetlands leading to changes in the ecological character of a wetland and the possible permanent loss of its benefits to people
5. Conserve wetlands from intensive agricultural and aquaculture activities (Shrimp farming) which can disturb wetland functions and ecosystem services such as conversion of wetlands to cultivated land or aquaculture; the introduction of invasive plant and animal species; the introduction of human and animal disease vectors; and the disturbance of breeding, migration and feeding patterns of wetland fauna
6. Introduce combined production systems (agri-pisciculture) to several stretches of coastal low-lying area and estuarine areas where fish provide fertilizer for the rice and help to control insect pests and weeds in the fields, while the rice provides shade and habitat for the fish.

5.6 Parts of Western Ghats and any Other “No-Go” Areas

The Western Ghats biogeographic region in southern India runs along the west coast with north to south distance of 1,490 km, a minimum width of 48 km and maximum width of 210

km, covering a total area of 136,800 sq. km (CEPF 2007). The Western Ghats extends along the west coast of India covering an area of 140,000 sq. km (Fig. 5.5). The area is considered as one of the biodiversity 'hotspots' in the world due to its extraordinary richness of biodiversity. The Western Ghats Mountain range traverses the states of Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu interrupted only once by a 30 km break called the Palghat Gap in northern Kerala¹⁰⁷.

Broadly, the freshwater rivers and streams in the Western Ghats fall under five main categories or ecoregions, viz., Narmada-Tapi, the Northern Deccan Plateau (Godavari River system), the Southern Deccan Plateau (Krishna River system), the Southern Eastern Ghats (Cauvery River system) and the Western Ghats (west flowing rivers) (Abell et al. 2008). The freshwater ecosystem and all its denizens together constitute the rich biodiversity of one the world's 34 hotspots (Myers et al. 2000).

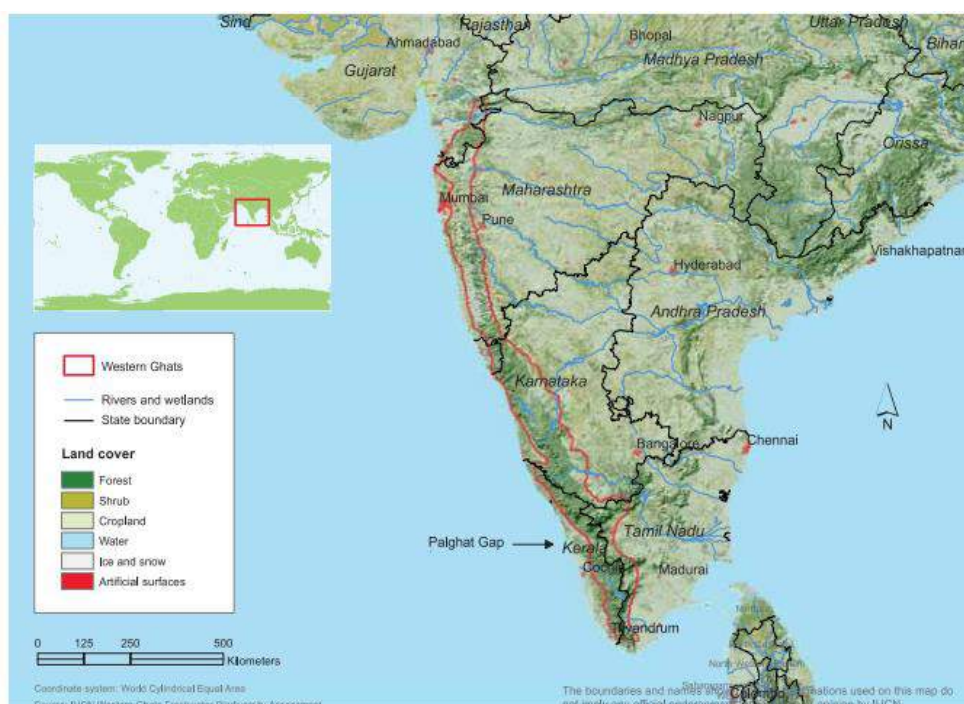


Figure 5. 5: Map showing the location of the Western Ghats and its key features
(Source: ICUN portal)

The Western Ghats is home to some of the world's most unique fauna, flora and fungi. Compared to the other hotspots, it has the highest human population per unit area (more than 300 humans/sq. km), making it that much more challenging to conserve (Molur 2009). The Western Ghats have also lost nearly 50 percent of forest cover since the early 1900s and the trend is continuing with increased fragmentation and encroachments (Figure 5.5). Additional threats include hunting in many parts, which has extirpated local populations of several species and groups of terrestrial and freshwater fauna.

¹⁰⁷The status and distribution of freshwater biodiversity in the Western Ghats, India- S.Molur, K.G.Smith, B.A.Daniel and W.R.T Darwall (Compilers)

Below is the analysis of the riverine regions of the Western Ghats by Subramanian (2010)

Regions	Number*	Protected Areas
Dhule-Tapi	S5	2
Nashik-Mumbai-Pune	S5	6
Koyna Valley- Sawanthawadi	R5	3
Aghanashini Valley Terekhol Valley	S6	7
Sharavathy Valley-Pushpagir	R7	7
Kodagu Wayanad-Nilgiri	R4	10
Anamalai-Periyar	R7	12
Agasthyamalai	R4	4

*The total number of streams of rivers in the region or valley (S/R followed by the count) S: Streams and R: Rivers

Table 5. 7: Below is the analysis of the riverine regions of the Western Ghats
(Source: Subramanian (2010))

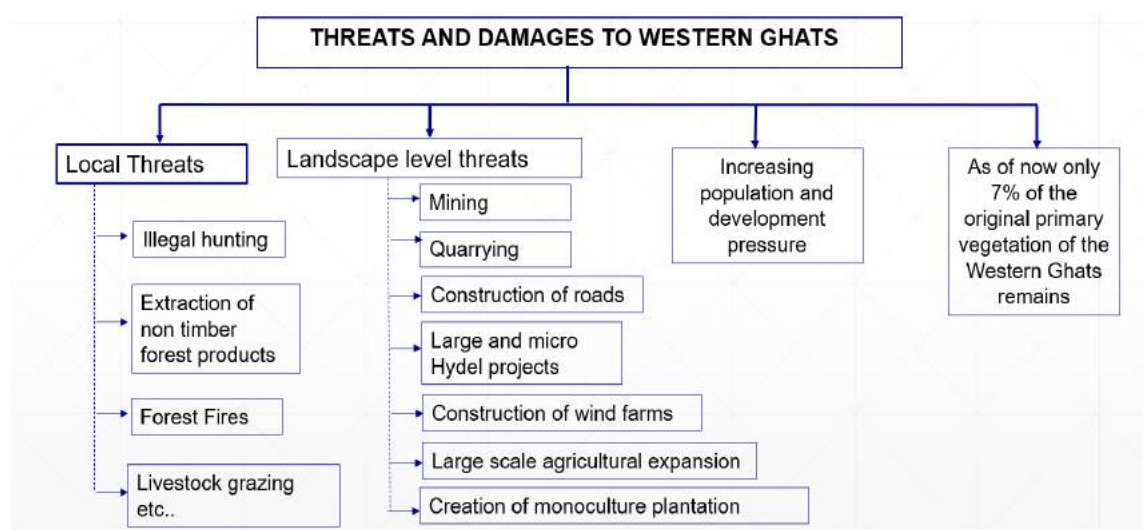


Figure 5. 6: Threats to Western Ghats

The protected areas within the Western Ghats are established for conservation of forestry produce, water harvest areas and occasionally for terrestrial plants and mammals. The number of the protected areas decreases with the rivers flowing eastward. However, there is no exclusivity in the protected areas created for freshwater biodiversity needless a dam or reservoir (drinking water, irrigation or power generation). The Western Ghats directly supplies approximately 120 million people with drinking water, irrigation and hydro-powered electricity, while the extended part of the assessment region spreading across peninsular India supports approximately 400 million people in seven states (Census 2011). The world's heaviest

population densities are managed by Krishna, Godavari and Cauvery river systems providing power, livelihoods, drinking water, transport and jobs.

The largest rivers in the Western Ghats region are the Godavari (1,500 km long, 340,000 sq. km catchment area), Krishna (1,300 km, 260,000 sq. km) and Cauvery (750 km, 72,000 sq. km). The Godavari River supports extensive cultivation in the states as it flows through Maharashtra and Andhra Pradesh. The Krishna River rises in Maharashtra and flows into the Bay of Bengal joining other major rivers namely, Bhima, Koyna, Tunga, Bhadra, Ghattaprabha and Mallaprabha which also originate in the Western Ghats. It provides irrigation to nearly 10 percent of cropland in India and covers the three states of Maharashtra, Karnataka and Andhra Pradesh. The Cauvery River arising in Kodagu District of Karnataka State flows through Tamil Nadu before joining the Bay of Bengal. The only westerly flowing river, the river Tapi, which forms the northern limit of the Western Ghats, originates in the Satpura range in Madhya Pradesh and flows into the Arabian Sea. It has a total length of about 725 km covering an area of approximately 65,000 sq. km. Many other rivers originating in Western Ghats equally play important role in supporting people's livelihoods

The Western Ghats also supports some unique freshwater biomes that are highly restricted, fragmented and unique that provide homes to a variety of species of plants and amphibians endemic to those habitats. A few examples of such areas are the *Myristica* swamps in Kerala and Karnataka, the laterite rock pool habitats in Maharashtra, Karnataka and Kerala, and the peat bogs in Karnataka.

Currently, 290 species of the freshwater fish have been identified which is under representation of the true freshwater fish diversity in this area. This could be due to lack of detailed taxonomic reviews which could lead to misidentifying species checklists or the carryover of the mistakes of the previous workers resulting in an unending confusion (Raghavan 2011). For a better understanding of the fish species richness, resolution of the taxonomic problems in the recognized species would be key as descriptions of new species from less explored areas would occur. Incorrect identification has undermined approximations of the true species richness in the Western Ghats. For example, until recently *Mystus seengtee*, a species endemic to the Western Ghats assessment region, was synonymized with the gangetic species *M. cavasius* (Chakrabarty and Ng 2005). Similarly, *Channa diplogramma*, a valid species restricted to the southern Western Ghats, was treated as a synonym of a widespread species *C. micropeltes* (Benziger et al. 2011). An additional problem with taxonomy is the presence of species complexes. Several related potential 'species' found in the Western Ghats are currently recognized as the same species. Recent revisions of the *Puntius filamentosus* group (Pethiyagoda and Kottelat 2005, Devi et al. 2010, Knight et al. 2011) suggest that there is a need for detailed taxonomic revisions of species in this area.

5.6.1 Conservation Status of Western Ghats

Analysis of the conservation status of freshwater fishes in the Western Ghats finds that the endemic species are far more threatened than the non-endemics. Of the species for which sufficient data are available, 37 percent are threatened (assessed critically Endangered, Endangered or Vulnerable), and 2 percent are Near Threatened. Of the 97 species which are threatened, only one species, *Tor khudree* (EN) is not endemic to the Western Ghats assessment region.

Five percent of the fish species in the Western Ghats assessment region are assessed as Critically Endangered, the highest level of threat that can be assigned to a species in the wild. All these species are endemic to the study area.

Species	Red List category	Reason
Hypselobarbus pulchellus, Mesonoemacheilus herrei Psilorhynchus tenura	Critically Endangered	Highly restricted geographical distributions; Habitat threat
Barbodes wynaadensis	Critically Endangered	Drastic declining population
Hemibagrus punctatus		
Parapsilorhynchus prateri	Critically Endangered	Restricted geographical distributions; Habitat threat; No recent collections
Barbodes bovanicus		
Tor khudree	Endangered	high levels of exploitation as a food fish
Labeo potail,	Endangered	Severe decline in population
Pterocryptis wynaadensis Schismatorhynchus nukta		

Table 5. 8: Fish species in the Western Ghats and their red list status

Global Red List Category	Number of fish species		
	Endemic	Non-endemic	Total
Extinct (EX)	0	0	0
Extinct in the Wild (EW)	0	0	0
Critically Endangered (CR)	12	0	12
Endangered (EN)	53	1	54
Vulnerable (VU)	31	0	31
Near Threatened (NT)	3	3	6
Least concern (LC)	66	95	161
Data Deficient (DD)	24	2	26
Total species	189	101	290

*The highlighted rows (CR, EN and VU) are the 'threatened' categories.

Table 5. 9: Number of fishes in the Western Ghats in the IUCN Red list category

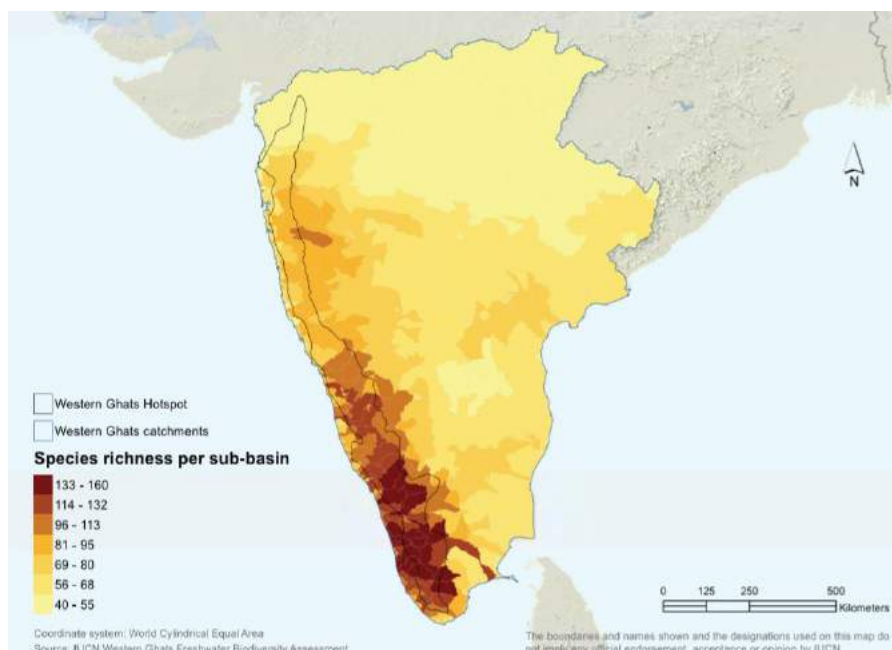


Figure 5. 7: Total species richness in the Western Ghats assessment region

5.6.2 Freshwater mollusks of Western Ghats

A total of 77 species of freshwater mollusks identified in the Western Ghats Hotspot assessment region includes 52 species of gastropods and 25 species of bivalves. Of existing species for which sufficient data is available, 7 species are assessed as threatened.

Cremnochonchus syhadrensis, *C. carinatus*, *Arcidopsis fotei* and *Pseudomulleria dalyi* are assessed as endangered. *Cremnochonchus conicus*, *Parreysia khadakwaslaensis* and *Scaphula nagarjunai* are assessed as vulnerable. *Cremnochonchus syhadrensis*, *C. conicus* and *C. carinatus* belong to the family *Littorinidae* (periwinkles), the only freshwater genus. They are adapted to the spray zone of perennial waterfalls in Karnataka and Maharashtra region of the Western Ghats.

The Western Ghats is the origin for 37 west flowing and three large east flowing rivers with numerous tributaries (Srikantha et al. 2007). The rivers originating in the Western Ghats and their tributaries are increasingly vulnerable due to a wide variety of anthropogenic activities. The major threats to Western Ghats mollusks have been identified as agricultural and urban water pollution, over harvesting, dams, urban development and mining.

5.6.3 Summary of the Gadgil Commission

Gadgil Commission is an environmental research commission is named after its chairman Madhav Gadgil. The commission is formally known as Western Ghats Ecology Expert Panel (WGEEP). The commission submitted the report to the Government of India on 31 August 2011 that stated:¹⁰⁸

1. The WGEEP designated the entire hill range as an Ecologically Sensitive Area (ESA).
2. The panel, in its report, has recommended 64 percent of the western area be declared as an Ecologically Sensitive Area (ESA). And the 142 taluks have been classified in the Western Ghats boundary into three Ecologically Sensitive Zones (ESZ) namely:

¹⁰⁸<https://www.clearias.com/gadgil-report-kasturirangan-report-western-ghats/>

ESZ-1 (highest sensitive zone), ESZ-2 (mid sensitive zones) and ESA-3 (moderate sensitive zone).

3. ESZ-1 and ESZ-2 were considered as high priority areas and considered largely as 'no-go zones' wherein almost all developmental activities (mining, thermal power plants, new railway lines etc.) were restricted. Additionally, ESZ-1 debarred building of new dams based on large-scale storage.
4. The report has recommended stricter regulation on tourism, phasing out plastics and chemical fertilizers, a ban on diversion of forest into non-forest applications and a ban on conversion of public lands into private lands. The report states that the system of governance should be a bottom-to-top approach.
5. The commission recommended constitution of a Western Ghats Ecology Authority (WGEA), as a statutory authority under the Ministry of Environment and Forests, with the powers under Section 3 of the Environment (Protection) Act, 1986.

5.6.4 Summary of the Kasturirangan commission

1. The report distinguished the estimated 1, 64,280 sq. km of Western Ghats area between cultural (58 percent occupied in the Western Ghats -by human settlements, agricultural fields and plantations) and the remaining as natural landscape (42 percent) (90 percent of it should come under ESA according to the committee). The ESA was lowered from the 64 percent (Gadgil Commission) to 37 percent by the Kasturirangan commission.
2. This report calls forth a complete ban on mining, quarrying and sand mining in ESA. Current mining areas in the ESA should be phased out within the next five years, or at the time of expiry of mining lease, whichever is earlier.
3. No thermal power be allowed and hydropower projects are allowed only after detailed study. Highly polluting industries will be banned.
4. The Kasturirangan report on the Western Ghats has made several pro-farmer recommendations, including the exclusion of inhabited regions and plantations from the purview of ecologically sensitive areas (ESAs).

5.6.5 Conservation action and Recommendations for Western Ghats

1. Promote fish sanctuaries in areas of Western Ghats providing fish species protection
2. Notify Coastal & Marine areas of biodiversity importance (e.g., key fish breeding sites, migratory routes, etc.) as Biodiversity Heritage Sites (BHSs) as per the Biodiversity Act, 2002
3. Ensure dams are well managed during constructing new hydroelectric power projects to protect riverine ecosystems and their endemic and threatened biota
4. Construction of large dams should carry out an assessment to identify species at risk to such developments, undertake a full and comprehensive environmental impact assessment, and follow the framework set out in the World Commission on Dams report (World Commission on Dams 2000).
5. Appoint appropriate agencies/Institutes in the country with adequate expertise to suggest the most suitable, location-specific fish passes (fish ladders, fish locks, fish

lifts, diversion channels and so on) keeping in mind the swimming and migratory habits of target species, hydrodynamics and the nature of hydraulic structures to meet the requirements of the dams/barrages. This component must be included in Draft Project Proposal (DPP) of dam projects.

6. Take measures to control sand mining and encourage alternatives to river sand for construction purposes. Strictly enforce the “Sustainable River sand/boulder mining management guidelines, 2016”, published by the MoEF&CC, to ensure environmentally sustainable mining.
7. Carry out an integrated environmental assessment; a management and monitoring program for the sand extraction processes; physical, chemical and biological studies on the impacts of instream mining on a river basin scale etc.
8. Initiate a combination of strategies such as improved enforcement of pollution laws; best management practices for crop and livestock production, use of robust effluent treatment plants by industries etc. to prevent pollution in Western Ghats. Formulate a national/state level policy on the introduction of exotic species and their management. Formulate guidelines for hobbyists and ornamental fish keepers about holding and disposal of stock to avoid these species from reaching natural water bodies. Detailed investigations on the spread and impact of invasive species in the drainages of the Western Ghats are urgently needed as at least 300 exotic aquarium species are imported and traded in India, without any regulation.
9. Ensure to follow the provisions contained in the BD Act, 2002 when developing pharmaceutical products based on available seaweeds and sea grasses and aquatic animals and other life forms. This entails that research institutions/companies who access the country's biological resources from the EEZ for research/commercial utilization/bio-survey/bio utilization purposes should seek prior approval of the National Biodiversity Authority/ SB.
10. Set up community and conservation reserves outside the existing terrestrial protected area network in the Western Ghats to act as refugia or closed areas for fishing to reduce biodiversity loss and protect individual or multiple threatened species.
11. Carry out risk assessment studies for ‘sleeper species’, species that are yet to demonstrate their invasive capacity, but are deemed to have the potential to spread and have adverse impacts.
12. Amend India's Wildlife (Protection) Act (WPA), 1972 (with amendments in 2002), to include protection of smaller and less charismatic taxa including freshwater fishes.
13. Set up Live gene banks to hold live animals or cryopreserved gametes, and contribute to conservation of threatened species by captive breeding and restocking in species specific recovery programs. E.g.: Live Gene Banking (LGB) of Fishes of the Western Ghats by NBFGR.
14. Use Flagship species as a marketing strategy to create awareness and build public participation in conservation actions. For E.g.: The concept of ‘state fish’ was mooted by the National Bureau of Fish Genetic Resources, which 16 states have subsequently adopted.
15. Promote education and community engagement for conservation of freshwater fish resources, especially endemic species by means of stewardship and knowledge

building. An integrated approach of awareness, capacity building, and monitoring and policy interventions is the key to conserving the freshwater fishes of Western Ghats.

16. Initiate mapping of indigenous fish species, their habitats and production trends and document the available inland aquatic bio-resources through People's Biodiversity Registers (PBRs) and electronics database.
17. Promoting the regeneration of riparian vegetation along the river basins of the Western Ghats by planting of indigenous tree species along the river margins can protect and stabilize the river margins. Strict laws need to be developed and implemented to curb tree felling and deforestation in the Western Ghats ecoregion along with other social forestry and afforestation programs.
18. Carry out in-depth studies on the life history traits, population and ecology of the biodiversity of fishes in the Western Ghats and outline action plans to conserve these species.

5.7 Conservation and Protection of Endangered Species

Whales, turtles, sharks, dolphins are some of the species that are in great danger due to anthropogenic activities such as plastic pollution, loss of habitat and prey, climate change, collisions with the ships, overfishing and even noise pollution. Many researchers and environmental activists have been raising their voices to protect these species and their habitat over the past several decades.

The following are the highlights of some of these endangered species, their occurrences in the state of Karnataka and conservation actions that need to be taken in order to protect and conserve them.

5.7.1 Turtles

Sea turtles have many recognized roles and are an integral part of the interspecific interactions in marine ecosystems as prey, consumer, competitor, and host. Sea turtles are an important part of the planet's food web and play a vital role in maintaining the health of the world's oceans. All the five species of sea turtles occurring in India, including the Olive Ridley turtles, are legally protected under Schedule I of the Wildlife Protection Act, 1972 and Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES Convention) which prohibits trade in turtle products.

Karnataka, has just one species of sea turtle i.e., the olive ridley turtle visiting its beaches to nest. There are occasional reports of green, hawksbill and leatherback turtles in the offshore waters, sometimes in fisheries bycatch. Their peak nesting season is said to be between September and May every year. Female turtles come ashore on sandy beaches where they were born, dig a nest and bury their eggs in it. However, the success rate of the hatchlings is found to be very low. Out of 1500 eggs laid, some 1200 baby turtles are hatched, with only 250 of them finally surviving. After hatching, the turtles find their way back to the sea. Although the density of nests is low and disturbance along the coast is high, the undisturbed sites where nesting occurs are considered significant (Sharath, 2002).

Both religious sentiments and awareness of the Indian Wildlife (Protection) Act, 1972 prevents the killing of adult sea turtles. Despite laws prohibiting the take of these turtle eggs, clandestine sea turtle egg trade is believed to be carried out. Two studies conducted to survey the coast for sea turtles, separated by nearly two decades, show that nesting densities have drastically reduced whereas egg-sales have increased, since the 1980s. Predation by

domestic and feral dogs & consumption of turtle eggs by coastal-dwellers are major threats to the Olive Ridley population on this coast.

Sea erosion along the coast of Karnataka has resulted in the loss of valuable beaches which is important for marine turtle nesting. Interviews of fishermen to ascertain the reasons for decline in turtle nesting was conducted during 2013 in 28 beaches of coastal Karnataka¹⁰⁹. In Dakshina Kannada district, fishermen responded that sea erosion, seawall construction as well as lighting, human activities and litter in the beaches were ranked as important reasons for loss of turtle nesting. In Udupi district, sea erosion, construction of seawalls and fishing mortality were the reasons ranked first in equal number of beaches. In Uttara Kannada district, lighting, human activities and litter in the beaches was ranked in three beaches while fishing related mortality was ranked in two beaches.

Trasi beach in Udupi is predominantly sandy with sand dune plants *Ipomoea pes-caprae* on the beach and a favourable site for turtle nesting. Yet during the rough monsoon season the beach is eroded. Climate change can also bring about increased wave action on beaches and result in loss of beach width. From 2005, a turtle hatchery was operational and regular awareness programmes used to be conducted in this beach but of late this has been discontinued. Uttara Kannada district has beaches of tourist interest as well as fishing activities. With the electrification of the beaches, the time spent by tourists and visitors to the beaches have also increased. This in turn has resulted in more litter on beaches. Turtles that come for nesting can also get entangled in the damaged fishing nets left on the beach. Marine litter on the beach, illumination of beach front and fishery linked mortality are some of the threats perceived to turtle nesting along Karnataka coast.

Despite being heavily impacted by seawalls, coastal roads, ports and industries, and dense human settlements, the Karnataka coast still harbors important sea turtle nesting sites wherever sandy, undisturbed nesting beaches occur. Presently, Turtle nesting grounds are found only in Uttara Kannada district covering a total area of 0.72 sq. km and along nine sandy beaches as tabulated in Table 5.10

Sl. No.	District	Taluk	Location
Turtle Nesting Grounds			
1	Uttara Kannada	Honnagara	Manki Beach
2		Honnagara	Kasarkod Beach
3		Honnagara	Saraswati Beach
4		Kumta	Alvedande Beach
5		Ankola	Manjaguni Beach
6		Ankola	Belekeri Beach
7		Karwar	Devbagh Beach
8		Bhatkal	Ternamakki Beach
9		Bhatkal	Bailur Beach

Table 5. 10: Distribution of Turtle nesting ground in the Karnataka state

¹⁰⁹Mar. Fish. Infor. Serv., T & E Ser., No. 222, 2014

With increase in awareness on turtle conservation, incidents have been recorded where fishermen have willingly damaged their nets and released the turtles trapped accidentally while fishing.

Another example is the Kharvis of Apsarakonda in Uttara Kannada, who have banned all activities found dangerous to sea turtles with a community court penalizing anyone found in the possession of a turtle or its eggs. Such practices can go a long way in encouraging community stewardship towards better management of turtle conservation.

At locations in Honnavar and Kundapura areas, NGOs such as FSL India and Canara Green Academy are aiming to protect turtle eggs from consumption and conducting awareness campaigns within coastal communities. They also assist fishermen communities in protection of key turtle nesting habitats.

The conservation recommendations for Turtles are as follows:

1. Launch frequent surveys to keep a tab on turtle population and nesting habitats jointly with local communities and maintain a database. Develop a mechanism by which these nests can be saved from predation and carry out a nest protection program
2. Ecotourism may be considered for active community participation to support long term conservation of turtles -Train local communities to become local tourist guides and guide turtle walks. For example, adopting unique methods such as involving poachers in conservation by turning them into informants, giving them honorariums for their services will help avoid purchase of eggs and reduce its consumption by local communities.
3. The hatchery programs operated earlier by the Karnataka Forest Department may need to be re-established with active community participation. Shifting eggs from their initial location will alter the natural sex-ratio and success rate of incubation. Hence, protecting the eggs in situ for two weeks after deposition and then relocating would help embryonic development of eggs as well avoid egg poaching
4. Initiate education and awareness programs on turtle conservation for coastal communities, local school teachers, nature clubs in schools and colleges.
5. Carry out tagging of turtles to create a database on various aspects such as their biology, population size, migration, nesting females, time interval between nesting and nesting sites.
6. Initiate co-management and integration of the activities by state government departments such as local panchayat, port Authorities, CRZ authorities and the forest officials for effective conservation of sea turtles as presently most of them are working in isolation.
7. Revive turtle nesting areas that have disappeared on account of erosion and anthropogenic activities along the Karnataka coast especially in Mangaluru, Mukka, Apsarakonda, Dhareshwar region following the manual on best practices for safeguarding sea turtle nesting beaches. Avoid sea walls along coasts that are important turtle nesting habitats and implement soft solutions such as dune building and plantation for managing eroding coasts.
8. Regulate commercialization of beaches that are important habitats for turtle nesting.

5.7.2 Dolphins

Dolphins play an important role in keeping the ocean environment in balance. Dolphins are top-level predators in the ocean food chain and they act as bioindicators to find out if something is wrong with the ocean environment. When dolphins are found with a disease, such as immune system dysfunction, reproductive malformations or cancer, this shows us that something needs to be addressed, such as water pollution from agricultural, residential and industrial runoff. Dolphins often prey on ill or old fish. By eating these fish, the dolphins rid the water of these sick fish, helping to cut down on infectious disease among fish populations and keep infected fish off the dinner table.

Below are the details of the dolphin species found on the Karnataka coast. The status of these dolphins under the IUCN category is also listed in Table 5.11 below.

Scientific name	Common name	IUCN Red list status
Dolphins		
Sousa chinensis	Indo-pacific Humpback	DD-Data Deficient
		VU- Vulnerable
Stenella longirostris	Spinner dolphin	LR/cd-Lower Risk (conservation dependent)

Table 5. 11: Details of the Dolphin species in Karnataka with their IUCN category

There have been instances where dolphin carcasses of these species have been found washed along the beaches off Karnataka coast or they have got entangled in the fishing gear causing mortality.

Karnataka Forest Department who are responsible for protecting and conserving these mammals have drawn up conservation plans. Increased awareness to fishermen and coastal communities needs to be ramped up to further co-management efforts in conservation of Dolphins. Some of the specific measures that can be adopted for conservation and protection of Dolphins are as follows:

1. In line with the nation's Dolphin project for the conservation and protection of the Dolphins in the rivers and in oceans of the country, scientific conservation methods along with existing stakeholders need to be taken up. Conduct an initial baseline survey of the species along each district followed by identification and selection of dolphin congregation areas, where monitoring could be carried out annually. The state forest Department along with NGOs should actively take part in conservation and protection of Dolphins
2. Intensify conservation efforts by reducing the flow of plastic to the oceans, minimizing pollution load and ALDFG, establishing monitoring network, population estimation, habitat conservation for dolphin hot spots, strengthening marine stranding network and developing livelihood by building eco-tourism projects around conservation of the species
3. Carry out studies on habitat of dolphins and their migratory routes
4. Fishermen should be educated about the importance of dolphins, their significant role in the balance of the ecosystems. Strictly enforce usage of by-catch reduction devices

(BRD's) and high efficiency fishing practices to reduce non-targeted catch of endangered fish species

5. Incentivize protection efforts by fishermen to make co-management efforts attractive.

5.7.3 Whales and Sharks

Whales

Whales roam throughout all of the world's oceans, communicating through complex and mysterious sounds. Whales are at the top of the food chain and have an important role in the overall health of the marine environment. Whales play a significant role in capturing carbon from the atmosphere; each great whale sequesters an estimated 33 MT of CO₂ on average, thus playing their part in the fight against climate change.

Despite living in the water, whales breathe air and like humans, they are warm-blooded mammals who nurse their young. Unfortunately, their large size and mythical aura does not protect them; six out of the 13 great whale species are classified as endangered or vulnerable, even after decades of protection. An estimated minimum of 300,000 whales and dolphins are killed each year due to pollution, loss of food sources, loss of habitat, climate change, toxic substances, being entangled in or ingesting plastic, net entanglement, oil-slicked areas, trapped as incidental by-catch of the fishing industry and ship strikes. The commercial whaling era has killed millions of whales and made them into lamp oil, lubricants, cosmetics, and meals. Moreover, shipping activity and oil and gas development cause noise that can disrupt whale communication or even damage whales' hearing. Such disturbance can exclude whales from critical feeding and breeding grounds and disrupt their migratory paths.

The blue whale can reach lengths of more than 100 feet and weigh up to 200 MT (as much as 33 elephants). They were hunted almost to the point of extinction until the International Whaling Commission banned all blue whale hunting in 1966. Currently, the blue whale is classified as an endangered species under the IUCN's Red List.

Many non-profit organizations around the world and in India are working towards protecting whales such as World Wildlife Fund (WWF), Save the Whales, Wildlife Trust of India (WTI) etc. The Indian Ministry of Environment, Forests and Climate Change has listed the Arabian Sea Humpback Whales as a priority endangered species for recovery has endorsed a concerted action under the Convention on Migratory Species, supported the proposal for a Conservation Management Plan under the International Whaling Commission, and has provided funding to the Karnataka State Forest Department for an Arabian Sea Humpback whale research and recovery program. There has been new evidence for movement of Arabian Sea humpback whales between Oman and India. Trans-Arabian-Sea movement was first documented in November 2017 when a female whale that was satellite tagged off the coast of Oman journeyed to the Southern tip of India and back to Oman again. On December 21st, 2019, scuba divers near Netrani Island encountered a humpback whale.

Literature review on whale strandings in Karnataka include six baleen whales that were stranded on the coasts of Uttara Kannada district. The earliest ones were at Nadibag, near Ankola on 16th April 1987 and another at Hollangadde 7 km south of Kumta on 29th April 1987. Another stranding of baleen whales was recorded on 29th September 1996 at Harikantrawada, Keni of Ankola Taluk. However, in a rare phenomenon, three instances of stranding baleen whales were observed along the coast of Uttara Kannada district of Karnataka during July and August 2016 in decayed condition. The first whale was washed ashore on 20th July 2016 at Ramangindi, Dhareshwar, 12 km south of Kumta; the second whale was washed ashore on 27.7.2016 at Hollangadde 7 km from Kumta; third, identified as

a baleen whale (*Balaenoptera* sp.) washed ashore on 13th August 2016 at Pavinkurvatari bagilu 7 km from Honnavar¹¹⁰.

The ICAR-CMFRI has been monitoring mammals stranding along the Indian Coast for the last 25 years. A 10-ft long whale, identified as a False Killer Whale (*Pseudorca crassidens*) was washed ashore on February 4th 2021 at Mogaveerapatna in Ullal, off Mangaluru.

Sharks

Sharks are apex predators in marine ecosystems, playing a critical role in maintaining biodiversity and keeping the ecosystem functioning. India is one of the major shark fishing nations of the world, contributing to about 9% of the global catch of sharks during 2000-2009 with an average annual production of 54,614 MT. Sustainable shark fishing was practiced in India by artisanal fishermen before the introduction of mechanized fishing, which led to sharks being landed as by-catch. Later, in the 1990s, targeted shark fishing began when the demand for sharks increased in international markets. Although there was an increase in shark catches initially there has been a consistent decline in the last one decade which has raised serious concern on this resource.

In 2001, India joined other nations in conserving sharks by protecting ten species under Schedule I of the Indian Wildlife (Protection) Act, 1972. India is also a signatory party to the recent CITES Appendix II listing of 5 species of sharks (of which 4 species are commonly found in Indian waters) and 2 species of manta rays, thereby initiating regulation of fin and gill plate trade in these species. Shark finning and export/import of shark fins are also prohibited in India. However, strategies to avoid protected or trade-regulated species from capture in directed as well as multispecies fisheries do not exist.

CMFRI, has formulated a Guidance on National Plan of Action for sharks (NPOA-Sharks) in India in line with the International Plan of Action for conservation and management of sharks (IPOA-Sharks) developed by FAO. Development and implementation of the NPOA-Sharks calls for integrated research and discussion between R&D organizations, Government agencies, NGO's and stakeholders including fishermen, traders and exporters. This document presents an overview of the shark fishery in India, current management measures, knowledge gaps to be addressed and suggested action plan for shark fishery management.

One of the important shark species that has gained conservation importance is the Whale Shark (*Rhiodon typus*). It is the largest fish known, attaining a maximum of 14 m in total length and weighing 8–10 MT. Whale sharks grow slowly, mature late, produce a few offspring and live long. These features make them extremely vulnerable to overfishing. Whale sharks are an “endangered” species under the IUCN Red List of Threatened Species.

The occurrence of whale sharks in India and elsewhere in the world was considered a rarity until recently, as most of the publications on the whale shark were restricted to its stranding and incidental catch. Between 1889 and 1998, only 12 Whale sharks have been stranded/landed along the entire length of the Karnataka coast.

Incidences of beaching of whales along Karnataka coast have been reported in 2015; however, the exact reasons are not clear. Pollution of coastal waters could be one of the reasons for the diversion of whales and dolphins from their migratory routes. One such species of Whale Shark is the *Rhincodon typus*, the largest fish known, attaining a maximum of 14 m in total length and weighing 8–10 MT. Whale sharks grow slowly, mature late, produce a few

¹¹⁰Mar. Fish. Infor. Serv., T & E Ser., No. 231, 2017

offspring and live long. These features make them extremely vulnerable to overfishing. Whale sharks are an “endangered” species under the IUCN Red List of Threatened Species.

College of Fisheries, Mangaluru had carried out a post mortem of a whale shark (*Rhincodon typus*) that was washed along the coast of Surathkal in July 2019. Based on the above observations it was concluded that the species which was starving due to lack of food had strayed from its migratory route and had deviated from deeper waters to shallow coastal waters of Karnataka. On account of prevailing monsoonal conditions along the Karnataka coast the animal must have got entangled in the rough sea conditions as it is a poor swimmer. The strong currents and wave actions must have pushed the tired starved fish towards the coast which is rocky in nature. The animal probably got hit by the boulders and rocky platform along the Surathkal beach which has led to profuse bleeding from the mouth and external injuries observed on the body.

In 2001, the whale sharks were included in Schedule I of the Wildlife (Protection) Act of India, 1972, rendering the capture and killing of the fish a cognizable offence. The Whale Shark also received international protection due to its inclusion in Appendix II of the Convention in International Trade in Endangered Species of Fauna and Flora (CITES). Despite the protection, whale shark landings were common on India's West coast, especially in Gujarat. In response to this trend, in 2005 the Wildlife Trust of India, launched the Whale Shark Conservation Programme in Gujarat in a bid to reduce the whale shark landings. The programme entailed raising awareness to fishermen, compensation for net breakage while releasing caught Whale Sharks etc. The programme was then extended to Maharashtra, Kerala and Lakshadweep. This programme has been highly successful and killing of whale sharks has reduced drastically. It is to be noted that the export of shark fins has been banned in India in 2015. In addition to the Whale Shark, Long Nosed Shark, Gangetic Shark and Speartooth Shark are included in Schedule I of the Wildlife (Protection) Act of India, 1972.

In November 2019, fishermen caught a whale shark off Murudeshwar coast. It is reported that the fishermen were unaware of the ban on fishing of whale sharks. In light of such incidents, it is prudent to raise awareness among the fishermen community on the fishes banned for fishing in India. Some of the recommendations for conservation of Whales and Sharks are as follows:

1. Introduce an immediate suspension on fishing of Sharks, Whales, Rays and Skates. Duration of the suspension to be fixed after detailed fish stock assessment studies
2. Conduct regular awareness programs among fishermen, chefs and consumers on ill effects of rampant fishing of sharks, their endangered/threatened status, their role in the ecosystem etc. to promote sustainable exploitation of sharks and their conservation.

Interventions are required both at consumer level to decrease demand for shark products and at the level of fishing communities to bring in sustainable fisheries and ecosystem-based management which would conserve critical marine mammals, including sharks.

3. Use of excluder devices and pingers to be made mandatory in trawl fisheries after detailed studies on developing efficient ones. Adequate training to be provided to fishermen on the effective use of excluder devices and pingers. Track efficiency of these devices and carry out continuous research on improving these devices to protect endangered/threatened marine mammals
4. Train and equip Coastal Security Police Force to regulate and minimize illegal fishing and over exploitation of endangered and threatened species. (Unauthorized foreign fishing vessels/poaching in Indian waters). Impose strict fines on unauthorized foreign

fishing vessels poaching in Indian waters and fishermen not using by-catch reduction devices

5. Organize public awareness campaigns, street plays on conservation of endangered marine mammals such as Sharks, Whales, Rays, Skates, Dugong, Bottlenose Dolphins, etc. in schools, colleges, coastal tourist areas, coastal communities etc.
6. Encourage fishermen to provide information on sighting threatened marine mammals
7. Improved monitoring and mitigation of bycatch in fishing gear
8. Adopt modern techniques to study the behavior and migration pattern of marine mammals in the seas to formulate and enhance suitable conservation strategies to protect the marine mammals.
8. Explore the possibilities of establishing whale shark tourism in India to incentivize coastal communities and contribute towards the conservation of marine wildlife and habitats¹¹¹.
9. Urge shipping companies, fishing fleets, and the Government to adopt new tools and best practices that can significantly reduce whale deaths and injury.
10. Document and work to protect critical feeding & breeding areas and migration routes of whales by shifting shipping lanes, and curtailing seismic surveys that disrupt feeding grounds.

5.7.4 Migratory Birds

Avian migration is a natural process, whereby different birds fly over distances of hundreds and thousands of km in order to find the best ecological conditions and habitats for feeding, breeding and raising their young. Birds migrate for many reasons that include the need to travel to areas where food resources are at their peak abundance, the climate is milder and there is less competition for safe nesting places. Migration may be either during the day or night. Larger birds generally migrate by day and smaller ones by night. Some species of birds prefer diurnal migration.

The Indian subcontinent plays host to a number of migratory birds in summers as well as winters and over a hundred species of migratory birds fly to India, either in search of feeding grounds or to escape the severe winter of their native habitat. In India and South Asia, out of over 2000 species and subspecies, about 350 are migrants.

Karnataka has several water bodies which attract several migratory bird species. Further, several migratory birds find their comfort in the existing bird sanctuaries which are managed to provide a happy home for them, and a blissful view to bird-watchers. Some of these bird sanctuaries lie by the banks of the river, some amidst dense forests while some on hills, each of which have their own unique calling for the birds. Among all, Ranganathittu Bird Sanctuary is the most famous as far as its vastness and miscellany is concerned. The following Table 5.11 provides a list of bird sanctuaries in the state, their location and some of the birds spotted therein.

¹¹¹<https://www.wti.org.in/projects/whale-shark-conservation-project/>

Sanctuary	Location	Birds
Ranganathittu Bird Sanctuary	Mandya	The Little Cormorant, Asian Open-Bill Stork, Painted Stork, and White Ibis and many more
Gudavi Bird Sanctuary	Shivamogga	White Ibis, Grey Heron, Night Heron, Jungle fowl, Pond Heron, Indian Shag, Bittern, and many more.
Attiveri Bird Sanctuary	Uttara Kannada	The Cattle Egrets, Little Cormorants, Black-headed Ibis, Pied Kingfishers, White-breasted Kingfishers, Indian grey Hornbills, Eurasian Spoonbills, and Barn Swallows
Bonal Bird Sanctuary	Yadgiri	Purple Herons, White-necked Storks, Black Ibis, White Ibis, Bar-headed Geese, and Brahminy Ducks.
Bankapura Peacock Sanctuary	Haveri	Peafowl, Woodpeckers, Babblers, Great-horned Owls, Magpies, Robins, Green Bee-eaters, Nightjars, Spotted Mainas, Paradise Flycatchers, Spotted Doves, Parakeets, Kingfishers, Grey Hornbills, Black-winged Kites, Tailor Birds, and Blue-tailed Bee-eaters
Ghataprabha Bird Sanctuary	Belagavi	Demoiselle Cranes, European White Storks and other migratory birds.
Dandeli Wildlife Sanctuary	Uttara Kannada	Great Indian Hornbill, Malabar Pied Hornbill, Black Rock Pigeon, Malabar Parakeet, Black-hooded Oriole and others
Magadi Bird Sanctuary	Gadag	Bar-headed Goose, Eurasian Spoonbills, Comb Ducks, Oriental Ibis and others
Mandagadde Bird Sanctuary	Shivamogga	Median Egrets, Little Cormorants, Darters, Snake-birds and many more.
Adichunchanagiri Peacock Sanctuary	Mandya	Peafowl, Yellow-throated Bulbul
Ramanagara Vulture Sanctuary	Ramnagar	Egyptian Vulture and Long-billed Vultures
Kokkare Bellur Pelicanry	Mandya	Spot-billed Pelicans and Painted Storks
Kaggaladu Bird Sanctuary	Tumakuru	Painted Storks
Puttenahalli WS Lake	Bengaluru	Darters, Painted Storks, Little Grebes, Purple Moorhens and others
Mookambika Wildlife Sanctuary	Udupi	Jungle Mynas, Peafowls, Great Indian hornbills, Brahminy Kites, Red-vented Bulbul, Purple Sunbirds, Golden Orioles, Scarlet Minivets and scores of others
Nallur Tamarind Grove	Bengaluru	Heron, Kite, Ret-Wattled Lapwing, Pigeons, Doves, Parakeets, Koel, Owls, Kingfishers, Hoopoe,

		Barbets, Larks and others
Hogarekhan Giri	Chikkamagaluru	Shola Vegetation and grasslands with a number of flora species
University of Agricultural Sciences	Bengaluru	13 species of mammals, 10 species of reptiles, 165 species of birds, 530 species of plants

Table 5. 12: List of bird sanctuaries in Karnataka

The Karnataka State Biodiversity Board (KBB), NIO and CMFRI (of Cochin) conducted a survey with the assistance of many marine institutes to catalogue the marine biodiversity of Netrani Island. KBB has proposed this area be declared a marine sanctuary to safeguard marine life from the Seabird Naval Base.

Several migratory bird species are facing the risk of extinction due to hunting, poaching, habitat damage, persecution and control¹¹². The following are the recommendations for conservation of migratory birds:

1. Restore degraded habitats of migratory birds such as wetlands, mudflats, estuaries to support birds on every step of their staggeringly long journeys. Protect these habitats from the pressures of land reclamation, pollution and other human disturbances
2. Encourage the sectors that have invested in coastal ecosystems, such as shell fisheries, aquaculture and salt extraction, to incorporate conservation objectives in their wetland management, and facilitate restoration of coastal wetlands
3. Consider the Soaring Bird Sensitivity Mapping Tool during project planning stage which shows areas where it might be inappropriate to locate wind farms and power lines
4. Raise awareness among tourists in bird sanctuaries, mangrove areas etc. on various species of birds and the need for conserving them and their critical habitats.
5. Embed conservation in school curriculums and create awareness among communities, schools, hunting organizations to champion zero tolerance of illegal poaching of migratory birds.

5.8 Important Coastal and Marine Biodiversity Areas (ICMBAs)

India has taken several steps to achieve the National Biodiversity Target No. 6 and Aichi Biodiversity Target No. 11 which aims to conserve a substantial portion of the coastal and marine areas in the country and the world. Towards achieving these two targets, the Wildlife Institute of India has carried out a 4-year long independent process covering 350 sites in the 13 coastal states and identified 106 coastal and marine sites to be prioritized as Important Coastal and Marine Areas (ICMBAs)¹¹³. Out of these, sixty-two ICMBAs have been identified along the west coast of India, and 44 have been identified along the east coast. Of these, 22 ICMBAs have been prioritized for immediate conservation actions and proposed to be upgraded as Protected Areas under categories such as Conservation or Communities Reserve to increase participation of the local communities in governance.

¹¹²Thirteenth meeting of the Conference of Parties (COP-13) to the Convention on the Conservation of migratory species (CMS) of wild animals, February 2020

¹¹³K. Saravanan, B.C. Chowdhury & K. Sivakumar (2013). Important coastal and marine biodiversity areas on East coast of India. In Sivakumar, K. (Ed.) Coastal and Marine Protected Areas in India: Challenges and Way Forward, ENVIS Bulletin: Wildlife & Protected Areas. Vol. 15 Wildlife Institute of India, Dehradun 248001, India. 292-298 pp.

The following sites in Karnataka were targeted and physically surveyed for identification of ICMBAs: Devgad, Kali, Tolnaka, Kantriwada, Gangavali, Madanagiri, Tadri, Nushikote, Burgi, Kumta, Devari, Honnavar, Kasarkod, Murudeshwar, Netrani Island, Bhatkal, Byndoor, Upunda, Yadamavina, Turtle Bay, Arati, Kollur, Jaladi, Rajadi, Haladi, Gangoli, Vittalavadi, Paripally, Kodikanyana, Seeta estuary, Upinikote, Madhirali, Swarna estuary, Malpe, Kaup, Shambaviri, Nandini, Surathkal, Kuloor, Panambur, Mangalore Port, Ullal, Someshwar, Uchilla

Out of the above sites, the following ten sites have been identified as ICMBAs.

Sl. No.	Identified Site	District	North	East	Area (sq. km)	Suggested Category
1	Kali Estuary	Uttara Kannada	14°51.206	74°06.712	25.3	CCR
2	Aghanasini	Uttara Kannada	14°50.521	74°08.503	46	CCR
3	Sharavati/ Honnavar	Uttara Kannada	14°16.581	74°27.958	13.6	CCR
4	Murudeshwar	Uttara Kannada	14°05.709	74°29.149	30	CCR
5	Netrani Island	Udupi	14°01.048	74°19.559	5	CnR
6	Kundapur/ Haladi	Udupi	13°38.865	74°42.317	16.7	CCR
7	Kodibengre/ Swarna-Sita	Udupi	13°23.334	74°44.704	15	CCR
8	Malpe	Udupi	13°21.624	74°41.874	38	CCR
9	Mulki-Pavanje	Dakshina Kannada	13°05.835	74°47.267	3.5	CCR
10	Gurpur-Netravati	Dakshina Kannada	12°51.254	74°50.058	13.8	CCR

CCR: Community or Conservation Reserve, CnR: Conservation Reserve

Table 5. 13: Important Coastal and Marine Biodiversity Areas in Karnataka

5.9 Climate Change adaptation by conserving marine biodiversity

Oceans are among the greatest victims of climate change; they are threatened by rising concentrations of CO₂, rising temperatures, falling oxygen causing rising acidity, all of which raise sea levels and increase the risks of flooding in coastal communities. These climate change pressures further impact ecosystems by drowning wetland habitats due to rising sea levels, bleaching coral reefs that may ultimately be lost if the planet warms by 2°C, proliferations of harmful algae, hypoxia or reduction in oxygen levels that suffocate marine animals and habitats, temperature rise which harms calcifying animals, and disruption of fisheries affecting local livelihoods and global food security (IPCC 2019).

Oceans are also the largest active carbon sink on Earth, with management of marine ecosystems offering great climate mitigation and adaptation opportunities (Duarte et al. 2013). Vegetated coastal habitats, such as mangroves, sea marshes, seagrass beds, and kelp forests provide climate adaptation and resilience to local communities (Duarte et al. 2013), especially in developing countries who depend largely on natural resources ecosystem services (Vignola et al. 2012), (Vignola, Locatelli, Martinez, & Imbach, 2012), as shown in Figure 5.2. Degradation of vegetated coastal habitats impairs their natural functions and ecological services. Rapid degradation of mangroves and coastal ecosystems that accumulate carbon in layers of sediment and biomass of plants can release large amounts of CO₂ into the atmosphere (Duarte et al. 2013; Kauffman et al. 2011.) Therefore, maintaining the health of our oceans and coastal ecosystems is not only important for our livelihoods and global food security but is also a cost-effective strategy for climate mitigation and adaptation co-benefits.

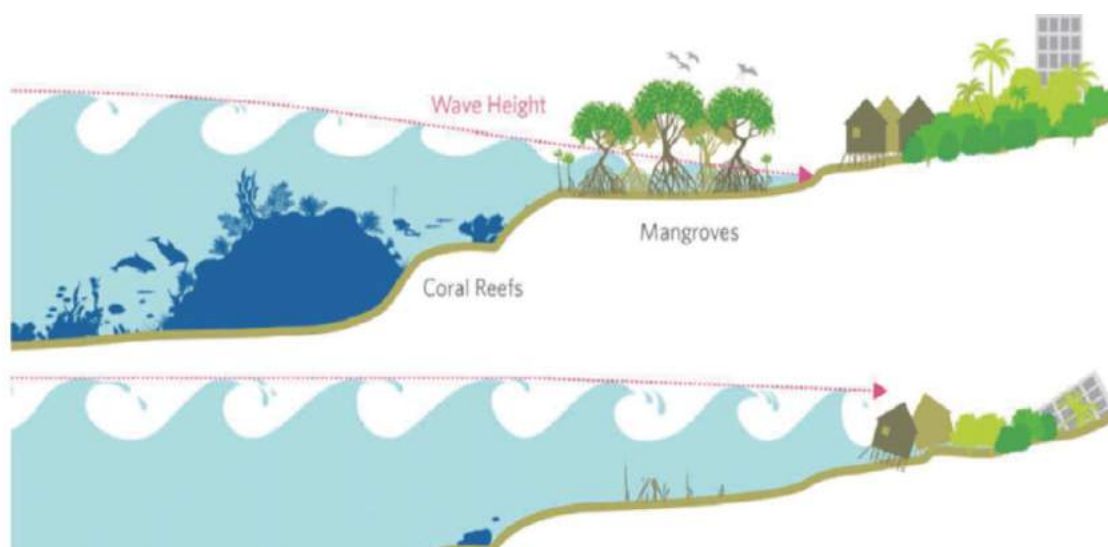


Figure 5. 8: Coastal Ecosystems mitigating risks

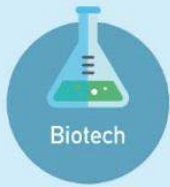
(Source: Losada et al. 2018)



Aquaculture



Tourism



Biotech



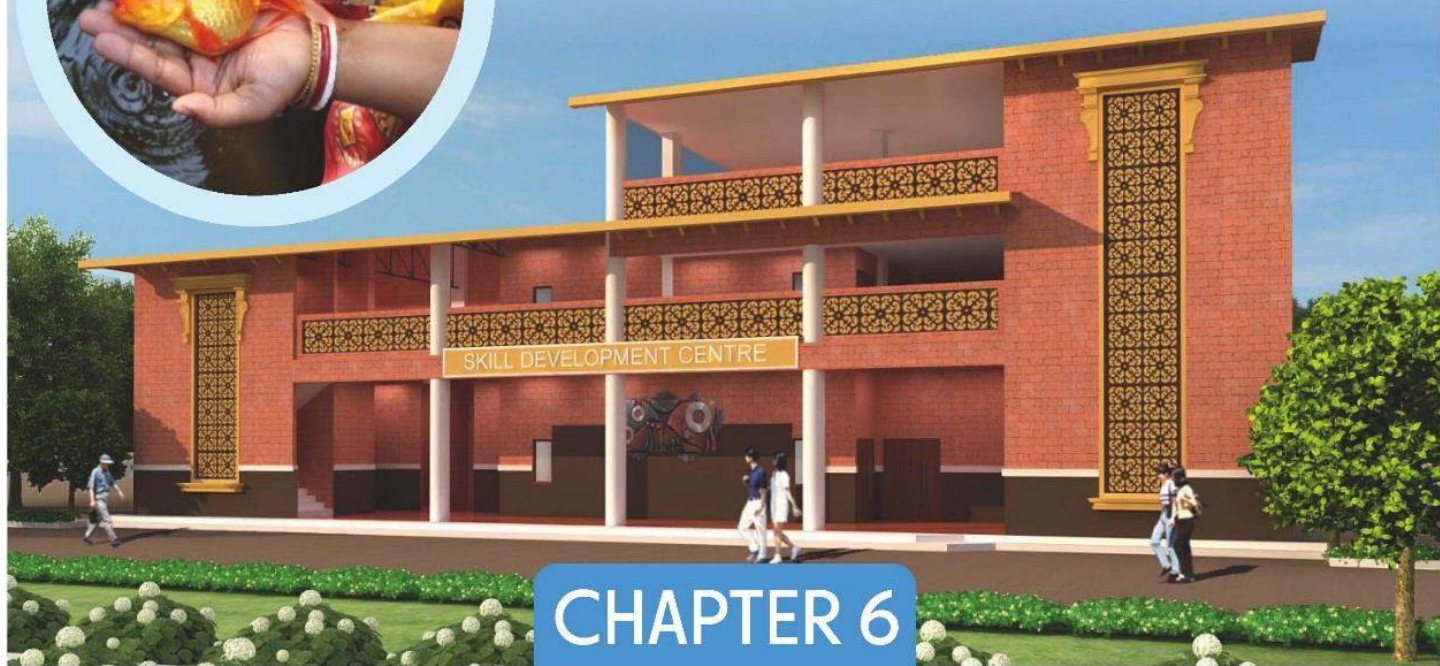
Fisheries



Spatial
Planning



Shipbuilding



CHAPTER 6

**Strategy for Augmentation of Institutional Capacity and
Human Resources Development in a Blue Economy Context**

Chapter 6: Strategy for Augmentation of Institutional Capacity and Human Resources Development in a Blue Economy Context

6.1 Introduction

The growth of the blue economy in Karnataka holds vast potential in terms of economic opportunities, employment generation and sustaining livelihoods. Karnataka's geographical advantages have given it economic gains from its established Blue Economy (BE) sectors such as fisheries and tourism. However, overexploitation and unsustainable management practices have placed undue pressure on these resources. Over the past few decades in the fisheries sector illegal, unregulated and unreported fishing has led to a significant decline in the main fish stocks, resulting in loss of livelihood and revenue for the majority of state's fisher folk. Due to unsustainable fleet expansion and subsidized loans, fishing pressure on marine resources has become a major concern along with challenges in the fishery export sector wherein meeting global quality standards have hindered the products to be less competitive in international markets. A lack of development in value-added products has also hindered the sector's growth.

In addition, the emerging sectors of blue economy like aquaculture, ocean-based energy and marine biotechnology also face various challenges like lack of skilled human capital, lack of entrepreneurial innovation and new venture creation. Studies show many blue economy entrepreneurs have cited bureaucracy, fear of failure, lack of networking and mentorship opportunities as major obstacles in innovative venture creation. Additionally, limited access and know-hows to tap into appropriate financing seem to have fueled a culture of imitative business models, with entrepreneurs preferring low-risk, go-to-market strategy and avoiding expensive disruptive innovation altogether.

The economic value of marine ecosystem services is mostly ignored in development policy and decision-making processes. Major innovations remain few and far between while depleting marine habitats, resources and conflicting stakeholder interests threaten the country's blue future development. In addition, adverse effects of global warming and climate change are posing a great threat to the sector. These include rising ocean temperatures, ocean acidification and rising sea levels, as well as changes to long term rainfall/weather patterns etc. leading to reduced fish populations, species loss and food-stock decline¹¹⁴. The potential impacts include tidal surges and flooding, impacts on coastal infrastructure and rise in the vulnerability of sectors such as tourism, fisheries, agriculture and marine/terrestrial biodiversity. Hence, there is dire need to adopt sustainable blue economy practices for long-term economic and social benefits from blue resources.

Sustainable blue economy is the one that ensures sustainable use of marine resources while promoting economic growth, preserving and improving the livelihood across the range of sectors in the blue economy. The pillars essential for transforming the traditional "Ocean and marine economy" to a "Blue" or "Sustainable" economy requires appropriate governance in the sustained utilization of the ocean, coastal and marine economies, vision, technology, management, monitoring and time-bound regulatory reforms¹¹⁵. Sustainable blue economy practices include adopting sustainable harvesting strategy while augmenting institutional capacity and human resource development. Institutional capacity development for integrated ocean governance is essential to achieve sustainable development of oceans and coasts including responses to address new challenges, climate change and biodiversity loss and provide sustainable ocean and coastal livelihoods. Sustainable ocean-based development and growth, sustainable management practices and effective institutional frameworks are

¹¹⁴<https://www.orfonline.org/research/the-blue-economy-charting-a-new-development-path-in-the-seychelles>

¹¹⁵Marine Geo-resources & Geotechnology <https://doi.org/10.1080/1064119X.2018.1501625>

urgently needed to face the mounting challenges. Funding is limited and there has been little collaboration and coordination of efforts among the many actors that assist in capacity development. While various international fora have mechanisms for financing, blue economy programs continue to be aimed at sector-specific projects that fail to integrate capacity building projects into long-term strategic development of institutions and capacity among high-level decision-makers and ocean leaders. Hence global collaboration for funding should be taken up. A strategy for ocean readiness, mobilizing expertise and partnerships, is to be developed to ensure that governments and institutions have the skills, knowledge, and capacity to develop blue economy frameworks, and to address challenges on oceans and coastal communities in a long-term, integrated manner. Thus, there is a need to support capacity projects that are forward-thinking, comprehensive, and integrated across sectors. The overarching issues could be addressed effectively through capacity development.

Capacity development for achieving integrated management of the oceans is crucial at three levels for: Individual, institutional, and societal. Individually there is a need to develop ocean policy expertise through human resource development programs. At an institutional level, institutional capacity development involves providing support from internal and external sources to advance the design, implementation, and evaluation of ocean and water resources legislation. It also includes the development of implementation strategies such as intergovernmental and cross-sectoral coordination mechanisms and conduct of targeted research and development projects related to water resources. At the societal level, capacity building involves the development of public awareness and empowerment to be able to take part in decision-making in ocean governance. The focus needs to be on developing the capacity of decision makers and managers to address challenges facing marine resources and coastal communities, and strengthening institutional structures for capacity development through sharing of best practices. In addition, long-term capacity building is to be supported through the introduction of effective governance, system knowledge, and strategic planning skills and frameworks. The combined focus at the individual and institutional level will ensure oceans remain on the top of the sustainable development agenda, and ensure effective long-term implementation.

The capacity development program in integrated ocean governance is to be aimed at enhancement or establishment of university-based programs in marine affairs and policy, including through the enhancement of regional centers of excellence, and a consortium of university programs. The country's blue agenda will require highly skilled and innovative professionals; hence emphasis should be placed on appropriately upskilling the next generation. The knowledge and skills gap within the marine and coastal sciences, the legal governance arrangements and other spheres will require not only the involvement of a swathe of disciplines but the collaboration of global education institutions, given that the country's own educational facilities are limited. Thus, a collaborative effort of policy makers, government, local communities, entrepreneurs, coastal population and the local public is vital to curb the issues occurring in the blue economy sector. To overcome the various socio-economic and environmental challenges that threaten to undermine the state's Blue Economy journey, Karnataka's Blue Economy must be driven forward by innovation, capacity building, and durable multi-sectoral collaboration for a sustainable ocean development road map. This rapid assessment of Blue Economy potential in Karnataka has focused on this sustainable ocean-based development pathway. The focus of this chapter is a strategy that will help develop the skills and networks along with building institutional capacity that are required for effective leadership, policy development, negotiation, stakeholder engagement, and communication to further sustainable blue economy growth.

6.2 Institutional Mechanism in Blue Economy Context

The need for protection and conservation of environment and sustainable use of natural resources is reflected in the constitutional framework of India and also in the international commitments of India. The Constitution under Part IVA (Art 51A-Fundamental Duties) casts a duty on every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife, and to have compassion for living creatures. Further, the Constitution of India under Part IV (Art 48A-Directive Principles of State Policies) stipulates that the State shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country.

Several environment protection legislations existed even before Independence of India. However, the true thrust for putting in force a well-developed framework came only after the UN Conference on the Human Environment (Stockholm, 1972). After the Stockholm Conference, the National Council for Environmental Policy and Planning was set up in 1972 within the Department of Science and Technology to establish a regulatory body to look after the environment-related issues. This Council later evolved into a full-fledged Ministry of Environment and Forests (MoEF).

MoEF was established in 1985, which today is the apex administrative body in the country for regulating and ensuring environmental protection and lays down the legal and regulatory framework for the same. Since the 1970s, a number of environmental legislations have been put in place. The MoEF and the Pollution Control Boards ("CPCB", i.e., Central Pollution Control Board and "SPCBs", i.e., State Pollution Control Boards) together form the regulatory and administrative core of the sector. The MoEF was renamed as the Ministry of Environment and Forests and Climate Change (MoEF&CC) in 2014.

India is signatory to various international conventions and has also passed several Acts and Rules in order to safeguard the Environment which are attached as Chapter 6 Annexure 1 and Chapter 6 Annexure 2 respectively.

India's coastal zone is endowed with fragile ecosystems including mangroves, coral reefs, estuaries, lagoons, and unique marine and terrestrial wildlife, which contribute in a significant manner to the national economy. Economic activities such as rapid urban-industrialization, maritime transport, marine fishing, tourism, coastal and seabed mining, offshore oil and natural gas production, aquaculture, and the recent setting up of special economic zones have led to a significant exploitation of these resources. In addition to the contribution of increased economic activity, coastal development and livelihoods are under stress due to a higher incidence of severe weather events, which have the potential to inflict irreversible damage to lives and property, for communities that are traditionally poor and vulnerable to economic shocks.

To manage and conserve, the marine and coastal ecosystems, development in coastal areas, eco-tourism, livelihood options and sustainable development of coastal communities, the Coastal Regulation Zone Notification 2019 has superseded the earlier ones of 1991 and 2011.

6.3 Institutional Capacity- Blue Economy Context

Due to the wide-ranging activities within the sphere of the Blue Economy, a diverse number of stakeholders were identified entailing several central and state level institutes, organizations and Government bodies that would form part of the institutional arrangement for implementation of the **Summary Outline Blue Economy Development Plan** for the state. The list of Stakeholder institutions is provided as Chapter 6 Annexure 3.

A very important aspect of institutional mapping is to look at 3F's i.e., Funds, Functions and Functionaries. It is therefore crucial to ensure adequate staffing, funding and capacity building in every department/institution related to the blue economy sectors along with robust transparency and accountability mechanisms. Moreover, the institutional capacities of these responsible institutions would need to be further enhanced and augmented for knowledge based interdisciplinary learnings along with cooperation amongst the various stakeholders to successfully enhance blue economy growth which is quite lacking. A Training Assessment Program (TAP) needs to be carried out for these institutions to identify specific skills gaps for implementation of the various recommendations outlined in the **Summary Outline Blue Economy Development Plan**. Tailor made training programs could then be introduced to address these gaps and enhance their overall skills and research capacities (scientific, economic and market intelligence research).

6.4 Conservation and Protection of Priority Ecological Resources in Marine, Coastal and Estuarine Areas

The world's aquatic ecosystems are structurally and functionally highly biodiverse, a vital web of thousands of interconnected species which support fisheries and aquaculture, contributing to the nutritional, economic, social, cultural and recreational betterment of human populations. Maintaining aquatic biodiversity is critical to meeting the objectives of three pillars of sustainability namely, environmental, social and economic. An erosion of aquatic biodiversity would not only affect the structure and functioning of ecosystems but also would affect the blue growth.

Biodiversity protection networks, such as Marine Protected Areas (MPAs), can restore biodiversity and ecosystem function (Edgar et al. 2014) and directly benefit wellbeing by providing ecosystem services like blue carbon (marine carbon capture) (Bax et al. 2019, 2020; Gogarty et al. 2019), coastal protection (BenDor 2015, Lau et al. 2019), as well as coastal livelihoods (McLeod et al. 2018; Sanderman et al. 2018). While such restoration activities are lagging behind in marine areas compared with land (Bayraktarov et al. 2015, France 2016, McLeod et al. 2018), examples do exist (see: Worthington and Spalding 2018; Valdez et al. 2020). Implementing such networks can provide some of the most straightforward means of helping restore and preserve ecosystems whilst protecting sustainable practices, livelihoods and cultures. However, resources are still required (e.g., enforcement) to realise the goals from such networks.

One of the responsibilities of the Coastal Security Police Force and the Indian Coast Guard is to protect the ecologically sensitive marine and coastal areas i.e., preservation and protection of maritime environment including prevention and control of marine pollution. However, lack of manpower, adequate capacity building and enforcement facilities hinders their effectiveness to carry out this mandate. Hence, adequate staffing and capacity building would drive strict enforcement of legislation to conserve and protect the marine, coastal and estuarine areas from environmental degradation.

Since, the challenges faced in conserving priority ecological resources in marine, coastal and estuarine are complex and multi-faceted, a highly skilled, professional and interdisciplinary workforce such as Marine scientists, Marine biologists, Fishery scientists, Geneticists, Botanists, GIS specialists, Environmental scientists, Nature conservationists, Marine spatial planners would be required to plan mitigation and conservation measures for marine, coastal and estuarine areas. Moreover, these professionals must be abreast with globally practiced modern tools and technological advances to implement effective management strategies for conservation and protection of priority ecological resources of the state. Serious efforts must be taken up in the state to augment demand and employ the services of such skilled professionals in conservation efforts along with robust skill development programs. For example, using remote sensing and GIS tools for annual

monitoring of mangroves in coastal and estuarine ecosystems would provide information on degraded mangrove ecosystems and aid in implementing appropriate mitigation measures for protection and rehabilitation.

6.4.1 Augmenting institutional capacity for conservation and protection of Priority Ecological Resources

The following are the recommendations for augmenting institutional capacity for conservation and protection of Priority Ecological Resources in Marine, Coastal and Estuarine Areas:

1. Build capacities of stakeholders involved in preparation of ecosystem-based Marine Spatial Plan (MSP) and Coastal Master Plan (CMP) for identification of critical areas needing special attention and those offering potential for development by international collaborations and also collaboration with other government and non-government research institutes. For E.g.: To identify areas which are ecologically important (Ecologically important ecosystems, Critical Ecological habitats, protected areas Marine Protected Areas, Fish Sanctuaries), important areas for capture fisheries (Fisheries reserves, Community run fisheries reserve, Spill over zones) and areas important for vulnerable communities and non-mechanized fisherfolks. (Territorial User Rights for Fishing (TURFs) and Traditional Fishing areas).
2. Carry out capacity building of local Village Forest Committees, Biodiversity Management Committees etc. to evaluate health of critical ecosystems and keep vigilance at local level. These committees may be extended financial assistance under the existing forestry schemes or provisions of Biodiversity Act -2002.
3. Strengthen enforcement mechanisms by adequate staffing and skilling of Coastal Security Police etc. to curb unsustainable fishing practices
4. Train local communities to be stewards of eco-sensitive areas such as Mangroves by initiating schemes such as Mangrove Protection and Employment Generation Scheme in Maharashtra under the coordination of different departments especially Forest, Environment & Ecology Department, Fisheries Department and Tourism Department.

6.5 Sustainable Harvesting and Extraction of Potential Blue Economy Resources

6.5.1. Institutional Arrangement for Marine Fisheries

Positioning exclusive institutional arrangement at state level as multi-layer institutional architecture with policy measures for support services, planning, formulation of a roadmap, implementation strategies, coordination and monitoring of progress need to be prioritized. Linking the functions of governments with various organizations/local institutions responsible for establishing management systems such as fishers, business leaders, industry leaders, academia, experts and civil society to provide overall guidance, support and sustenance is the key.

Sustainable development of marine fisheries in the state includes roping in both resource management and regulatory regime and their effective implementation. Resource conservation is an important objective of marine fisheries management and warrants collaborative modes of governance to improve the sector sustainability and growth. Community based participatory management or co-management in fisheries, integrated approaches to development, collective action of local communities and the state, new technology development, training, capacity building, strengthening technological skills of traditional fishers and other stakeholders across the sector supply-value chain, effective

fisheries governance are the integral part of sector development and warrants for appropriate institutional arrangement (both formal and informal institutions) at all levels. Governance and institutional arrangements to address various issues of the sector are detailed in the document of Department of Planning, Program Monitoring and Statistics, Government of Karnataka (Bhatta, 2019).

Effective engagement of primary stakeholders, their local institutions- Fishermen Co-operative Societies (FCS) and Federations, those engaged in ancillary activities, planners and tutorial, R&D and outreach institutions, NGOs, civic society and others interested in sector development is needed to ensure that fisheries are ecologically and economically sustainable.

As local institutions, the state has 130 coastal Fishermen Cooperative Societies, two district level cooperative federations, one state level co-operative federation and Karnataka Fisheries Development Corporation (KFDC). In order to address issues of the sector in a holistic, coordinated and integrated way, the Department of Fisheries, GoK coordinates with other ministries and line departments. The Central Ministries involved are mainly the Ministry of Fisheries, Animal Husbandry and Dairying, Ministry of Agriculture and Farmers Welfare, Ministry of Commerce and Industry, Ministry of Food Processing Industries, MoES, MoEF&CC etc. The National institutes involved in sector development are mainly the Department of Fisheries (DoF), National Fisheries Development Board (NFDB), Marine Products Export Development Authority (MPEDA), Coastal Marine Police and the Indian Coast Guard (ICG) etc. Both Central and state Pollution control boards address issues related to resource pollution.

The various State Departments supporting the efforts of the Department of Fisheries, GoK in developing the sector are Ecology and Environment, Department of Mines and Geology etc. The state Department of Fisheries with the support of other institutions/organizations is implementing resource management strategies, monitoring and evaluation of performance and meeting compliance to FAO Code of Conduct, compliance to guidelines, extending weather related advisories and such other services/support.

In support of scientific knowledge, capacity building, Knowledge management, new technology development, technology hand holding develop research capacity and transfer of marine technology the State Department of Fisheries is coordinating with concerned scientific institutions, R&D and outreach institutions viz., Central Marine Fisheries Research Institute (CMFRI), Fisheries Survey of India (FSI), Central Institute for Brackish water Aquaculture (CIBA), Central Institute of Fisheries Technology (CIFT), Central Institute of Fisheries Education(CIFE), National Institute of Oceanography (NIO), National Institute of Fisheries Post-harvest Technology and Training (NIFPHATT), Central Institute of Fisheries Nautical and Engineering Training (CIFNET), Central Institute of Coastal Engineering for Fisheries(CICEF), Council of Scientific and Industrial Research (CSIR), Indian National Centre for Ocean Information Services, Space Applications Centre (SAC), National Remote Sensing Agency, Centre for Mathematical Modelling and Computer Simulations. At state level the regional centers of CMFRI, College of Fisheries, Mangaluru, KVAFSU, Bidar, State Agricultural Universities and Krishi Vignana Kendras (KVKs), traditional universities and academic institutions, local NGOs and other voluntary organizations are supporting the sector activities.

The International organizations viz., Food and Agriculture Organization of the United Nations [FAO), the International Maritime Organization (IMO), the International Labor Organization (ILO), Indian Ocean Tuna Commission (IOTC) are supporting sector development by setting up international standards and norms and state has to comply with the international regulations, FAO's Code of Conduct for Responsible Fisheries (CCRF or Code) and such others relating to fishing in the EEZ and beyond in the high seas.

Financial institutions for supporting institutional credit includes National Bank for Agriculture and Rural Development (NABARD), as a refinance agency for commercial banks, co-operative banks and regional rural bank viz, State Finance Corporations (SFCs), Industrial Finance Corporation of India (IFCI), Industrial Development Bank of India (IDBI), Shipping Credit and Investment Company of India (SCICI).

The sustainable management of natural capital requires a comprehensive and quantitative method to measure and monitor the health of marine ecosystems including implementation of an appropriate policy and legislative mechanism. One of the major harvestable commodities is the fish and shellfish both in marine and freshwater ecosystems. The marine sector along the country including in Karnataka waters have been overfished. Some of the marine areas including estuarine zones have been destroyed on account of unscientific fishing and continuous trawling. Government of India has brought out National Policy on Marine Fisheries (NPMF) 2017¹¹⁶. The NPMF is aimed at preserving marine life and ocean health in India's Exclusive Economic Zone, through sustainable harvest, which is based on seven pillars, namely sustainable development, socio-economic upliftment of fishers, principle of subsidiarity, partnership, inter-generational equity, gender justice and precautionary approach. While the gist of the policy's vision is to maintain a healthy fisheries sector which would cater to the needs of the present and future generations, its mission is to ensure sustainability of the resources where the policy framework is in sync with the national, social and economic goals, livelihood sustainability and socio-economic upliftment of the fishing community.

6.5.2 Institutional Arrangement for Inland Fisheries Sector

Aquaculture is a more reliable tool for expanding capacities and regulating species mix. However, there is a serious down side of unsustainable practices by way of nutrient / antibiotics / pesticide pollution / disease outbreak / gene pool contamination by escaping non-native species. For nutrient pollution mitigation the industry needs to work on new feed mixes using phytoplankton and other sources of plant protein to avoid excessive dependence on fish meal. There are successful stories of multi trophic aquaculture for reducing pollution and promoting recycling of harmful waste which can be replicated. The Guidelines for regulating Coastal Aquaculture appended to the Coastal Aquaculture Authority Rules, 2005 under the Coastal Aquaculture Authority Act, 2005 provides various measures, which inter alia include environment impact assessment, environment monitoring and management plan, waste water management and integrated coastal zone management in order to address the environmental issues and to ensure environmentally responsible and socially accepted aquaculture in coastal areas. New technologies need to be introduced that are going to have an impact at every stage of the supply chains from the catch to the plate. New net systems are deemed developed for pre-extraction selection of target catch so has to minimize bycatches. Technology induction could help improve the sanitation at the landing stations, hygienic processing and packaging, adequate refrigerated storage and cold supply chains. These operational steps coupled with better regulations could help reduce wastage and rejection to a large extent. Collection of remote sensing, Automatic Identification System (AIS), GPS and real time ground data could help improve fishing domain awareness by way of weather, currents, fish stock movement, spawning activities illegal / unauthorized fishing, real time market demand / prices which could bring extraordinary efficiencies in the sector. This domain knowledge could also help in promoting and strengthening Marine Spatial Planning (MSP). With growing awareness and concern about hygiene and sustainability there could be greater demands on accountability of stakeholders through the entire supply chain that could well be addressed through application of domain linked block chain.

¹¹⁶<http://dahd.nic.in/news/notification-national-policy-marine-fisheries-2017>

Until recently, fisheries were dealt by one of the departments under the Ministry of Agriculture, Animal Husbandry and Fisheries. During the financial year May 2019, the, Ministry of Fisheries, Animal Husbandry and Dairying (Matsyapalan, Pashupalan aur Dairy Mantralaya) has been created with two Departments namely: Department of Fisheries (Matsyapalan Vibhag) and Department of Animal Husbandry' & Dairying (Pashupalan aur Dairy Vibhag)

On creation of the new Ministry for fisheries the momentum for blue revolution gained tremendously with a budget outlay of 3000 Cr was provided, with the following salient features.

- Development of Inland Fisheries and Aquaculture
- Development of Marine Fisheries, Infrastructure and Post-Harvest Operations
- Strengthening of Database & Geographical Information System of the Fisheries Sector
- Institutional Arrangement for Fisheries Sector and monitoring, Control and Surveillance (MCS) and other need-based Interventions.

6.5.3 Major institutions governance the fisheries sector in the country

The Ministry of Fisheries, Animal Husbandry & Dairying (MFAH&D) working to establish Liaison and cooperation with international organizations in matters relating to livestock, poultry and fisheries development, livestock Census and statistics, matters relating to loss of livestock due to natural calamities, regulation of livestock importation, quarantine and certification, fishing and fisheries (inland, marine and beyond territorial waters), fishery survey of India, Mumbai, prevention of the extension from one state to another or infectious or contagious diseases or pests affecting animals, fish and birds, insurance of livestock, fish and birds. National Fisheries development board is the novel body under MFAH&D to provide focused attention to fisheries and aquaculture, achieve sustainable management and conservation of natural aquatic resources, apply modern tools of research and development for optimizing production and productivity from fisheries, provide modern infrastructure mechanisms for effective fisheries management and optimum utilization, train and empower women in the fisheries sector and also generate substantial employment, enhance the contribution of the fish toward food and nutritional security.

The Ministry of Commerce and Industry formulates, implements and monitors the Foreign Trade Policy (FTP). The Marine Products Export Development Authority (MPEDA) was set up under Section (4) of MPEDA Act, 1972 and became functional from 20th April, 1972. It is a statutory body functioning under the Department of Commerce. MPEDA works for diversifying the culture practices into commercially important Shellfish and Fin fishes to enhance aquaculture production and increase the varieties, establishing traceability of Aquaculture and Capture Fishery products through primary producers' enrolment, establish traceability of aquaculture and capture fishery products through primary producers' enrolment, promoting Ornamental Fish Breeding for export, upgrading of fishing harbors to international standards, extending financial assistance, implementing Catch Certification scheme for preventing / discouraging Illegal, unreported and unregulated (IUU) fishing, Assisting the setting up of state-of-art processing facilities for Value Added Marine Products meant for export, extending linkages to the grass root level by ensuring better extension packages to fishermen

Ministry of Home Affairs – Island Development Agency an apex body, under the chairmanship of Hon'ble Home Minister, in June 2017, have Mandated NITI Aayog as a steering body for the Holistic Development of Islands program which includes, carrying Capacity based tourism and economic activities, green Energy (de-dieselization), promotion

of fisheries, job creation for Islanders, developing basic and support infrastructure to support socioeconomic development, providing fast, reliable and cost effective connectivity – intra & inter islands.

The Ministry of Food Processing Industries (MoFPI) works to create infrastructure under the food processing sector. Planning, development and control of and assistance to food industries Further with regard to development of aquatic resources and associated activities relating to development of blue economy the various ministries and departments involved are;

1. Ministry of Environment, Forest and Climate Change
2. Ministry of Commerce & Industry
3. Ministry of Earth Sciences
4. Ministry of Fisheries, Animal Husbandry & Dairying
5. Ministry of Food processing industries
6. Ministry of Health and Family Welfare
7. Ministry of Defense, Coast Guard
8. Ministry of Shipping
9. Ministry of External Affairs
10. Ministry of Drinking Water and Sanitation (Peya Jal aur Swachata Mantralaya)
11. Ministry of Consumer Affairs, Food and Public Distribution
12. Ministry of Human Resource Development
13. Ministry of New and Renewable Energy
14. Ministry of Micro, Small and Medium Enterprises
15. Ministry of Skill Development and Entrepreneurship
16. Ministry of Tourism
17. NITI Aayog (National Institution for Transforming India)

Apart from the above governance and financial systems the nationalized banks also play an important role in promotion of fish and fisheries (State Bank of India, Canara Bank, IDBI Bank, Axis Bank, PNB etc.).

Micro Units Development and Refinance Agency Bank (MUDRA) scheme is another platform to avail financial aid to set up and develop your animal husbandry venture. Aquaculture and fisheries are highly risky enterprises whereas aquaculture plays a sudden loss of the fish and shellfish on account of various reasons insurance cover is one of the prime requirements. Presently no financial institutions cover insurance for Aquaculture.

Presently, a comprehensive and integrated draft National Fisheries Policy, 2020 has been formulated by integrating the National Policy on Marine Fisheries, 2017 (NPMF), the Draft National Inland Fisheries and Aquaculture Policy (NIFAP) and the Draft National Mariculture Policy (NMP) along with the elements of post-Harvest.

The recommendations for capacity building and human resource development in the marine and inland fisheries sector has been included in the Summary outline Blue Economy Plan.

6.5.4 Blue Jobs in Emerging sectors of the Blue Economy

Some of the emerging sectors that have huge potential for generating jobs and livelihood opportunities include Mariculture, aquaponics, offshore energy, value-added fishery products for export market and development of pharmaceutical products based on available aquatic life forms. For example, the proposed Marine Biotech Park in Mangaluru and Karwar to promote research in areas such as structural and functional genomics and bio prospecting from marine organisms (seaweeds and microbes) will boost the economic growth as well as provide jobs in the state. The institutions that are responsible to facilitate these sectors include the Karnataka Renewable Energy Development Corporation Limited (KREL), Department of Fisheries, Department of Electronics, Information Technology, Biotechnology and Science & Technology as well as other institutes, NGOs, private organizations that are working on these new avenues.

Although these areas are in their nascent stages, efforts to introduce related professional courses as well as increase in capacity building in these areas are crucial to expand the state's potential from blue economy resources. The various technical and professional job roles that would be essential to further these emerging sectors are production & process development technicians, quality assurance technicians, lab technicians, market development staff, marine scientists, marine biologists, microbiologists, botanists, earth and ocean scientists, geneticists, food chemists, food technologists, new product development technologists, ocean farmers, food process engineers, environmental scientists, quality auditors, food economists, wave scientists, marine energy engineer, Marine surveyor, oceanographers, energy economists etc.

Any harvesting and extraction of blue resources in an unscientific and unsustainable manner would be detrimental to ecosystems and a threat to the future potential of the sector and livelihoods that depend on them. From the example of some developed and other developing countries where emerging sectors such as intensive Mariculture are quite established, it is learnt that the threats posed by the production of invasive (potentially non-native) species in aquaculture are not worth the risk. Once invasive, these species would compete with native flora and fauna and lead to an ecological catastrophe. These risks have to be managed with better management and controls learning from other countries for sustenance of local ecologies and safeguarding current fish stocks and local livelihoods.

Hence, it is highly recommended to carry out mandatory pilot studies and specific Environment and Social Impact Assessments (ESIA) for all proposed aquaculture activities like mariculture, seaweed farming, ranching activities by an independent committee of subject experts such as Ecologist, Fisheries Scientist, Social Scientist and Hydrologist to assess and evaluate the immediate and long-term impacts of the proposed activities on the near and distant ecosystems. Similarly, any exploration regarding extraction of non-living resources should be undertaken only in the area which is not listed as ecologically important, carrying out ESIA studies and ensuring safeguards for the local environment, living-natural resources, local biodiversity and livelihoods of local vulnerable communities. This calls for highly skilled professionals and subject matter specialists to carry out such robust ESIA studies to safeguard the future prospects of ocean-based livelihoods. There is a need to impart adequate skills to such experts from time to time.

6.6 Coastal and Marine Area Management

The marine environment includes the adjacent coastal areas which support productive and protective habitats such as mangroves, coral reefs, sand dunes etc. The 320 km long Karnataka coast is blessed with an ecologically rich environment; however, these coastal and marine areas are facing severe negative impacts due to unsustainable developmental activities arising out of the needs of people, and the multiple uses that coastal and marine

areas can be put to. Climate change impacts such as sea level rise, storm surges, coastal erosion, monsoon pattern shifts, fish migration etc. are also increasing the challenges faced by the coastal and marine areas. The aggravated impacts of marine pollution, increased cyclonic events, coastal erosion etc. has intensified the need for a sound coastal and marine area management.

To address these challenges in India, several interventions have been initiated by the Government of India. Some of these include the CRZ Notification (governs the developmental activities in coastal, marine and tidal influenced water bodies), Climate Change Adaptation Guidelines for Coastal Protection and Management in India, education and capacity building, Coastal Biodiversity Conservation Studies, Climate Literacy and Marine Litter Management, Blue Flag initiative etc.

The Reference Manual on Climate Change Adaptation Guidelines for Coastal Protection and Management provides detailed guidance on the sustainable management of the coast in the climate change scenario. The manual suggests that although the CRZ notification regulates construction over horizontal zones at the coast up to the “hazard line”, the impending Sea Level Rise and projected storm surge levels calls for the vertical dimension to be considered and more formally incorporated into the regulations. Considering the vertical dimension includes the concept of Minimum Beach Level (MBL) viz. the safe beach elevation to prevent overtopping and flooding of the hinterland during storms and Minimum Floor Level (MFL) viz. the safe floor level of buildings to protect buildings and infrastructure in the coastal and low-lying areas from the risk of flooding. To guarantee a level of security, MFL must be higher than MBL, particularly in regions prone to river flooding. The safe elevation will vary between locations and should be determined and referenced in building permits. However, there is very minimal knowledge regarding these concepts among coastal communities. Hence, serious efforts towards creating awareness on these concepts is required to manage development activities in marine and coastal areas and make it more climate change resilient.

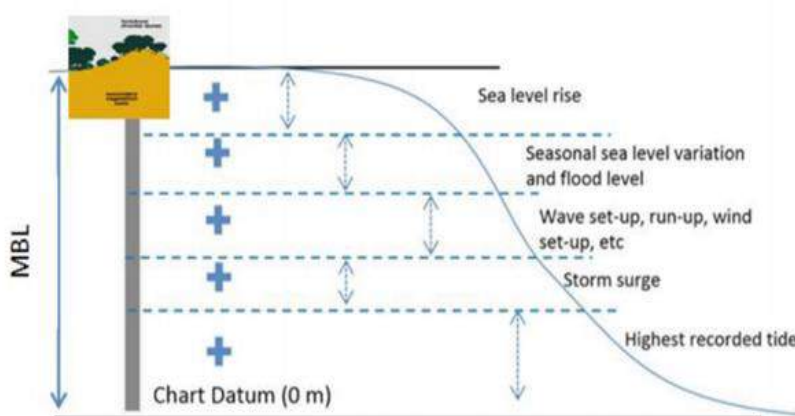


Figure 6. 1: The concept of Minimum Beach Level (MBL)

Coastal erosion is a severe hazard faced by the coast of Karnataka. The factors that are causing shoreline change and coastal erosion can be natural and anthropogenic. The natural factors causing coastal erosion are waves, winds, currents, tides, sea level rise and storm surge whereas the anthropogenic factors are construction of harbors, damming, beach sand mining, dredging of harbors and navigation channels, poorly designed coastal protection structures viz. inappropriate hard structures such as seawalls etc.

In response to flooding of hinterland during high tide or cyclonic events, unsuitable coastal protection structures such as seawalls are a common sight on most beaches along the Karnataka coast and routinely practiced as an emergency measure. Case studies in the reference manual have indicated that hard structures can be locally successful but in the long run are unsustainable, costly to build and a short-term solution as scouring and downdrift effects are often severe. Lack of awareness by coastal communities on this fact has often led to increased demands for seawalls after flooding events. Hence, there is a need for increased awareness among the local communities and implementing agencies of coastal protection measures to choose sound practices for sustainable management of the coastline.

Realizing that piece-meal shore protection measures are no more a solution, the Government of Karnataka implemented the Sustainable Coastal Protection and Management Investment Program (SCPMIP) funded by the Asian Development Bank (ADB) loan through the Multi Tranche Financing Facility (MFF) executed in 2 Tranches (2011-2020). The objective was to address the immediate coastal protection needs of the state and implement economically viable, environmentally sound and socially appropriate long term sustainable protection works for identified sites of Karnataka, which are severely affected by beach erosion or flooding causing loss of livelihoods, public property and land. The project also aimed at strengthening institutional capacities for sustainable coastal protection and management and increasing engagement of the private sector and coastal communities in shoreline management, coastal protection and management.

Under Tranche I of the SCPMIP-K implemented during 2011-2017, coastal protection measures were taken up at Ullal in Dakshina Kannada to solve the severe erosion that has been taking place at Ullal for the past few decades. An important contribution of the SCPMIP-Karnataka, was the development of a Shoreline Management Plan (SMP) in 2015 for the three coastal districts to effectively manage the coastal and marine areas in the state. The Shoreline Management Plan (SMP) of 2015 provided the structure and context for the implementation of ten sub projects under SCPMIP-Tranche 2, implemented during 2017-20.

Since the coast is very dynamic, it is necessary for the SMP to be revised and updated at least every 5 years as a continuing effort on the part of the State for scientific management of the coast. One of the key activities of the capacity building and institutional development is updating of the Shoreline Management Plan including climate change impacts and expanded stakeholder consultation.

The SMP 2020 was endorsed by the State Government as a guideline for managing the coastal activities in the state. The SMP 2020 was prepared under SCPMIP-Tranche 2 revising and updating the policy scenarios presented in the SMP (2015) based on latest beach environmental data, primary and secondary data on coastal hydrodynamics, beach and inner shelf sediments, beach and inner shelf topography, longshore sediment transport, erosion/accretion scenario, coastal land use/land forms etc. The SMP 2020 has the Minimum Beach Level (MBL) computed at different locations of the Karnataka coast for 10s wave period and 12s wave period considering 50-year MBL components (m).

The SMP noted that much of the coastline is populated by fishing communities, particularly towards the south. These folks are affected by coastal erosion and issues arising from poorly enforced and/or inadequate coastal management such as poorly designed sea walls. For example, sand dunes, which are a vital element for healthy beaches, are common along the State's coast. However, because of population and developmental pressures, many of these sand dunes are degenerated.

Significant infrastructure exists along the coastal zone of Karnataka including National & State highways and other roads, railways, ports, jetties, breakwaters, fish landing areas, shore protection structures and industries. Many coastal roads have been built on these

dunes, without any regard for the ecology, coastal protection, and other factors that sustain the coast. These factors make the coast and coastal communities vulnerable to the impacts of disasters such as cyclonic storms that frequently hit the coast as a result of climate change. For example, in 2019, the Karnataka coast unusually faced many cyclones such as Vayu in June, Hika in September, Kyarr in October and Maha during October and November.

A range of soft and hard structural options are presently available for coastal erosion management. Soft engineering options like dune management, beach nourishment, sediment by-passing, vegetation or offshore submerged reefs could be considered independently or with a combination of soft and hard options for wider and safer beaches. Furthermore, site specific solutions based on a detailed understanding of the local coastal processes are required rather than a generalized generic design.

The SMP 2020 has noted the prevalence of illegal beach sand mining, untreated effluent discharges from fish processing plants directly to the sea, untreated discharges being made by coastal urban bodies onto the beach and presence of litter on-shore along the coast of Karnataka. These activities if not curtailed will lead to severe ecological impacts and aggravated erosion. Hence, it is important that each of these issues are regulated effectively for maintaining the sanctity of the coastal and marine areas of the state.

It is important that the beach and near shore waters are made litter free. Local Self Government (LSG) have to be sensitized for curtailing litter on beaches and near shore waters and initiating plans for periodic cleaning of beaches.

Sand mining must be controlled to stop further loss of beach sand. The following course of action is proposed:

1. Sensitize the Local Self Government Local Bodies about the ill-effects of sand mining.
2. Promote use of eco-friendly, alternative building materials to curb sand mining which is mainly extracted for construction purposes.
3. Strict enforcement for preventing illegal sand mining by Deputy Commissioners and Regional Directorates of CRZ, Mines and Geology of the three coastal districts.
4. Sensitize the coastal communities on the impacts of sand mining on beach stability.

Untreated effluent discharge from fish processing plants is against the CRZ Notification. The following action plans are proposed to curtail this illegal activity:

1. Apprise the Local Self Government (LSG), Pollution Control Board and Regional Directorates of CRZ about the ongoing illegal discharge of effluents requesting for measures to ensure the functioning of Effluent Treatment Plants in each of the fish processing plants.
2. Carry out awareness programs to sensitize the local bodies, coastal communities and other stakeholders about the need for maintaining contact water quality in the coastal water bodies.

Untreated discharges are made by coastal urban bodies on to the beach. The following actions are proposed:

1. To sensitize the LSGs against release of untreated urban discharges to the beach.
2. Channelize the storm water drainages so as to drain out the waters directly to the nearshore waters.
3. Monitoring of the rivulet water quality and follow up measures with the LSG to maintain contact water quality.

6.6.1 Federating Shoreline Management Organizations (SMO)

The SCPMIP-K has set up Shoreline Management Organizations (SMO) that are registered under the Societies Registration Act, 1960 in locations where the coastal protection measures were implemented as part of the ADB loan covenant. They are micro-level community-based organizations formed by local people who have agreed to work together on a voluntary basis and contribute to shoreline planning and management processes. If funds could be provided to these SMO's, they could be trained, strengthened and mobilized for furthering responsible coastal management initiatives, taking up community actions related to emergency responses during natural calamities, taking up beach cleaning activities, promoting community-led beach tourism etc. Further, if Shoreline Management Organizations (SMO) are established in each of the Shoreline Management Units (SMU's) identified in the SMP document, they will serve as a valuable tool for sustainable management of the shoreline.

6.6.2 Coastal Infrastructure Management Unit (CIMU)

A Coastal Infrastructure Management Unit (CIMU) is being formed in Karnataka to ensure that erosion issues are tackled in a scientific way to ensure sustainability. At present there is no dedicated cadre of coastal engineers in the Government. Engineers from Public Works Department etc. are mostly deputed for implementing coastal protection works. The goal of the CIMU is to create a multi-disciplinary staff who are trained and experienced in coastal erosion problems so that they have the ability to review ideas and concepts or plan best solutions for a site. The goal is to find stable staff who will be trained in beach and surf zone data collection, pre- and post-studies, survey techniques with modern oceanographic equipment. They should be able to understand the complex technical issues and computer models, review EIA reports or plan for beach works themselves.

The initial establishment will include training in field data collection, purchasing of modern beach measurement equipment and exposure to computer modelling. This initiative ensures more stability in the staffing and expertise in the responsible agencies, while creating a focus on beach management. A proposed initial structure for CIMU as proposed in Project Management Design Consultants-Karnataka (2017) is reproduced in Figure 6.2.

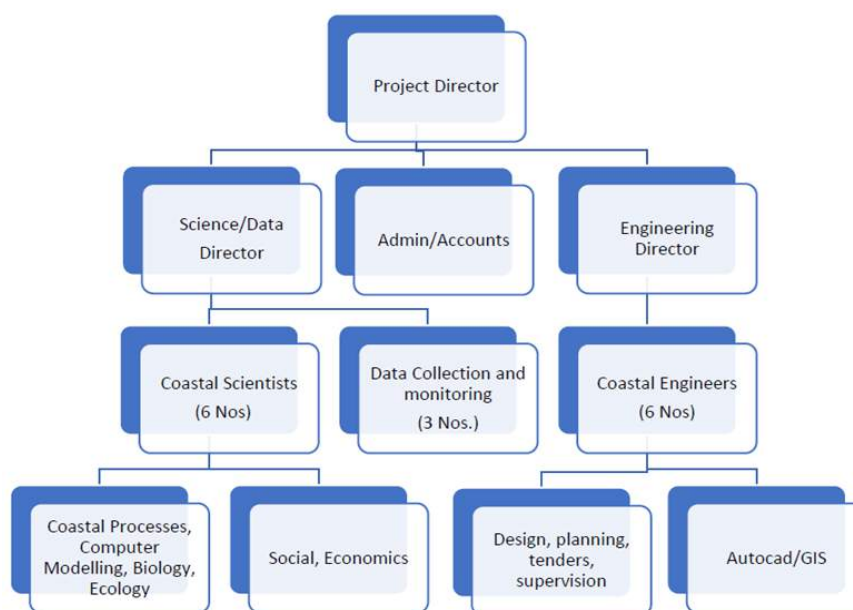


Figure 6. 2: Proposed initial CIMU structure
(Source: PMDCK, 2017)

The global structure for CIMU would involve two independent and co-operative streams which are “Science” and “Engineering”. The overall leadership for CIMU would come via the Ports Department, possibly with a new appointment of an on-site Director for the first 2 years to help establish a functioning CIMU.

The science stream would be managed by the National/Regional Institutes/Universities and NITK. Science underpins decisions and studies needed for sound decision-making about the best coastal protection measures. The science group could incorporate experts understanding coastal processes, biology and economics.

The engineers would be responsible for design and construction elements (with a strong and close link to the economics) while also developing skills in the sciences through active participation of CIMU staff and other interested engineers. The engineering elements would be managed by the Ports Department CIMU group. The joint cooperative would engage both sides in opportunities for training and capacity building.

6.6.3 Coastal Management Information System (CMIS)

Coastal Management Information System (CMIS) is an information system that encompasses a wide range of coastal data/maps/information that is required by planners, managers, local bodies and various other stakeholders of the coast. It is equipped to provide coastal information to stakeholders and equip them to perform query and analysis of coastal data. A CMIS Karnataka has already been developed under the SCPMIP-K. It has provision for providing a wide range of coastal data like waves, currents, tides, sea level, beach profile, bathymetry, etc. to the different stakeholders. It is loaded with district level and state level maps on beaches, land use, infrastructure, rivers and estuaries, mangroves, shore protection structures, shoreline change and so on. The CMIS sources and compiles information from national and state level institutions and other specialized agencies. CMIS also encompasses primary information generated during various stages of project implementation. A well-functioning CMIS is at the core of the envisioned technical excellence of Coastal Infrastructure Management Unit (CIMU). Maintenance, management and regular updating of CMIS will be the key responsibility of CIMU. The data/information accrued in the CMIS is very helpful for the periodic updating of SMP.

6.6.4 Conclusion and Recommendation

The Shoreline Management Plan (SMP) is a key strategy to address the future needs for a better management of the shoreline of Karnataka. Enforcement of CRZ Notification, incorporation of climate change projections in design of structures, an updated and well-functioning Coastal Management Information System (CMIS), a vibrant Coastal Infrastructure Management Unit (CIMU) and the presence of a committed Shoreline Management Organization (SMO) at each Shoreline Management Unit (SMU) coordinated by a district level federation are the essential requirements for sustainable management of shoreline. These future infrastructural and administrative frameworks in conjunction with the updating Shoreline Management Plan (SMP) will facilitate better management of the Karnataka coast. The coastal community and government departments implementing coastal protection measures must be trained and appraised on selecting coastal protection measures based on the Environmental softness Ladder (ESL) rather than implementing generic sea walls along the coasts facing erosion to ensure sustainable coastal protection solutions are taken up.

It is crucial that Climate change resilience has to be built into coastal management and the coastal protection measures implemented from now on should conform to the Minimum Beach Level (MBL). As postulated in the Manual on Climate Change Adaptation Guidelines, beach is the best form of coastal protection, and the endeavour should be to build beaches through sand-based solutions. New buildings and constructions in the CRZ should be above

the Minimum Floor Level (MFL) to allow for climate change projections of storm surge, waves and sea level rise.

The Coastal and Marine Program of the Centre for Environment Education (CEE) focuses on initiating, designing and implementing strategic projects that enhance participatory and integrated approaches for sustainable coastal and marine area management. The Karnataka state's CEE Cell could partner with local governments, corporates and various foundations to create awareness on sustainable management of coasts and marine areas.

The state shall also strive to have a maximum number of beaches achieve the blue flag certification to promote awareness on the importance of clean beaches. The following are some of the recommendations for coastal and marine area management:

1. It is important that the beach and near shore waters are made litter free. Local Self Government (LSG) have to be sensitized for curtailing litter on beaches and near shore waters and initiating plans for periodic cleaning of beaches.
2. Sensitize the Local Self Government Bodies/Departments about the ill-effects of sand mining.
3. Strict enforcement for preventing illegal sand mining by Deputy Commissioners and Regional Directorates of CRZ, Mines and Geology of the three coastal districts
4. Sensitize the coastal communities/Local government bodies on the impacts of sand mining on beach stability.
5. Strict enforcement to prevent the illegal discharge of effluents by Local Self Government (LSG), Pollution Control Board and Regional Directorates of CRZ
6. Carry out awareness programs to sensitize the local bodies, coastal communities and other stakeholders about the need for maintaining contact water quality in the coastal water bodies.
7. Ensure a well-maintained Coastal Management Information System (CMIS), a vibrant Coastal Infrastructure Management Unit (CIMU) to meet the objective of sustainable management of the state's shoreline. These future infrastructural and administrative frameworks in conjunction with the updating Shoreline Management Plan (SMP) will facilitate better management of the Karnataka coast.

6.7 Disaster Management and Mitigation

A disaster is a serious disruption occurring over a short or long period of time that causes widespread human, material, economic or environmental loss and which exceeds the ability of the affected community or society to cope using its own resources. As per the United Nations Office for Disaster Risk Reduction, disaster is

“A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts”

Disasters are either natural or human-made. Natural disaster is a natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage Various natural phenomena like earthquakes, landslides, volcanic eruptions, floods, hurricanes, tornadoes, blizzards, tsunamis, cyclones, storm surges and pandemics are natural disasters that kill thousands of people and destroy billions of dollars of habitat and property each year. Human-made or human-instigated disasters are the consequence of technological or human

hazards namely stampedes, fires, transport accidents, industrial accidents, oil spills, terrorist attacks, nuclear explosions/nuclear radiation, war and deliberate attacks, catastrophic global warming, nuclear war and bioterrorism.

Disasters, natural or man-made, have the potential to cause great pain and suffering. Disasters can result in human casualty/death, loss of livelihoods, property damage/loss, habitat damage/loss, environmental damage/degradation, social disruption and economic impacts. The after effects of disasters often linger long after the event.

Developing countries suffer the greatest costs and are much more seriously affected when a disaster hits – more than 95 percent of all deaths caused by hazards occur in developing countries, and losses due to natural hazards are 20 times greater (as a percentage of GDP) in developing countries than in industrialized countries. Even in developing countries the vulnerable and especially those with limited resources tend to suffer more and are adversely affected at the impact of natural disasters.

Conventional responses to disasters include immediate relief and rehabilitation (immediate and short-term) and restoration measures (long term) after the event. These measures being reactive, do not reduce the extent of impacts but are more of a restorative nature. In contrast, pro-active approaches have the potential to diminish the extent of impacts. Adequate planning towards disaster preparedness and mitigation, if carried out, can minimize periodic shocks to the development efforts.

Planning helps to influence events before they occur rather than attempting to respond as events unfold. It actively mitigates issues before they arise by involving relevant stakeholders. Effective planning is therefore essential to successfully prepare for, respond to and subsequently recover from a disaster event.

6.7.1 Disaster Management

The Indian sub-continent spans several geographic, meteorological and climatic zones and is vulnerable to multiple natural hazards and industrial accidents owing to the very large number of industries.

Subsequent to the three consecutive disasters related to Cyclone (1999), Earthquake (2001), and Tsunami (2004), an urgent need was felt for a comprehensive and holistic disaster management system. This ultimately led to the enactment of the Disaster Management Act in 2005 and the subsequent National Policy on Disaster Management in 2009. In 2005, the National Disaster Management Authority (NDMA) was formed with a mandate to frame policies, lay down guidelines and best-practices for coordination with the State Disaster Management Authorities (SDMAs) to ensure a holistic and distributed approach to disaster management. Accordingly, the NDMA released India's first ever disaster management plan called the "National Disaster Management Plan 2016" with a view to make India disaster resilient, achieve substantial disaster risk reduction and significantly decrease the loss of life, livelihoods and assets. The national plan was subsequently revised and the latest plan is the National Disaster Management Plan 2019.

The Disaster Management Act in 2005 made it mandatory for every state to form its own State Disaster Management Authority (SDMA) and prepare a state specific State Disaster Management Plan (SDMP). Accordingly, the Karnataka Disaster Management Authority was formed. In addition, a district Disaster Management Authority (DDMA) was formed in every district of Karnataka. Each DDMA in the state is mandated to prepare a district specific Disaster Management Plan (DDMP). Each district in the state has its own specific disaster management plan. The disaster management plans are updated annually and the latest edition is 2019-20.

6.7.2 Disaster Management Plans and Blue Economy

The disasters directly affecting the Blue Economy are Cyclones, Tsunamis, flash floods, Oil Spills, landslides in coastal areas and flooding, landslides in Inland areas. These have been suitably addressed in the District Disaster Management Plans (DDMP) of the individual districts. The necessary institutional arrangements with regard to disaster management are already in place. The District Disaster Management Authorities (DDMA) regularly conduct mock drills as entailed in the plan.

Preparation for disasters is a joint venture of various departments and agencies within the district. Accordingly, the department wise preparedness checklist has been prepared in the DDMP with the respective tasks and responsibilities. Some of the major departments that have a active role during disasters are the District Administration, Education Department, Electricity Department, Food & Supplies Department, Irrigation Department, Corporation Offices, Pollution Control Board, Public Works Department, Regional Transport Office, Fisheries Department, Police Department, Home Guards, Fire Services, Health Department, Agriculture Department etc. These department personnel are to be adequately trained in their roles and responsibilities and are to be roped in while carrying out mock drills. Regular awareness campaigns including imparting requisite skill sets related to quick response during disasters are to be given importance to have a robust disaster preparedness mechanism in place.

The DDMP is annually revised by all districts. However, regular awareness sessions to various stakeholders on revision of the DDMPs are to be carried out.

Moreover, community partnerships and participation need to be given importance to strengthen the capacities of the first respondents. Awareness of disasters that affect particular vulnerable communities especially those in high-risk areas are to be imparted along with their preparedness for immediate response. For example, forming disaster response teams in coastal villages, including women and training them periodically on rescue operations, first aid etc. is extremely crucial. Organizing frequent mock drills and providing each of the teams with requisite disaster management kits (Ropes, walkie-talkies, Life jackets etc.) that are easily accessible would further strengthen community-based Disaster Risk Mitigation Programs. This would ensure better emergency preparedness and response during disasters.

The west coast of India is vulnerable to oil spills because of the significantly higher shipping traffic. Hence all 3 coastal districts of Karnataka are particularly vulnerable. In light of this fact, the Dakshina Kannada District Disaster Management Plan entails a Oil Spill Mitigation Plan for the district whereas Udupi and Uttara Kannada districts are yet to incorporate Oil spill mitigation plan in their respective DDMPs. Along with having plans in place, a robust

Planning for diversification of livelihoods and provisions for alternate livelihood options is extremely important in cases where disasters may affect livelihoods of vulnerable communities especially in areas prone to disasters and where people depend on only one resource in particular such as fishing.

The recent Tauktae cyclone has left devastating impacts including affects to infrastructure such as roads and homes of coastal communities. Coastal protection measures are usually carried out as a reactive mitigation response. However, in vulnerable areas wherein well planned scientific coastal protection measures were carried out, absolute minimum damage was witnessed. Taking cue from this, it is recommended that infrastructure projects that have the potential to reduce the impact of disasters (such as in coastal areas shore protection using dune building and plantation, scientific hard solutions for highly eroding coasts, construction of roads and buildings considering Minimum Beach Level etc.) needs to

be explored and implemented as a long-term measure. This is extremely important considering the future climate change challenges and hence planning for resilient measures is the need of the hour.

6.7.3 Current status of existing laboratory facilities during disasters

The following are some of the existing laboratory facilities that play an important role during disasters:

1. Geographical Information system (GIS) – Laboratory. The Centre for Disaster Management (CDM) has set up a GIS laboratory with the latest GIS software ArcGIS-10. The laboratory is used extensively for conducting training programs on preparation of Disaster management plan, HRVC analysis, mapping etc.
2. The Centre for Disaster Management- Administrative Training Institute (CDM ATI) Mysuru is providing awareness and training in collaboration with fire service and other Departments/organizations to the principals, HMs, NSS/NCC Officers and school teachers.
3. The Centre for Disaster Management (CDM) in collaboration with the Departments of Factories and Boilers and MaH Units and other expert organizations are involved in necessary training on Chemical/Industrial Disasters Management and making them prepare both onsite and offsite Plans.
4. CDM, ATI, Mysuru in collaboration with NIMHANS, Bengaluru has been organizing workshops and training programs on Psycho-social care during and after disaster to all the officers and staff.
5. CDM, ATI, Mysuru in collaboration with DTIs, DIETs, District Health and Family Welfare Training Center, District Agriculture Training Center will be organizing training on community-based disaster management. For instance, Self Help Groups (SHGs) members will be trained on first aid, relief etc.,
6. Collaboration with Space Applications Centre (SAC), Ahmedabad (An ISRO, GoI Organization) and CSIR-4PI (formerly CMMACS), NAL Campus Bengaluru, KSNDCM has developed Gram Panchayat level Rainfall and Weather forecast mathematical models. The Gram Panchayat level rainfall and weather forecast is being generated daily at 12 hours format for next three days. This initiative is the first of its kind in the Country.
7. Information, Alerts and Early Warnings, Reports, Weather forecast and related Advisories are being made available through SMS to the mobile phones, e-mail, social media and Web Portal to all the DC's, CEO's, HQA's, AC's, Tahsildars, JD's (Agri), AD's (Agri), Agri Officers, SP's, Raitha Samparka Kendras, Farmer's facilitators under Bhoochetana Program, Krishi Vigyana Kendras (KVKs), Agriculture Universities, Civil Defence, Home guards, Print and Electronic Media.

The above facilities are to be strengthened by embracing recent technological advances along with adequate skilling and upskilling of various personnel. This would ensure a robust disaster management and mitigation framework.

6.8 Human Resource Planning and Skill Development in Blue Economy

Employment generation in the Blue Economy is the most attractive public policy attraction for countries like India with an abundant young workforce. Blue Economy encompasses multiple sectors and all types of economic activities— primary, secondary and tertiary with varying levels of technological applications, capital requirements, skill development, trade prospects etc.

There is a need to explore employment opportunities that different sectors of the blue economy offer and the specific skills that are needed to match job profiles in those sectors. The level of technological sophistication and the human labor component vary widely across marine manufacturing sectors, which determine the nature and type of job roles created in those sectors. Additionally, the services sectors of the blue economy also have a strong technology component including information technology applications and this would certainly need professionals with specific domain knowledge to carry out various functions. Among services sectors, ship repair, marine finance, coastal tourism, port services etc. can unleash a huge potential for investments and job-creation under an integrated policy to develop and harness the potential of the Blue Economy.

Some of the potential high-employment sectors are fisheries, port and shipping, marine biotechnology, coastal tourism and marine services. Along with the domestic expansion of the Blue Economy, the greater market access for exports and scope for value addition would contribute indirectly to the competition-induced catch-up of local labor force to global standards. These employment opportunities would need to be complemented by matching/requisite capacities in a talent pool in each of the constituent sectors. This would require investment in capacities to impart new blue skills and career development by orienting higher educational courses towards the blue economy.

In India's Draft Blue Economy Policy, the Ministry of Earth Sciences has classified the blue economy human resource requirements into six categories - operative grades, administration, skilled trades, associate professional & technical, professional and management. In consensus with this, the state can look at offering Blue Economy related educational programs on various technical and managerial skills in universities and engineering/technical institutes of the coastal states, provide on-the-job industrial training at the Industrial Training Institutes (ITIs) for existing workforce and devise awareness programs to sensitize youth about Blue Economy jobs with state level chambers of commerce and industry.

Moreover, the capacity building provided should focus on providing on the job skills rather than knowledge-based, theoretical learning. The government needs to invest in quality trainers and suitable infrastructure to provide long-term skill-based training. Industries, corporates, NGOs etc. in the blue economy sectors need to volunteer as training partners, training the trainers and also assisting the government in curriculum and content development for skilling programmes to meet the skilled manpower requirement.

6.8.1 Skill Development Program in Blue Economy Context -Karnataka

Given the prevailing situation of COVID-19 pandemic it is extremely important to develop skills in the area of Blue Economy. As job markets are drying up, investment in developmental infrastructure has considerably reduced, the farming community is under distress due to lack of market. In view of this, a robust skill development program would ensure that technical, vocational education and training of consistently high quality, relevant to the needs of industry are accessible to interested stakeholders including underprivileged groups and women. Moreover, a routine skill gap assessment for existing and emerging job roles needs to be prioritized to ensure a skilled task force is always available to be employed in a broad range of blue growth industries.

The priority sectors that are key blue economy drivers for enhanced employment generation and socio-economic development are the Port and Maritime sector, fisheries sector, tourism & hospitality sector. The increase in port development activities, waterfront marina development, industrial development, increased urbanization, smart city initiatives etc. will attract a large talent pool of skilled and professional manpower. The following are some of the established and potential emerging sectors of the Blue Economy in the state for which skill

development training of various cadres such as operative grades, administration, skilled trades, associate professional and technical grades as well as professional grades could be augmented:

1. Ports and allied sectors

New Mangalore Port Trust (NMPT), a major port in the state handles general cargo, edible oil, bulk cement, crude oil, LPG, coal, chemicals, liquid ammonia/ Phosphoric acid, bulk cargo etc. Port & maritime sector is currently demanding a skilled workforce which is difficult to find in the job market. At present, there are no sector specific training institutes providing training for port operations. However, there is an in-house training division that imparts skill training on cargo handling and material handling.

The various job roles in the sector of Maritime Transport, Shipbuilding and services are as follows:

Job roles in Maritime Transport, Shipbuilding and services				
Operative grades	Administration	Skilled trades	Associate professional & technical	Professional
• General operatives • Crane/Tug operators • Deckhands • Boat crew riggers • Fork lift Operator • Winch Operator • Equipment Operator • Signalman	• HR staff • General Administrators • Receptionists • Tally Clerk	• Harbor masters • Berthing masters • Bunker brokers • Pilots • Radio operators	• Marine insurance agents • Marine underwriters • Cargo supervisors • Ship agents • Fleet Manager • Logistic Manager • Freight forwarders • Commodity traders • Charterers • Ship brokers • Ship chandlers • Equipment suppliers	• Master Mariners • Deck officers • Engineering officers • Naval architects • Marine surveyors • Hull surveyors • Cargo surveyors • Maritime analysts • Shipping accountants and lawyers • Hydrographic surveyors • Marine planners

Table 6. 1: Job roles in Maritime Transport, Shipbuilding and services

2. Manufacturing of Value-Added Products/Seafood and bio products

Manufacturing industries such as value-added fish products and novel bio-products for various applications etc. would require highly skilled and semi-skilled labor force. Presently, on the job training is provided by the industries. However, up skilling of existing workforce will have to be taken up in tune with the skills required for emerging blue economy sector requirements. This can be implemented with the help of training providers and industry partners to improve the awareness/opportunity.

The matrix below entails the jobs roles that would be required for blue economy sectors such as manufacturing of value-added products and bio-products/bio prospecting.

Job roles in manufacturing of value-added products and bio-products				
Operative grades	Administration	Skilled trades	Associate professional & technical	Professional
• General operatives • Boat crew • Deckhands • Riggers • Food production & process operatives	• HR staff • General administrators • Receptionists	• Radio operators • Production supervisors • Maintenance technicians • Mechanics • Plant operators • Maintenance and repair of fishing gear • Boat builder • Skippers-deck officer • Fishermen • Divers	• Production and process development technicians • Pollution control personnel • Safety officers • Quality assurance technicians • Lab technicians • Market development staff • Nature conservationists	• Marine scientists • Marine biologists • Fishery scientists • Microbiologists • Botanists • Earth and ocean scientists • Geneticists • Food chemists • Food technologists • New product development technologists • Food process engineers • Chemical engineers • Environmental scientists • Marine spatial planners • Fish veterinarians • Quality auditors • Food economists • Engineering officers

Table 6. 2: Job roles in manufacturing of value-added products and bio-products

3. Water based Tourism and Eco-tourism Sector

An appropriately skilled workforce in the tourism sector can offer excellent visitor experience and contribute to the inclusive growth of the tourism economy. In the long run, it is essential to identify skill gaps of workers already in the sector and train them accordingly to have a more enduring impact on the industry. Service excellence, upholding norms and standards are at the core of the tourism sector and hence providing skill sets in this direction that are demand driven are crucial as that would enhance labor market opportunities, positively sustain the industry and be a source of livelihood to local communities.

Some of the skill sets and training in the tourism sector are: lifeguard training, sustainable tourism management, hospitality management, adventure tourism and related safety skills, outdoor adventure guides, customer service skills, leadership skills, communication skills, generic management skills etc. These could be imparted to the local youth to promote the tourism/hospitality sector.

Job roles in Water based Tourism sector				
Operative grades	Administration	Skilled trades	Associate professional & technical	Professional
• Bar staff • Waiting staff • Cleaners • Drivers • Retailers • General operatives	• HR staff • General administrator • Receptionists	• Surfing and Stand-Up Paddling instructors • Canoeing/ /sea Kayaking instructors • Angling instructors • Adventure sports instructors E.g., White water rafting • Life guards • Boat builders • Tour operators • Tour Guides • Maintenance technicians • Marine engine maintenance • Electricians • Chefs	• Engineering technicians • IT technicians	• Marketing and public relations staff • Translators • Environmental Managers

Table 6. 3: Job roles in Water based Tourism sector

4. Maritime Monitoring, Security and Surveillance

Considering the vulnerability of the Karnataka coastline, the need for strengthening the state's coastal security is definitely going to be given importance to keep watch on anti-national activities like smuggling of goods, gold, narcotics, explosives, arms and ammunition as well as infiltration of terrorists through our coast. Hence the below matrix entails the positions that would be required to ensure robust maritime monitoring, security and surveillance by means of new technological advancements.

Job roles in Maritime Monitoring, Security and Surveillance				
Operative grades	Administration	Skilled trades	Associate professional & technical	Professional
• General operatives	• HR staff • General administrators	• Mechanics • Electricians • Maintenance technicians • Divers	• Web developers • Programmer/ software developers	• Network engineers • Telecoms engineers • Software engineers • Electronic engineers • Civil/ structural engineers • Systems analysts • Data analysts • Geoscientists • Oceanographers

Table 6. 4: Job roles in Maritime Monitoring, Security and Surveillance

5. Fisheries sector

The fisheries sector is a recognized employment generator that has the potential for creating livelihood opportunities for a large section of the population in the state. The present fisheries and aquaculture industry are in dire need of skilled manpower as the sector is moving from subsistence farming to commercial activities wherein a lot of scientific and technical developments are taking place throughout the world. This can be achieved by building capacities of fishers through job-specific training that can improve their incomes and empower them with latest techniques to manage post-harvest issues, processing, packaging etc. with utmost hygiene to avoid wastage and other losses. Another challenge lies in ensuring fishers receive appropriate skilling and access to latest know-how for increasing production and meet the domestic and international demand.

The Agricultural Skill Council of India (ASCI) has embarked on many initiatives to collaborate with education and research institutions, training colleges and other national bodies to create outcome-based curriculum for 26 job roles in Fisheries and Aquaculture. They are on a mission to expedite blue revolution through skill-based training and are also seeking private partnerships to provide training in fishing clusters across India.

The top job roles identified for skilling in Aquaculture sector are Aquaculture Technician, Aquaculture Worker, Freshwater Aquaculture Farmer, Hatchery Manager, Hatchery Production worker, Fish seed grower, Brackishwater Aquaculture Farmer, Shrimp Farmer, Feed Technician, Aquarium Technician, Mariculture Operator, etc. In Capture Fisheries, job roles are Marine fisherman, Inland fisherman, Fishing Boat Driver, Fishing Boat Deckhand, Fishing Boat Maintenance Worker, Fishing Boat Mechanic and other support services¹¹⁷.

As per the norms of Centre for Fishery Education (CIFE), the tentative demand of jobs in various fishery sub-sectors are provided below:

1. Fish Processing: Each processing plant, processing 10 MT of fish per day requires about 70 semi-skilled workers, 10 skilled workers and 5 technicians.
2. Fish Seed Hatcheries: A hatchery with 2-5 million fry per year capacity would require 6 technicians and 4 skilled fish farmers while a hatchery of 10-50 million fry per year would require 10 skilled fish farmers and 16 technicians.
3. Fish Feed Industry: Major industrial units require 5 fishery professionals and a medium unit requires 4 fishery professionals.
4. Deep Sea Fishing: Each deep-sea vessel requires 15 fishermen apart from professionals and technicians.

The various fishery sectors for employment are Government sectors (MPEDA, CAA etc.), private sectors, academics, entrepreneurship (Ornamental fish culture, aquaculture, hatchery and seed production, commercial pearl production etc.) and ancillary sectors (Net mending, Boat building, Manufacturing of fishing accessories, aqua feed preparation, fish oil antibiotic and aqua drug supply, Fishing by trawlers in high seas, preservation and marketing of sea products etc.)

6.8.1.1 Proposal for Blue Economy Training Institute for Research and Skill development

It is recommended to establish “**Blue Economy Training Institute and Research Centre/s**”, in order to streamline and accord due focus to promote skill development and facilitate growth in every blue economy sector. This Institute would be required to facilitate the capacity building recommendations that are entailed in the **Summary Blue Economy Development Plan** (SBEDP) by engaging the various responsible institutions.

Moreover, a Training Assessment Program (TAP) needs to be carried out district wise for farmers, fisherfolks, women, authorities related to the various blue economy sectors in line with the various recommendations outlined in the SBEDP. Tailor made training programs could be introduced after carrying out detailed market studies to identify gaps in specific skills that can boost a sustainable blue economy in the state.

The stakeholder consultation has revealed a serious gap in training needs and those currently provided (especially to fisherwomen). The Institute needs to be equipped with experts to carry out such detailed market studies. It is also essential to forecast skills which would be required in the future by collecting data through skill surveys and determining skill gaps in respect of all blue economy related sectors to meet the demand and supply of skilled human

¹¹⁷Agri Skills- Newsletter March 2018

resources. A robust monitoring mechanism and grievance redressal mechanism should be the core of this Institute for transparency in promoting the Blue Economy sector.

The Government of Karnataka has set up the Department of Skill Development, Entrepreneurship, and Livelihood in 2016 to enable the youth to acquire necessary skills for employment and livelihood promotion. The vision and mission of the department is in line with the goals this proposed institute is foreseen to achieve.

Establishing the proposed institute will help to provide particular focus to skilling in all the established and emerging blue economy sectors. The Institute could plan for the training needs of the local communities by identifying skill gaps and providing various training to create livelihood opportunities. The Institute can also carry out targeted marketing and involve in continual improvement in the sector based on inputs from customer experiences/satisfaction.

The proposed Sagarmala project would also lead to creation of Special Economic Zones (SEZs) along the coastline of the state as already established in Dakshina Kannada i.e., close to the major port in the state (NMPT). These industries would create a plethora of job opportunities. To bridge the demand and supply gap, the industries (including contractors and sub-contractors) could plan their manpower requirement, skills required in the candidates etc. beforehand (prior to 6months) and inform the Blue Economy Training Institute. The institute could then plan to provide skill training for that job role to suitable candidates giving preference to women wherever feasible and disadvantaged/underprivileged persons or communities.

Establishing the proposed institute will help to provide particular focus to skilling in all the established and emerging blue economy sectors. The Institute could plan for the training needs of the local communities by identifying skill gaps and providing various trainings to create livelihood opportunities. For example, the growing cruise tourism sector would require well-trained and certified tour guides with exceptional communication and management skills who could be trained in the Institute. Further, the Institute can also carry out targeted marketing and involve in continual improvement in the sector based on inputs from customer experiences/satisfaction.

Efforts in the direction of skill development and training have already seen light in the state with a Skill Development and Safety Training Centre established in the College of Fisheries, Mangaluru (Hoige Bazar Campus) under Mangaluru Smart City Mission with funding of INR 4.9 crores. This project aims to provide state of the art training facilities, skill development and hands-on training to local unemployed youth, school & college drop-outs and home-makers, primarily from the fishing and farming communities to enhance employment opportunities in local industries as well as outside ventures with standardized certification processes.

In addition to long term training, short term and vocational training are also proposed to be imparted to the desirable beneficiaries. The following are skill development trainings proposed to be offered at the training center:

- i. Artificial feed preparation and culture of live fish food organisms
- ii. Fish feed manufacturing and nutrients mix
- iii. Fish breeding and seed rearing
- iv. Breeding of ornamental fishes
- v. Fish and shrimp pond preparation and maintenance
- vi. Fresh fish preservation and marketing

- vii. Preparation and value addition to fish by-products
- viii. Aqua clinics
- ix. Fish, Shellfish, Coral and Mangrove Taxonomy
- x. Design, manufacturing, operation, maintenance and repair of fishing craft and fishing gear
- xi. Design, manufacturing, operation, maintenance and repair of fisheries related equipment such as refrigeration, ice making, fish product preparation etc
- xii. Water budgeting & its conservation measures for different aquaculture systems
- xiii. Water quality analysis and testing
- xiv. Water purifiers, aerators, aquaculture equipment manufacturing
- xv. Aquaculture engineering in pond preparation, water and electric systems
- xvi. Scuba diving, snorkeling, etc.
- xvii. Lifeguard
- xviii. Beach beautification and designing recreational activities

The tentative syllabus for imparting these skills is outlined below:

1. Aquarium fabrication, maintenance and propagation of ornamental fish

Fabrication, setting up and maintenance of freshwater and marine aquarium, Water quality management, Water filtration system biological, mechanical and chemical; Aquarium plants and their propagation: Lighting and aeration, Aquarium accessories and decorative Aquarium fish feeds-dry, wet and live feed, breeding and rearing of ornamental fishes Brood stock management, Management practices of ornamental fish farms, Common diseases and their control; Conditioning, packing transport and quarantine methods, Trade regulations and wildlife act in relation to ornamental fishes.

2. Aquaponics/Hydroponics integration with kitchen gardening

Design and construct a basic Aquaponic grow-out technologies, apply Best Aquaculture Practices (BAP) for culturing fishes in an Aquaponic setting: Water quality parameters and management to maximize fish, plant and microbial outputs in an Aquaponic setting Use best agricultural practices (BAP) for plant crop production in Aquaponic setting Seedlings for planting, harvest produce, stagger production of both plant and fish and apply food safety procedures. Horticultural crops Vs greenhouse management Assessment of water quality, Principal factors involving EC and pH, Assessment of plant structure, photosynthesis, nutrition Common pests and control: spider mites, whitefly, thrips, fungus gnats, aphid, russet mite, broad mite, caterpillars, etc. Plant health, harvesting, grading, and marketing.

3. Production of value-added fish products and promotion

Preparation of salted fish, dried fish and smoked fish, Quality assessment of salted, dried and smoked fish; Preparation of prawn, squid and fish pickles, fish fingers; fish cutlet, fish roll; fish chutney, fish wafers, fish nuggets, fish samosa; fish sandwich; fish pakora, fish papad: fish sausage; fish cakes burgers; fish noodles; fish-soup powder, fish flakes fermented fish sauce and marinated products: Surimi and Surimi based products; diversified and value added fish products: Quality assessment of market samples of dried and fermented fish products.

4. Advanced technology of fish preservation and its reward

Different models and capacities for hygienic drying of fish, Hybrid model Solar dryers Eco-friendly and hygienic drying by harnessing solar energy during favourable weather conditions without changing its colour and flavour, Improved shelf life and value addition to fish products for higher income generation, preservation of fishes, chilling methods, smoking of fishes, sun drying of fishes; wet and dry salting of fishes, salt curing techniques, other preservatives to improve shelf life of fish, packaging technology

5. Utilization of fish waste for manure

Preparation of fish meal, fish oil, fish liver oil, fish silage; ensilage fish glue, fish gelatin, chitin, chitosan and fish manure; preparation of acid and fermented silage, preparation of fish protein concentrate and fish hydrolysate, utilization of fish wastes like scales, fins, skin, vertebrae, viscera etc for extraction of fish oil, cosmetics and production of fertilizers for plantation crops underutilized fishes like discards and by-catch for production of fish meal and animal feed; utilization of crustaceans shells for production of chitin and chitosan for pharmaceutical industries, extraction of seaweeds for agar and gelatin production

6. SCUBA diving and Snorkeling

Training for SCUBA divers and Snorkelers will skills needed to manage risks and effectively handle surface and in water problems and diving emergencies including assists transports, surface rescue, depth rescues and using shore/ boat-based personnel to assist in the rescue; Beneficiaries to be exposed to search and recovery, Light salvage and full-face masks with underwater communications

7. Modernization and safeguarding of fishing boats

Traditional boat building modern wooden boat building, fiber reinforced plastic (FRP) boat building; instruction in outboard engines, fuel systems, diesel engines, inboard engine propulsion systems and hull design diagnose, repair and maintenance of various boat components including motors, transmissions and stem drive engines, opportunities for off-site training at local boat repair yards and ship building yards, various materials used for boat making, shipping industry as a means of entrepreneurship development

8. Manual fish net making and mending

Study of net making tools, knots and hitches used in net making methods of net making hand braiding chain mesh method and loop methods of net making, shaping of webbing baiting, creasing and reducing mesh size step by step, tailoring method: T and N direction of webbing, T-cuts, N-cuts, B-cuts and their combination joining of net pieces; net mounting hanging coefficient, hung depth and their calculation methods of net mounting reeving stapling and norselling, mending and net shooter techniques.

The skill development training would be imparted by the faculty of the College of Fisheries, Mangaluru, private entrepreneurs, industrialists, scientists from different institutes, NGO representatives etc. Hence, this Skill Development Centre and Safety Training Centre could be upgraded to being a nodal “Blue Economy Training Institute and Research Centre” by infusion of adequate funds to take up skilling, up-skilling and capacity building programs related to the various blue economy sectors. It is also proposed to set up such centers in other districts of the state to cater to the skill development needs of several blue economy stakeholders across the state. This would result in maximizing job opportunities for local communities especially women and other marginalized/disadvantaged communities.

CHAPTER 7

STAKEHOLDER CONSULTATION

Chapter 7: Stakeholder Consultations

7.1 Stakeholder recommendations received by E-mail

This section presents the summary of the responses received from key stakeholders for the draft brief status papers and recommendations on “Rapid Assessment of Blue Economy Potential in Karnataka” by E-mail.

The key stakeholders to the various sectors of the Blue Economy were identified as listed below and the draft brief status papers and draft recommendations were shared (E-mail) for their review, inputs and suggestions.

Sl. No.	Institution/ Department	Contact Person
1	Central Institute of Brackish water Aquaculture (CIBA)	Director
2	Central Institute of Coastal Engineering for Fishery (CICEF)	Director
3	Central Inland Fisheries Research Institute (CIFRI)	Principal Scientist and Officer-in-Charge
4	Central Marine Fisheries Research Institute (CMFRI), Mangaluru	Principal Scientist and Scientist in charge
5	Central Institute of Fisheries Education (CIFE)	Director
6	Central Institute of Fisheries Nautical & Engineering Training (CIFNET)	Director
7	Central Institute of Fisheries Technology (CIFT)	Director
8	Central Institute of Freshwater Aquaculture (CIFA)	Principal Scientist
9	Centre for Environment Education (CEE)	Regional Coordinator
10	Coastal Aquaculture Authority (CAA)	Member Secretary
11	Coastal Development Authority (CDA)	Chairman
12	Coastal Security Police (CSP)	Superintendent of Police
13	Department of Energy, Govt. of Karnataka	Additional Chief Secretary
14	Department of Fisheries, Govt. of Karnataka	Director of Fisheries
15	Department of Forest, Ecology & Environment, Govt. of Karnataka	Principal Secretary and Regional Director, Mangaluru(Nodal Officer)
16	Department of Home, Govt. of Karnataka	Additional Chief Secretary
17	Department of Mines & Geology, Govt. of Karnataka	Director
18	Department of Personnel and Administrative Reforms (DPAR), Govt. of Karnataka	Additional Chief Secretary
19	Department of Ports and Inland Water Transport (P&IWT), Govt. of Karnataka	Director
20	Department of Revenue, Govt. of Karnataka	Principal Secretary
21	Department of Tourism, Govt. of Karnataka	Director

22	Deputy Commissioner, Dakshina Kannada District	Deputy Commissioner
23	Deputy Commissioner, Udupi District	Deputy Commissioner
24	Deputy Commissioner, Uttara Kannada District	Deputy Commissioner
25	Directorate General of Hydrocarbons (DGH)	Directorate General
26	Directorate of Municipal Affairs	Director
27	Environmental Management & Policy Research Institute (EMPRI)	NA
28	FISHCOPFED (The National Federation of Fishers Cooperatives Ltd.)	Managing Director (In charge)
29	Fishery Survey of India (FSI)	Deputy Director General
30	Geological Survey of India (GSI)	Director General
31	India Meteorological Department	Director-In-Charge
32	Indian Coast Guard, MRSC New Mangalore	Officer-in-Charge
33	Indian Fish Meal and Fish Oil Exporters Association (IFMFOEA)	NA
34	Jungle Lodges and Resorts (JLR)	Managing Director
35	Karnataka Biodiversity Board (KBB)	
36	Karnataka Biotechnology and Information Technology Services (KBITS)	
37	Karnataka Power Corporation Limited (KPCL)	Managing Director
38	Karnataka Renewable Energy Development Ltd (KREDL)	
39	Karnataka State Natural Disaster Monitoring Centre (KSNDMC)	Director
40	Karnataka State Pollution Control Board (KSPCB)	Chairman
41	Karnataka State Remote Sensing Applications Centre (KSRSAC)	Director
42	Karnataka State Small Industries Development Corporation (KSSIDC)	Director
43	Karnataka State Tourism Development Corporation (KSTDC)	Managing Director
44	Karnataka Fisheries Development Corporation	Managing Director
45	Mangalore Refinery & Petrochemicals Limited (MRPL)	Director (Refinery)
46	Marine and Coastal Survey Division, Geological Survey of India	Head of the Department
47	Marine Products Export Development Authority (MPEDA)	Director
48	Ministry of Earth Sciences	Secretary
49	National Bank for Agriculture and Rural Development (NABARD)	Chief General Manager

50	National Bureau of Fish Genetic Resources (NBFGR)	Director
51	National Centre for Sustainable Aquaculture (NaCSA)	NA
52	National Centre for Sustainable Coastal Management (NCSCM)	Director
53	National Fisheries Development Board (NFDB)	Chief Executive
54	National Institute of Advanced Studies (NIAS)	Director
55	National Institute of Fisheries Post Harvest Technology and Training (NIFPHATT)	NA
56	National Institute of Ocean Technology (NIOT)	Director
57	National Institute of Oceanography (NIO)	Director
58	Network for Fish Quality Management and Sustainable Fishing (NETFISH)	President
59	New Mangalore Port Trust (NMPT)	Chairman
60	Pilikula Nisargadhama	Executive Director
61	Public Works Department (PWD)	Principal Secretary
62	Rajiv Gandhi Centre for Aquaculture (RGCA)	NA
63	Rural Development and Panchayat Raj Department (RDPRD)	Principal Secretary
64	Rural Drinking Water and Sanitation Department, Govt of Karnataka	Secretary
65	Salt Commissioner	Salt Commissioner
66	Skill Development, Entrepreneurship and Livelihood, Govt of Karnataka	Secretary to Government
67	Social Welfare	Commissioner
68	Space Applications Centre	Director
69	Tungabhadra Board	Assistant Secretary
70	Watershed Development	Director
71	Senior Assistant Director of Fisheries	Mr. T.S. Vishwanath
72	Senior Deputy Director of Fisheries (In-charge), Mangaluru	Mr. Harish Kumar
73	Senior Deputy Director of Fisheries, Karwar	Mr. P. Nagaraj
74	Senior Deputy Director of Fisheries, Udupi	Mr. Ganesh K.
75	Associate Professor & Head, Fisheries Research and Information Centre (Inland)	Dr. Manjappa N
76	Consultant, Social Development	Dr. Maya Sitaram
77	Director, Sanctuary Beach, Singapore	Dr. Joseph Mathew
78	Fisheries Consultant, Fish Stock Assessment Expert, Former Professor & Head, College of Fisheries Mangaluru	Dr. Nachiappan Jayabalan
79	Former Director, National Centre for Earth Science Studies	Dr. N. P. Kurian

80	Former Emeritus Scientist (Economics) Indian Council of Agricultural Research and Former Professor of Fisheries, Economics	Dr. Ramachandra Bhatta
81	Former Executive Director, CAT-ESSC (Centre for Advanced Training in Earth System Sciences and Climate)	Dr. M. Baba
82	Former Managing Director, Karnataka Fisheries Development Corporation	Dr. Vichitra Kumar Shetty
83	Professor & Head, Department of Applied Mechanics and Hydraulics, National Institute of Technology, Karnataka (NITK)	Dr. Dwarakish G. S
84	Professor, Department of Social and Economic Sciences, Indian Institute of Sciences	Dr. A. Damodaran
85	Professor (Dept. of Marine Geology), Director (PMEB) & RUSA Nodal Officer, Mangalore University	Dr. K. S Jayappa
86	Retired Professor, College of Fisheries, Mangaluru	Dr. B.A. Shamasundar
87	Retired Survey General of India, Consultant NCSCM	Dr. M. Dharma Raj
88	Senior Consultant, Professional Fisheries and Agricultural Consultancy	Dr. Dasappa Seenappa
89	Assistant Professor (Research), Gujarat National Law University	Mr. Tarun Singh
90	The Honorable Vice Chancellor, Pondicherry University	Prof. Gurmeet Singh
91	Ashoka Trust for Research in Ecology & the Environment (ATREE)	NA
92	Canara Green Academy	Mr. Ravi Pandit
93	Dakshin Foundation	Associate Director
94	Centre for Research in Alternative Farming Technology (CRAFT)	NA
95	Nature Conservation Foundation (NCF), Mysuru	Administrative Director
96	Society for Marine Research & Conservation	NA
97	FSL India	President

The following are the responses received (by Email) from various stakeholders on the draft brief status papers and recommendations. These inputs have been included in the various Chapters and the Summary Outline Blue Economy Development Plan.

7.1.1 National Fisheries Development Board (NFDB)

NFDB nominated Dr. Vijaykumar Yaragal, Executive Director (vijaympeda@gmail.com, 9445151368) as their nodal officer. The following recommendations were provided by

Dr. Vijaykumar Yaragal via email dated 06-05-2021 at 3:06PM.

The following are the inputs to the existing recommendations:

1. NFDB has a scheme for establishing fish/shrimp hatcheries through the state fisheries department.
2. NFDB supports women and vulnerable sections with 60 percent assistance to take up crab/mussel/seaweed farming. Co-operative societies and FFPO can be formed under govt assistance to establish a good market for their produce.
3. NFDB supports seaweed farming on top priority and arranges awareness training with the state fisheries department to encourage seaweed culture and to provide employment.

The following are the new recommendations:

4. Training and awareness programs will also be supported by NFDB.
5. Seaweed farming and its products development for local consumption to be considered.
6. Domestic marketing of value-added fish products to be encouraged.
7. MIS establishment may be looked upon
8. Livelihood of the fishermen is considered during the fishing ban period.
9. NFDB supports fisher training and the same may be proposed through institutes or state Fisheries department.

7.1.2 Central Institute of Fisheries Technology (CIFT)

CIFT nominated Dr. M.V. Baiju, Sr. Scientist (vishnubaiju@yahoo.com, 9447464697) as their nodal officer. The following new recommendations were provided by Dr. M.V. Baiju via email dated 07-05-2021 at 10:24AM.

1. Fishing vessel design and construction to be standardized and have uniform engine power, for avoiding conflicts among fishers: Formulate an agency at State level to address this issue.
2. Implementation of Turtle and Juvenile Excluder Devices: Mandatory to have excluder devices for issue of license.
3. Square mesh cod end implementation: Mandatory to have square mesh cod end for issue of license.

7.1.3 Dr. Shailesh Nayak (Director-National Institute of Advanced Studies)

(director@nias.res.in, shailesh@nias.res.in, 9868262969, 080-23601969)

Dr. Shailesh Nayak provided the following inputs to the existing recommendations via emails dated 06-05-2021 at 05:28PM and 09-05-2021 at 10:59AM:

1. It is necessary to plan activities as per available hazard maps.
2. The technology to scale up biofuel from microalgae is a challenge. Although it has been demonstrated in the lab, the technology development for commercial production is a necessity.
3. Establish Marine Biotech Parks for bio-prospecting of various species of seaweeds, mangroves, potential aquatic plants & animals, seafood by-

products/wastes etc. for production of bioactive compounds/synthetic molecules for commercial applications

4. Ensure development of ornamental fishery.
5. The Ocean Thermal Energy Conversion (OTEC) technology is yet to be developed. Although ESSO-NIOT has been working on it, at present, it is not a viable option.
6. The development of island tourism is worth pursuing. However, the model of Maldives tourism is not sustainable.
7. Developing beaches as 'Blue Flag' beaches is an ideal proposition.
8. Water Sports activities such as surfing, parasailing, jet skiing, paragliding, speed boating and other adventure sports can be started with Kasarkod and Padubidri, already identified as 'Blue Flag' beaches.
9. OTEC technology is yet to be demonstrated. Hence, other renewable energy sources such as solar or wind to be explored to power desalination plants for Islands off Karnataka's coast which may be proposed to be developed as resorts/hotels/tourism facilities.
10. It may be necessary to recommend carrying out research related to understanding of pathways from source to sink, especially plastic litter and spatial and temporal distribution of marine litter.
11. An annual monitoring of coastal and estuarine ecosystems, especially mangroves, using remote sensing to be undertaken.
12. It may be useful to propose an Empowered Group having executive powers for coordination and implementation of various actions/tasks proposed/recommended.

7.1.4 Dr. Vichitra Kumar Shetty (Former Managing Director, Karnataka Fisheries Development Corporation) (vikushetty@rediffmail.com, 9845145953)

Dr. Vichitra Kumar Shetty provided the following new recommendations via email dated 09-05-2021 at 03:25 PM:

1. Creation of an engineering unit under the control of the Director of Fisheries for smooth planning and execution of fishing harbors, landing centers, fisheries roads, fish markets & fish farms.
2. Procurement of suitable dredger with required staff for creating safe navigation of fishing boats-capital and maintenance dredging of Ports & Fishing harbors
3. Creation of Harbor Management Societies with required staff for proper management and development of fishing harbors and fish landing centers
4. Creation of as special Police Wing under Director of Fisheries for proper implementation of KMFR act, Inter and intrastate disputes etc.
5. Creation of a technical committee to decide the feasibility of no. of mechanized boats to be introduced in DK, Udupi and UK districts to conserve the marine fish resources in a scientific way
6. Creation of statistical unit with required enumerators to collect marine fish data and other important fisheries data in the state Will help to know the real picture of marine catches so as to plan for conserving marine fish resources

7.1.5 Dr. B.A. Shamasundar (Retired Professor, College of Fisheries, Mangaluru) (bashamasundar@gmail.com, 9448250057) has provided general comments on the

document structure and contents via email dated 09-05-2021 at 10:30 PM. Additionally, he has provided several inputs during the online stakeholder discussion.

7.1.6 Dr. Prathibha Rohit (Principal Scientist and Scientist in charge, CMFRI, Mangaluru) (prathibharohit@gmail.com, prathibha.rohit@icar.gov.in, 9916129255) has suggested her inputs via email dated 09-05-2021 at 11:15PM.

Dr. Prathibha Rohit has provided reference to The Marine Fisheries Policy Series -5 “Management Plans for Marine Fisheries of Karnataka” which has addressed several points mentioned in the recommendation pertaining to Sustainable harvesting and conservation strategies for living resources and Strategy for augmentation of institutional capacity and human resources development in a blue economy context. She has suggested to include the recommendations mentioned in this document in the final summary blue economy Plan. The major recommendations in the said document are as follows:

1. Overcapacity may be reduced by strict compliance of registration of fishing vessels with a validity of 10 years and fleet strength to be maintained at 1,312 for multi-day fleet (MDF), 729 for single-day fleet (SDF), 182 for mechanized purse seiners and 2,330 for Out board (OB) crafts
2. Controlled license measures for craft-gear combination and engine speed length ratio
3. Compliance of mesh size regulation and Minimum Legal Size and maintenance of Log books
4. Regulate light-based fishing, strengthen enforcement to prevent pair trawling and strengthen cold chains and marketing infrastructure.
5. Subsidy to be linked to compliance and given as incentive to those following responsible fishing practices
6. Ecologically sensitive areas and identified breeding as well as juvenile grounds to be declared as fish refugia's.
7. Permission to establish new fish meal plants to be done only after thorough review of the status of fishery resources
8. State to impress upon the Centre to formulate fisheries laws for fishing between 12-200 nm
9. Formulate water lease policy for mariculture activities; establish collection and marketing centers and common depuration units to improve quality as well as price of farmed products
10. Welfare programs for traditional fishers to be implemented and 'Safety net' for migrant laborers to be introduced
11. The fishing activity being a dynamic process, where several players target common natural resources, needs to be regulated to ensure and safeguard fair access, sustainability and profitability for all. However, the recommendations need to be reviewed periodically and updated in the backdrop of the important role of fisheries in meeting food and employment requirements of the coastal fishers, taking into account changes in stock status to achieve the objectives of sustainable fishing for years to come. Good management of the available fishery resource can be achieved only by the concerted collective efforts of the researchers, enforcement wings and the implementing authorities.

7.1.7 Nature Conservation Foundation (NCF)

Mr. Rohan Arthur (rohan@ncf-india.org, 0821-2515601) and Mr. Mayuresh Gangal, Research Scholar have been nominated as nodal officers from Nature Conservation

Foundation, Mysuru. They have provided their inputs via email dated 10-05-2021 at 05:39 AM.

The following are the inputs suggested by them on the existing recommendations:

1. Detailed studies should be undertaken to determine population sizes and vulnerabilities of commonly landed fish species using modern genetic tools like “genetic population structures” and “effective population size using allele frequencies”. Annual documentation of life history parameters (listed in fish base) should be undertaken for all the species which are landed. Estimation of Maximum extractable Catch should be done annually using information from population vulnerabilities and life history parameters using Ecosystem based fisheries management tools like ECOPATH and ECOSIM. These studies should be carried out in collaboration with other Government institutes and research institutes from the non-government sector.
2. Reduce the number of fishing fleet to the optimum level in a phased manner starting with discontinuing registration of new mechanized vessels for an initial period of five years on high priority
3. Disincentivize active methods of fishing by discontinuing benefits (Subsidies, schemes) given for repair of Trawl and purse seine fishing (vessels and gear)
4. Adopt strict policies to ensure coastal waters up to 6 km from the coastline are made available to the traditional, small scale artisanal fisher folk by using GPS based tracking of Mechanized fishing vessels (safety and tracking)
5. Impose gear wise fishing restrictions need to be design to protect breeding periods of majority of fish caught in that gear type in consultation with National governmental and Non-governmental Scientific Research bodies
6. Strictly enforce the ban on manufacturing and use of all types of destructive fishing methods including small mesh size gears, light fishing, bull trawling and impose strict fines on violators including cancellation of permits on high priority
7. Facilitate implementation and enforcement of legislation by adequate staffing, technical training and legal empowerment of Coastal Security Police Force
8. Identify and demarcate places of fish breeding within the marine areas and coastal backwaters as protected zones in consultation and collaboration with National governmental and Non-governmental Scientific Research bodies and local Gram-Panchayat / other traditional fisheries institutions.
9. Extend micro financing to Non mechanized fishing operations for procurement of raw materials and maintenance of boats and gears
10. Provide financial assistance during fishing ban to the families of active marine fisher who fish by using non mechanized fishing techniques
11. Develop and manage a robust Monitoring, Control and Surveillance (MCS) regime including necessary infrastructure facilities (AVMS).
12. Provide assistance for insurance cover to fishing vessels of the marine fishermen with valid license for incidents which occur in permitted period and permitted area for that particular fisherman/ fishing vessel
13. Extend complete fuel subsidy only to non-mechanized registered fishing vessels and those mechanized registered fishing vessels which use passive fishing methods. For Other registered Mechanized fishing vessels there should be 25 percent reduction in the subsidy on gear and 20 percent reduction in subsidy on fuel.
14. Carry out experimental studies on ranching to explore its effects on nearshore ecosystems and communities. An Environment and Social Impact Assessment (ESIA) by an independent committee comprising of Ecologist, Fisheries Scientist, Social

Scientist and Hydrologist should be made mandatory before starting all the Ranching projects. No ranching project, Inland or Marine should be permitted in the areas which are ecologically important, important for capture fisheries (nursery areas, fisheries reserve, spill over zones etc.) and vulnerable communities (small scale fishers, traditional fishing grounds). This will allow sustenance of traditional fisheries and communities and safeguard current fish stocks.

15. Upgrading effluent treatment plants of fish meal plants to comply with water quality and pollution standards to be made mandatory. No license should be given to new fish meal plants.
16. Undertake study for Marine Spatial Planning and prepare a Coastal Master Plan in collaboration of government and non-government research institutes. Identify areas which are ecologically important (Ecologically important ecosystems, Critical Ecological habitats, protected areas Marine Protected Areas, Fish Sanctuaries), important areas for capture fisheries (Fisheries reserves, Community run fisheries reserve, Spill over zones) and areas important for vulnerable communities and non-mechanized fisherfolks. (Territorial User Rights for Fishing (TURFs) and Traditional Fishing areas). No activity apart from small-scale non mechanized fisheries and traditional fisheries should be allowed in this area. This has to be taken on high priority with responsible institutions such as MoES, MoEF&CC, NCCR, Government and Non-Government research institutes, Local fisheries societies, Gram panchayat, fisheries Unions.
17. Strictly monitor and implement mesh policy restriction on trawl (cod net size of at least 35 mm, MFRA2019) and purse- seine nets (mesh size at least 30mm) by Department of Fisheries and coastal police
18. Experimental studies on Mariculture can be conducted to explore its effects on nearshore ecosystems and communities on a low priority to ensure sustenance of local ecologies and safeguarding current fish stocks and local livelihoods. Environment and Social Impact Assessment by an independent committee of Ecologist, Fisheries Scientist, Social Scientist and Hydrologist should be made mandatory before starting all Mariculture projects. No Mariculture project, Inland or Marine should be permitted in the areas which are ecologically important, important for capture fisheries (nursery areas, fisheries reserve, spill over zones etc.) and areas which are important for vulnerable communities (small scale fishers, traditional fishing grounds).
19. They recommended LOW implementation priority for all proposed Mariculture and Coastal Aquaculture
20. Demarcate estuaries that are in the breeding, spawning and migratory routes of fish and shellfish as fish sanctuaries with the help of government and non-government research organizations.
21. Along with on shore efforts fishermen should be encouraged to collect ghost nets in the water and deposit in safe disposal units installed by responsible departments.
22. Identify degraded coastal and estuarine areas. Undertake intensive mangrove restoration measures. Ensure protection of existing mangrove ecosystems and removal of deleterious impacts.
23. Mangrove planting and maintenance should be undertaken as per natural zonation in mangrove ecosystem
24. Provide financial support to NGOs and other governmental organizations working towards ecological security, conservation of aquatic biodiversity, welfare, safety and livelihood of fishermen and fisherwomen in coastal areas

25. Pilot projects of Agri-pisciculture can be tried in areas which are NOT ecologically important, not important for capture fisheries (nursery areas, fisheries reserve, spill over zones etc.) and vulnerable communities (small scale fishers, traditional fishing grounds).
26. Tagging of turtles and green wall concept (Avoid casuarina)
27. Provide financial support to NGOs and other governmental organizations working towards ecological security, conservation of aquatic biodiversity, welfare, safety and livelihood of fishermen and fisherwomen in coastal areas

The following are the new recommendations:

28. The Fisheries Department should work actively on high priority with small scale fishing institutions to develop Territorial User Rights of Fisheries (TURFs). These co-managed nearshore fisheries should be based on approved management plans and sufficient rights and responsibilities devolved to local user groups. This will ensure co-management with small scale fishers for sustainable harvest of nearshore resources. (Responsible institutions: Department of Fisheries, FISHNET, SDEL KFDC, NFDB)
29. Detailed studies should be carried out on high priority to identify the geographical extent of populations of commercially important fish species using modern genetic and genomic techniques. This will provide protection of fish stocks of commercially important species for sustainable harvest. (Responsible institutions: Department of Fisheries, CMFRI, Other governmental and non-governmental research institutes)
30. The Department of Fisheries must put in efforts in identifying the biological extent of our fish stocks and initiate active dialogue with neighboring states on high priority regarding coordinating fisheries activities to ensure consistency not just in regulations but also in relevant schemes, subsidies to safeguard fish stocks of commercially important fish by minimizing impacts of un-coordinated harvest regimes and minimizing conflicts.
31. Environment and Social Impact Assessment by an independent committee comprising Ecologist, Fisheries Scientist, Social Scientist and Hydrologist should be made mandatory before starting all Aquaculture, mariculture, Ranching and seaweed cultivation projects for sustenance of local ecologies and safeguarding current fish stocks and local livelihoods. The same has to be carried out annually to ensure safeguarding the local environment, living-natural resources, local biodiversity and local vulnerable communities.
32. Intensive production techniques such as Aquaculture, Mariculture, Ranching and seaweed cultivation project are associated with a host of serious environmental issues (Land salinization, antibiotic overuse leading to resistance, destruction of local flora and fauna, escape of cultured species, invasive species, pollution, eutrophication, dependence on reduction fisheries leading to overfishing) and social justice issues (infringement on access rights of local community, high barriers to entry and exit, aggravation of economic divide). There is a wealth of literature highlighting these deleterious impacts. In addition, rarely do the economic profits of these ventures match the environmental damage or social disruption they bring in their wake. Thus, it is recommended to employ an abundance of caution in the execution of these activities, backed by rigorous scientific studies and regulated by a set of stringent rules, impact assessments, monitoring protocols and means to ensure/enforce compliance. Hence, safeguards which will protect ecological integrity and rights and livelihood of the local community should be drafted as a part of this document on a top priority basis. We recommend that activities like mariculture, seaweed farming, and ranching should be limited in their scope and not be undertaken in areas which are a.) Ecologically important, b.) Important for capture fisheries (nursery areas, fisheries reserve, spill over zones etc.) and c.) areas which are important for vulnerable communities (small

scale fishers, traditional fishing grounds). These need to be part of the marine spatial planning exercise and strongly enforced. Hence, mandatory pilot studies and specific impact assessments for all proposed aquaculture activities like mariculture, seaweed farming, ranching, by a committee of subject experts for assessing the risk of these serious environmental and social justice issues and evaluate the immediate and long-term impacts on near and distant ecosystems is also strongly recommended for sustenance of local Ecologies and safeguarding current fish stocks and local livelihoods.

33. Recognition of existing traditional fisheries management institutions. Steps should be taken to actively encourage and rebuild formal and informal traditional fisheries management institutions present along the coast. These institutions need to be recognized and given adequate agency for protection of traditional rights of fisheries, conservation of Local Ecological Knowledge (LEK) and coastal cultural practices.
34. Value addition of high-value target fisheries should be encouraged with the provision of adequate infrastructure for processing and handling at the time of capture (on boat facilities), increasing efficiency of ship-to-shore processes and increasing efficiencies in the supply chain. Training should be provided to fishers for value addition in processing, handling and packaging of fish. Ecological and Origin Certification programs need to be pursued. All these need to be done with the active involvement of the gram Sabha and/or local fisher institutions. This ensures that high-value target fish remain profitable and that bycatch and reduction fisheries are disincentive.
35. Any exploration regarding extraction of non-living resources should be undertaken only in the area which is not listed as ecologically important and no activity regarding extraction of non-living resource should be undertaken without approval from local gram-panchayat, Fisheries society and MoEF&CC, ensuring safeguards for the local environment, living-natural resources, local biodiversity and local vulnerable communities.
36. Moreover, Environment and Social Impact Assessment by an independent committee comprising Ecologists, Fisheries Scientists, Social Scientists and Hydrologists should be made mandatory for the application of permission or NOC for all projects involving extraction of Non-living resources. Also, the same has to be carried out annually to assess ongoing impacts, if any. This is to ensure that the negative impacts of harnessing non-living resources on fisheries and other living resources, including biodiversity, are minimized and mitigated.
37. Proposals on national waterways development in small rivers might come with great costs to fishery resources, through dredging, construction of navigation channels and ports, and vessel movement. There is a need to have strong environmental safeguards in place to monitor and objectively evaluate the impacts of such projects that are cumulative along with the existing water infrastructures, especially hydropower projects and storage dams that are causing damage to ecological indicators. Even worse impacts are likely with sand and rare earth mineral mining, communication cables, etc. Spatial zoning to minimize impacts, along with strict environmental safeguards and assessments by independent agencies, are critical in this regard.
38. Any activity related to tourism should be undertaken only in areas not listed as Ecologically Important and with prior approval from local gram-panchayat, Fisheries society and MoEF&CC. An initial as well as annual Environment and Social Impact Assessment by an independent committee comprising Ecologists, Fisheries Scientists, Social Scientists and Hydrologists should be made mandatory for the application of permission or NOC for all tourism and allied projects. This is to ensure that the negative impacts of tourism and allied activities on ecology, biodiversity and local capture fisheries are minimized and mitigated. Experiences from the past have made us aware that tourism and allied activities have a potential to constrain land use activities of

vulnerable fishing communities while being highly destructive of natural ecological processes. While promoting efforts to maximize social benefits we need to be mindful that these alternate efforts do not come in the way of current livelihoods and land use of the fishing community.

39. Policies ensuring environmental flows in all regulated rivers of Karnataka are absolutely essential. Securing environmental flow regimes maintained by dams and hydropower projects (both large and small) is a fundamental prerequisite for proposed sanctuaries and aqua parks. River ecosystems and their potential to contribute to the Blue Economy can be enhanced by first thinking "small". This can begin by considering the overall extent of dependence of people on capture fisheries in different rivers and estuaries across Karnataka. To sustain productive capture fisheries and secure livelihood and access rights of these fishers should be a priority. A significant contribution to this aim is to manage existing water infrastructure by accounting for the river flow requirements of these small-scale fisheries in all the major east and west flowing rivers of Karnataka. Monthly minimum environmental flow of all the regulated rivers should be determined in consultation with expert Hydrologists. This environmental flow should then be strictly maintained to ensure ecological security and integrity of freshwater ecosystems and livelihood security of fishers.
40. Access rights of all the inland fisherfolk fishing in natural and man-made water bodies should be recognized and any activity which alters these access rights and livelihood of fisherfolk should be strictly prohibited to ensure livelihood security of fishers.
41. Assess impact of inland fish harvesting for aquarium trade for conservation of endemic fish diversity of Karnataka.
42. Identify and conserve "fisheries heritage sites" such as Mahseer angling, bivalve fisheries along the Karwar-Kumta-Aghanashini estuaries, coracle fisheries for conservation of ecological and social heritage.
43. Fish, especially endemic species to the Western Ghats, are of great conservation importance and priority. Many of these endemic fish species are threatened by dams, hydropower projects, pollution, as well as unregulated harvesting for aquarium trade. There should be a proposal to implement ecosystem-wide measures to conserve these species. Fish are not merely food resources. They are vital elements of biodiversity. Hence, all fish species need to be granted some level of protection notwithstanding sensu stricto, their utility for food and commerce. Hence, it is important to establish community based and community run fish protection zone and harvest zones along the inland and estuarine waters based on guiding principles provided by the FAO's Voluntary Guidelines on Small Scale Fisheries (2014) and the FAO Code of Conduct for Responsible Governance of Fisheries (2012). This will give a stronger stake to local communities in harvesting as well as sustainable management of wild fish stocks.
44. Promote research and development to identify agricultural waste-based substitutes for low value fish for production of fish meal, fish feed and fertilizers thereby minimizing impact of reduction fisheries via research.
45. Build awareness on harmful practices of aquaculture, mariculture, and seaweed culture as well as inland and marine ranching activities. Provide mandatory training on environmentally sensitive aquaculture and mariculture practices for each person involved in aquaculture, Mariculture and Seaweed cultivation to encourage environmentally sensitive and responsible business models.

7.1.8 Prof. Dr. Ramesh Ramachandran (Director, NCSCM) (rramesh@ncscm.res.in, director@ncscm.res.in, 044-22200600) has provided the following recommendations via email dated 10-05-2021 at 12:56 PM:

1. Implement policy measures to limit the catch of fish species that are in a collapsed/declined state (catches less than 50 percent of historical maximum) until recovery of the stock to healthy levels through quotas to enable recovery of collapsed fish stocks so that future earnings are assured.
2. Fishing harbor design needs to be emphasized as it is closely linked to hygiene needs. Improve design of fishing harbors to ensure hygiene (provision of toilets, wash areas, water facilities) and also involve fishermen associations and other user associations including head loaders, ice suppliers etc.
3. Many fish markets have been built with poor design without stakeholder consultation, especially women's inputs. Hence, develop modern fish markets with user stakeholder inputs keeping gender requirements in mind.
4. Map common places in the fishing villages for net mending, fish drying, processing etc. Ensure such areas are protected, provide alternate options such as raised platforms, solar dryers, and net mending sheds. Usually, in traditional fishing communities such spaces are already in use. However, they may be encroached upon (roads) or lost due to erosion.
5. NCSCM could implement Marine Spatial Planning (MSP) for seas and Coastal Master Plan with identification of critical areas needing special attention and those offering potential for development.
6. Improve literacy and entrepreneurship skills of women and their health needs taking into account occupational hazards as women are employed in post-harvest activities and carry heavy burdens for long distances and suffer from fever, headache etc., also they suffer injuries related to fish processing.
7. Identify traditional market areas and improve facilities there. Many women sit by the roadside and sell fish – surveys need to be carried out to examine feasibility of regularizing such areas such as through temporal zoning.
8. Fishing regulations to avoid shark/dolphin/turtle/whales in bycatch. Ensure fishing nets have excluder devices. To be implemented by fishing co-operatives, boat owners, Fisheries Department and Forest Department.
9. Undersea pipelines for transport of crude, gas will result in decreased logistical costs and faster service. Responsible Institutions: ONGC/GAIL
10. Provide training in sustainable fisheries, navigation using modern aids, disaster response communication in high seas, maritime skills (youth from fishing communities to join merchant navy) and first aid to provide better employment opportunities and safer fishing. These trainings can be provided by National Skill Mission and Merchant Navy training institutions.
11. In Chapter 6, Annexure 1 it is essential to include key international conventions dealing with Ocean (UNCLOS), Biodiversity (e.g., CBD, Ramsar, CMS, CITES), Fisheries (e.g., UNFSA, FAO Conventions as well as guidelines such as VGSSF, CCRF, ILO conventions), Climate Change (UNCCC), Chemicals (POP, Basel), Disasters (Sendai Framework) and important relevant national policies from the Blue Economy viewpoint such as National Marine Fishing Policy, 2017, Draft National Fishing Policy, 2020, Tourism Policy, Ecotourism Policy, Sagarmala etc.
12. Chapter 6 Annexure 2 can include other relevant acts like Disaster Management Act, Forest Rights Act which are of high relevance. The list must include State Acts because many of these are locally applicable such as Karnataka Marine Fishing (Regulation) Act, 1986, Karnataka Inland Fisheries (Conservation, Development and Regulation) Act, 1996, Karnataka Fishing Harbor Terminals Authority Act, 1986, Karnataka Forest Act, 1963.

13. Chapter 6 Annexure 3 Ensure most of the stakeholders that are a part of the responsible institutions under various recommendations are included in this list.
14. Because of the wide-ranging activities even within the sphere of BE, the number of stakeholders would be high and unwieldy if they are all called together for discussions. It is advisable that such stakeholder sessions are held at multiple levels to obtain important feedback. The consultations can be held in three groups
 - a) Government
 - b) Academic
 - c) Those associated with 'blue' livelihoods such as fishermen, prawn farmers, Gazani farmers, tourist-related etc. including NGO, CSO, SHG, Coops etc

This will allow each stakeholder group to openly discuss and provide information and interventions/ solutions/ approaches that they believe will work. Earlier consultations in the fisheries sector in Tamil Nadu indicated that this approach was a lot more successful. This will enable collecting information on

- a) Skill sets available and required
- b) Whether an activity will be feasible/ meaningful or it has been tried and failed because of some reason
- c) Where can it be done and costing
- d) The interactions between various departments that would be required and what will be needed to ensure inter-departmental cooperation

Such a split consultation would also help in prioritizing activities. While the position papers may have been prepared based on a certain level of ground truthing, it must be ensured that it reflects current ground realities.

7.1.9 Centre for Environment Education (CEE)

Ms. Rejini Simpson (rejini.s@ceeindia.org, 9003240690), Regional Coordinator, CEE has provided the following inputs to the existing recommendations via email dated 10-05-2021 at 4:47PM:

1. Replacement of existing mesh design with square mesh in the cod ends for by-catch reduction. Mandatory use of fish excluder cum- shrimp sorting device and TED to conserve the biodiversity/ sea floor ecosystem and the non-targeted species in general and the endangered/threatened species in particular. Use of cutaway top belly trawl and semi and pelagic trawl system to allow escapement of juveniles promotes optimum level of fish stocks.
2. Use of biodegradable nets to be explored to avoid ghost fishing and to minimize marine debris.
3. Consider specifying Minimum Legal Size (MLS) and/or Minimum Legal Weight (MLW) for commercial species following the example of Kerala. Further, the Marine Fishing Regulation Act (MFRA) may be amended for regulating the harvest of juveniles and bycatch and setting up of fish meal plants that use low value/juvenile fish.
4. Besides fisheries, the Coastal & Marine resources are being utilized by many sectors such as tourism, shipping, oil and gas exploration, industries, etc. Therefore, it is essential that all these economic activities are carried out in a coordinated manner. In this regard, it is recommended that the State Government may consider carrying out Marine Spatial Planning (MSP) to accommodate the legitimate interests of the economic sectors and in the process reduce/eliminate possible conflicts.
5. Prepare Best Management Practice (BMPs) protocols and guidelines for cage culture, intensive aquaculture, etc. to insulate inland/marine/estuarine water bodies against

unsustainable aquaculture practices such as hyper-intensive aquaculture, higher stocking density beyond carrying capacity, import of exotic fishes' seed without clearance, illegal import of feeds and accessories and culture practices. (Responsible Institutions-CIFA, CIBA, DCFR and CAA)

6. Develop institutional mechanisms to ensure compliance of quarantine measures for the trade of ornamental fishes. Enforce regulation on transboundary import of seeds, feeds and ornamental fish species sustainable ornamental fisheries sector in the state. (Responsible Institutions- MoEF&CC, CIFA, CIBA and NBFGR)
7. Curb illegal trade of native/ endemic ornamental fishes and strengthen the monitoring mechanism. (Responsible Institutions-Department of Fisheries, MoEF&CC and MPEDA)
8. Following provisions contained in the BD Act, 2002, research institutions/companies who are accessing a country's biological resources from the EEZ for research/commercial utilization/bio-survey/bio utilization purposes should seek prior approval of the NBA/SBB for access and benefit sharing.
9. The "Sustainable River sand/boulder mining management guidelines, 2016", published by the MoEF&CC must be strictly adhered to, to ensure environmentally sustainable mining for conservation and restoration of inland aquatic ecosystems.
10. A state-level strategy is to be devised for mapping and creating a database on Invasive Alien Species from the Coastal & Marine resources. Study the problematic species and their potential threat to the Indian marine environment. Ratify the Ballast Water Management Convention. Bring out a regulation for Invasive Alien Species and their management to protect the marine environment from transfer of harmful aquatic organisms contained in ballast water. (Responsible Institutions: MoEF&CC, MoA&FW, NITI Aayog, Department of Fisheries, CMFRI, WII, Wetland International, SACON, CMLRE, CEBPOL, NIOT, NIO, NBA, SBBs, CSIR and Ministry of Shipping)

The following are the new Inputs/recommendations:

11. The BD Act, 2002 stipulates that the State Governments in consultation with the local bodies can notify Coastal & Marine areas of biodiversity importance (e.g., key fish breeding sites, migratory routes, etc.) as Biodiversity Heritage Sites (BHSs) for biodiversity conservation. (Responsible Institutions: Department of Fisheries, NBA, SBBs and BMCs, WII and NCSCM)
12. The State Government may consider providing necessary policy, legal and organizational support for recognizing and protecting the territorial use rights of traditional and small-scale fishing communities in the state. In this regard it is reiterated that the entire stretch of the Territorial Waters may be considered for reservation for fishing by traditional and motorized fishing crafts. (Responsible Institutions: NITI Aayog, Department of Fisheries, BOBP-IGO and ICSF)
13. Notify Coastal & Marine species that are threatened or vulnerable. The 'Species Recovery Plans' could consider both in-situ and ex-situ conservation measures for conservation of depleted species. (Responsible Institutions: MoEF&CC, NITI Aayog, WII, State Governments, NBA, SBB, FSI, CMFRI, WII, NBFGRs, Corporates and NGOs)
14. Prepare Notification list of Coastal & Marine biological resources under Normally Traded as Commodities (NTCs). Preparation of a set of comprehensive guidelines to assist the concerned agencies in the preparation of such a list. (Responsible Institutions: MoEF&CC, MPEDA, NBA and SBB)
15. Prepare a set of comprehensive guidelines for preparation of the People's Biodiversity Register's (PBRs) covering Coastal & Marine bioresources (Responsible Institutions: NBA, coastal SBBs and BMCs)

16. Since the major cause of biodiversity loss is the diminishing/impaired flows of water in rivers and associated wetlands due to various water abstraction projects, while providing approvals for river valley projects, environmental flow requirements must be made mandatory as a part of Environmental Impact Assessments (EIA) to conserve and restore inland aquatic ecosystems. (Responsible Institutions: NBFGR, MoWR, CIFRI and MoEF&CC)
17. Strategic Environmental Assessment (SEA) must be carried out for developmental projects in the biodiversity rich areas by mainstreaming the environmental concerns into economic development and integrating green economy targets into strategic and project related decision-making for conservation and restoration of inland aquatic ecosystems (Responsible Institution: MoEF&CC)
18. Community-based or co-management of open water fisheries can be strengthened. Fishing in open water resources should be under a strong co-management platform involving Cooperative Societies, Self Help Groups (SHGs) and Biodiversity Management Committees (BMCs) to ensure responsible fishing practices to conserve and restore inland aquatic ecosystems. (Responsible Institution: Department of Fisheries)
19. List of threatened endemic/ charismatic/keystone species in the inland water bodies must be documented for bringing them under the 'Species recovery program' for conservation of fish genetic resources. (Responsible Institutions: MOEF&CC, NBFGR, CIFRI)
20. Seed production and ranching of indigenous species must be encouraged and incentivized.
21. The seed produced from the original parents (Native germplasm with good effective breeding population and equal sex ratio) collected from pristine stretches of the river should be used for ranching. Seed produced from mixed spawning processes and the offspring of farm-based brood stock must not be used for river or lake ranching, as they adversely affect the riverine fish biodiversity. A protocol for ranching must be developed by the ICAR research institutes and the same can be circulated by the Department of Animal Husbandry, Dairying and Fisheries (DAHDF) to all State governments. To accomplish this, steps must be taken to create basic infrastructure facilities, such as hatcheries, nurseries, fry/advance fingerling raising centers, and so on. Stocking of fishes from unknown sources in the open waters or rivers for any purpose must be banned. (Responsible Institutions: Department of Fisheries, DAHDF, NBFGR and MoEF&CC)

7.1.11 Central Institute of Freshwater Aquaculture (CIFA)

CIFA nominated Dr. Gangadhar Barlaya, Principal Scientist (Aquaculture) (gbarlaya@yahoo.co.in, 9448863408) as their nodal officer. Dr. Gangadhar Barlaya has provided several inputs to the chapter on Sustainable harvesting and conservation strategies for living resources, write up as well as recommendations via email dated 10-05-2021 at 4:53PM. He has also highlighted the tasks that can be undertaken by CIFA.

7.1.12 Directorate General of Hydrocarbons (DGH)

DGH nominated Mr. Ujjal Ghosh, Advisor (G&G), DGH (hodgng@dghindia.gov.in, 0120-2472090) as their nodal officer. Mr. Ujjal Ghosh has provided the following input to the chapter on Scientific extraction and potential for utilization of non-living resources via email dated 10-05-2021 at 6:05PM:

"The on land sedimentary basin area in Karnataka State is 21 percent of its total geographical area of approx. 191.8 thousand sq. km. There are three distinctive basin/ sub-basin areas present. The Deccan Syneclise basin occupies 68 percent, Kaladgi

sub-basin 19 percent and Bhima sub-basin 13 percent of total state basin area of approx. 41 thousand sq. km. As per communication dated 16.04.2021 to DGH, a part of western boundary of the state has a coastline of 320 km, which borders the Kerala-Konkan offshore basin with a reported state EEZ area of 87 thousand sq. km. This offshore basin is currently placed in Category III, implying that there is no hydrocarbon discovery made so far. Given the relevance of blue economy, this Kerala-Konkan basin can be taken into cognizance in view of future exploration activity under Open Acreage Licensing Program (OALP)". A reference Indian Sedimentary Basin map was also provided.

7.1.13 Space Applications Centre (ISRO)

SAC-ISRO nominated Dr. Mini Raman, Scientist G and Head, Marine Ecosystem Division (mraman@sac.isro.gov.in, 079-26914340/9427001984) as their nodal officer. The following are the inputs on existing recommendations by SAC-ISRO via email dated 10-05-2021 at 6:45PM:

1. Carry out a pilot study using high resolution satellite images and classified images of mangrove distribution, LULC, CRZ available with KSRSAC, NRSC, SAC at various time frames as baseline data to evaluate the status of coastal zone, mangrove habitats, construction activities etc. for policy decisions. This would prevent/ reduce ecological damage. (Responsible Institutions: SAC, KSRSAC, NRSC, Dept. of Fisheries, KSPCB)
2. Carry out a pilot study using available high resolution satellite land use land cover maps and other ground-based observation for site suitability for developing one green fishing harbor. Green harbors would help in offsetting carbon footprint and effectively monitor pollution. (Responsible Institutions: ISRO (SAC, NRSC) KSRSAC, Ports Authority, Fisheries Dept.)
3. Strengthen the early warning system, rescue and relief measures in case of sea natural disasters by utilizing weather & sea state forecasts available with IMD, MOSDAC portals and providing Distress alert systems (DAT) and improved MSS terminals to fisher community so as to reach early warnings to fishermen at sea. This will provide real time updates on weather, sea state to prevent loss of life and protect livelihood of all fishermen who are in sea. (Responsible Institutions: SAC, INCOIS, State Fisheries Department, Coast Guard,
4. Carry out a Pilot study using remote sensing and in-situ data and to evaluate water quality parameters suitable for mariculture, seaweed culture and coastal aquaculture. (Responsible Institutions: Department of Fisheries, CMFRI, SAC)
5. Identify offshore regions where vertical ocean farming can be conducive based on physical (wind, waves, currents and temperature) and biological (Nutrients, O₂ and carbon) conditions. Thus, satellite and modelling based inputs would help in identification of regions where vertical ocean farming can be done. (Responsible Institutions: Department of Fisheries, SAC)
6. The current database of altimeter, scatter meter/SAR based wind and wave energy of SAC can be shared. These can be utilized for wind energy and windmills installation in coastal sites. SAC/ISRO has already developed a GUI based portal for wind energy resources and has carried out cost effective analysis. As regards to wind energy, SAC has developed satellite-data assimilative model output-based wave energy resource mapping. This would reduce dependence on fossil fuels and make power locally available. (Responsible Institutions: KSRSAC, SAC(ISRO), Dept. of Tourism/PWD)
7. Satellite derived insolation products and Solar calculator can be utilized (SAC)

8. Identification of hot-spot regions for OTEC using satellite data and numerical models and providing suggestions on its cost-effectiveness (high stratification of water column and distance from the coast). It can be beneficial if the cost of production is less than earned revenue.
9. A site-suitability analysis from combined wind-wave energy hot-spot zonation has also been done (SAC). This information can be shared with regional/state partners. This would reduce dependence on fossil fuels and make power locally available.
10. High-resolution satellite data can be utilized to survey micro/macro plastic disposal sites. Preservation of ecology and reduction in plastic pollution. (Responsible Institutions: SAC, KSRSAC, KSPCB)

The following are the new inputs/recommendations:

11. Utilize space-based inputs for determining regions of high salinity gradients for generating osmotic power. Environmentally friendly and replenishable source of power generation.
12. Identification of hot-spot regions for efficient wave power generation as an alternate and clean source of energy.
13. Identification of hot-spot regions for efficient tidal & ocean current energy generation as an alternate and clean source of energy.
14. SAC Geospatial Trainings such as TREES/SMART can be augmented for increase in experienced personnel to meet the need for marine applications, geospatial R & D and job creation. (Responsible Institutions: SAC(ISRO), Department of Fisheries, FISHNET, SDEL, KFDC, NFDB)
15. Identify the coastal regions vulnerable to storm surge induced coastal inundation for the next 100 years in the backdrop of climate change for timely preparation of mitigation plans on high priority. (Responsible Institutions: SAC(ISRO), Department of Fisheries, FISHNET, SDEL, KFDC, NFDB)

7.1.14 Dr. K. S. Jayappa (Professor (Dept. of Marine Geology), Director (PMEB) & RUSA Nodal Officer, Mangalore University) (ksjayappa20@gmail.com, 9945370876, 824-2284343) has provided the following new recommendations via email dated 10-05-2021 at 6:45PM:

“Sea walls are not a permanent solution for protection of eroding beaches. They are destroyed by huge waves during the SW monsoon period. Beaches in front of them are lost and the near shore gradient becomes steeper. In most cases they shift the erosion site to adjacent sides. We recommend green walls (casuarina trees, *Ipomoea pes-caprae* and other salt tolerant plants) instead of sea walls” with the following envisaged benefits: “Easy access to the sea for fishermen, Aesthetics of the beaches are maintained, Natural resources (mainly hard rocks) are conserved which are essential for various developmental activities” and the following responsible institutions: “KSCZMA, PWD, Department of Tourism, Fishermen Association, DDMA Dakshina Kannada, Udupi & Uttara Kannada”.

7.1.14 Dr. N. Jayabalan (Fisheries Consultant, Fish Stock Assessment Expert, Former Professor & Head, College of Fisheries Mangaluru) (maljaya2@gmail.com, 8056160685, 044-48620151) has provided comprehensive inputs to the draft chapters and recommendations vide email dated 10-05-2021 at 6:45PM for the chapters pertaining to Sustainable harvesting & conservation strategies for living resources (Chapter 1), Rehabilitation, conservation & protection of priority ecological resources (Chapter 5) and Strategy for augmentation of institutional capacity and human

resources development in a blue economy context (Chapter 6). He has also provided the following new recommendation with a high implementation priority:

Carry out detailed investigations of biology and population parameters of important species since these estimated parameters are required for modelling of fish stock assessment and management. Responsible institutions are CMFRI, FSI, CoFM (College of Fisheries, Mangaluru).

7.1.16 Dr. Manjappa N. (Associate Professor & Head, Fisheries Research and Information Center (Inland)) (frichesa@gmail.com, manjappan701@gmail.com, 7760284094, 080-28466244). Dr. Manjappa N. has provided the following inputs via email dated 13-05-2021 at 11:37AM:

1. Carry out ranching of commercially important species in coastal Karnataka by the Department of Fisheries.
2. Establishment of hatcheries (Shrimp, Seabass, Pearl spot, Groupers, Milkfish, Mullet, Lutjanus, Mud crab, *Macrobrachium rosenbergii*) in locations such as Mangalore, Mulki, Udupi Kundapura, Bhatkal Kumta, Ankola, Karwar by FRIC(M), College of Fisheries, Department of Fisheries, Private Entrepreneurs (PPP Mode).
3. Introduce polyculture technology (Fish and shrimp), monoculture technology (Seabass, Pearl spot, Groupers, Milkfish, Mullet, Lutjanus, Mud crab) and crab fattening in coastal Karnataka by FRIC(M), College of Fisheries and Private Entrepreneurs (PPP Mode).
4. Introduce Cage culture technology in offshore line and backwaters (Cobia, sea bass, Lutjanus, Pompano) and Mussel culture technology (Raft Method) in selected protective zones in Coastal Karnataka by FRIC(M), College of Fisheries and Department of Fisheries.
5. Establish live fish outlet units in selected districts by FRIC(M), College of Fisheries, and Department of Fisheries.
6. Introduce Seaweed farming in off shoreline (*Gracilaria edulis* and *Gelidiella acerosa*) in selected protective zone in Coastal Karnataka by FRIC(M), College of Fisheries, Department of Fisheries and Fisheries Societies
7. Fish seed rearing and fish culture in unutilized areas and plantation of mangrove saplings in backwater areas in coastal Karnataka by Fisheries Societies and private entrepreneurs.
8. Auto stocking (Naturally congregating fish seeds) in Gazini land with growing of Kagga variety paddy in Kumta and Ankola by the Department of Fisheries and Farmers.
9. Introduction of "Recirculatory Aquaculture System (RAS)" (Growing of Shrimp and high value fishes) in coastal Karnataka by FRIC(M), College of Fisheries, Department of Fisheries, Private Entrepreneurs and Fisheries Societies.
10. Introduction of aqua gallery, Aqua Park, sports fishery, boating in locations such as Panambur, Mulki, Malpe, Murudeswara, Gokarna and Karwar by Department of Fisheries, Private Entrepreneurs and Fisheries Societies.
11. Introduce different fish value-added products in mobile fish canteens (Fish burger, fish fry, fish ball, fish sausage, fish chakli, kurkure, canned food, etc) by Department of Fisheries and private entrepreneurs.
12. Introduce sport fishery and rafting in selected rivers in Western Ghat areas.
13. Aquaculture sludge and fish meal can be used for plants as a fertilizer.

14. Some of the initiatives that can be taken up by FRIC (I), College of Fisheries and Department of Fisheries include the following:

(a) In Western Ghats

- Establishment of Indigenous species brood bank in Karnataka
- Ranching of endangered Indigenous species in river
- Establishment of hatcheries to production of endangered fish seed

(b) In locations such as Madikeri, Kushalnagar, Mysuru, Chamarajanagar

- Establishment of sanctuaries in selected rivers
- Rehabilitation of Indigenous species
- Plantation and create protective breeding zone for riverine fishes

15. Establishment of capacity building centers in each district by Department of Fisheries

16. Ensure finance support from banks for fisheries activity

7.1.17 Dr. N.P. Kurian (Former Director, National Centre for Earth Science Studies) (npkurian@gmail.com, 9496549580). provided the following inputs to the existing recommendations vide email dated 17-05-2021 at 11:51AM:

1. Carry out Hazard mapping and demarcate vulnerable areas in terms of their levels of severity for Coastal area management by Department of ID, P&IWT, Pollution Control Board, Department of Ecology & Environment and KSRSAC.
2. Identify locations suitable for community coastal protection projects and implement them with participation of coastal communities for dune building, vegetation planting including nursery development by Department of ID, P&IWT for Climate change resilience of the coast and protection of the coastal community against coastal hazards including rising sea levels. This would also contribute to the economic upliftment of the local community through the medicinal, nutritional and industrial value of vegetation as well as employment and income generation for the local community especially youth and Women.
3. Use decommissioned ships for installation as offshore reef for shore protection after technical feasibility studies using numerical models and studies on long-term and short-term ecology and environment impact by the Department of ID, P&IWT.
4. Revive turtle nesting areas that have disappeared on account of erosion and anthropogenic activities along the Karnataka coast especially in Mangaluru, Mukka, Apsarakonda, Dhareshwar region by the Forest Department.

7.2 Recommendations received during Online Stakeholder Consultations

Due to the wide-ranging activities within the sphere of the Blue Economy, a diverse number of stakeholders were identified and the stakeholder consultations were held at multiple levels to obtain important feedback. This would allow each stakeholder group to openly discuss and provide information and interventions/ solutions/ approaches that they believe will work.

Hence, the consultations were held in three groups:

- a) Academicians and NGOs (Online Stakeholder Consultation)
- b) Government Institutions and Departments, Industry leaders (Online Stakeholder Consultation)
- c) Those associated with 'blue' livelihoods such as fishermen, prawn farmers, blue tourism-related stakeholders etc. including Self Help Groups, Coops etc. (Telephonic)

The online consultation with stakeholders was held via the Google Meet platform for Academics/NGOs and Government Institutions/Departments/Industry leaders on 18th May 2021 in the Morning and Afternoon Session respectively. In both sessions, a presentation was delivered on the high priority recommendations of the Draft Blue Economy Plan and subsequently discussions and recommendations were invited on various blue economy sectors.

The details of the consultations are as below:

Date: 18-05-2021

Session 1 (Time 11:00AM to 02:00 PM)

Sl. No.	Name	Designation/ Name of Institution/Organization
1	Dr. Dasappa Seenappa	Former Chief Scientific Officer, University of Agricultural Sciences, Bengaluru
2	Dr. Jayabalan Nachiappan	Fisheries Consultant, Fish Stock Assessment Expert, Former Professor & Head, College of Fisheries Mangaluru
3	Dr. Vichitra Kumar Shetty	Former Managing Director, Karnataka Fisheries Development Corporation
4	Dr. Jayappa Katihally	Professor, Department of Marine Geology and Director, PMEB & RUSA Nodal Officer Mangalore University
5	Dr. Maya Sitaram	Consultant, Social Development
6	Dr. B. A. Shamasundar	Rtd. Professor, College of Fisheries, Mangaluru
7	Dr. Rohan Arthur	Senior Scientist, Nature Conservation Foundation
8	Mr. Mayuresh Gangal	Research Scholar, Nature Conservation Foundation
9	Ms. Meleena Mascarenhas	Consultant

The presentation dealt on high priority recommendations Chapter wise and subsequent to each chapter recommendations were invited. The recommendations by various experts during the online stakeholder meet were as follows:

- 7.2.1** Dr. Dasappa Seenappa, former Chief Scientific Officer advised that all the recommendations need to be prioritized under specific segments. Moreover, strategies to address each of the issues need to be identified, prioritized and converted into an action plan. He also highlighted that an institutional mechanism needs to be established along with an appropriate monitoring mechanism set-up to monitor and evaluate the progress, to carry out benchmarking and implement recommendations in a phased manner.
- 7.2.2** Dr. Jayappa Katihally, Professor, recalled that dredging of the Netravati-Gurpur estuary in the 80s and 90s had solved the frequent capsizing of fishing boats. Hence, regular dredging of navigation channels is very much essential to prevent boat capsizing issues. He further stressed that a suitable location/place has to be found for dumping the dredged material so that it will not be re-enter back into the estuaries considering the longshore sediment transport or the littoral drift direction with respect to seasons. Ms. Sharon Dsouza, Consultant cited that as suggested under the ADB funded SCPMIP project, the dredged sand if found to be of good quality, could be used for beach nourishment and sand dune creation in the nearby beaches that are deficit in sand as an efficient method of shore protection.
- 7.2.3** Dr. Vichitra Kumar Shetty, Ex-MD KFDC, recommended that stock/resource assessment needs to be carried out in view of regulating the number of boats. He further emphasized that presently, the applications for new boats are approved by certain committees in the Department wherein there is a dearth of technical persons apart from Fisheries officers and the approvals for boats are based on political compulsions rather than the resources available/Maximum sustainable yield. Hence it is very crucial to have technical personnel such as CMFRI Scientists, College of Fisheries experts etc. to guide the department in matters concerning regulating the number of boats depending on the resource data.
- 7.2.4** Dr. N Jayabalan, Rtd. Professor, put forth a very valid point wherein he said that the analysis of the potential (6.02 lakh MT) Vs landings (5.01 lakh MT) statistics indicates an untapped potential that is available for harvest. Since there is an untapped potential available, why is there a requirement to reduce the number of boats (as various studies have rightly pointed out overcapacity of fleets in Karnataka). Hence fish stock re-assessment needs to be carried out regularly. Another reason for regular fish stock assessment is the change in stock of different species. In recent years, landings of the Indian oil sardine have come down drastically and the landings of a demersal fish i.e., *Odonus niger* has risen. Therefore, any decision to regulate the number of boats has to be preceded by fish stock assessment.
- 7.2.5** Dr. Shashikala Sitaram, Social Development Consultant suggested that wherever an upgradation of infrastructure has been recommended, it is important that maintenance of that infrastructure is also carried out and funds for O&M (Operation and Maintenance) should be considered upfront. She emphasized on the importance of the public grievance redressal mechanism that needs to be set-up in all sectors to promote transparency and ensure grievances are addressed effectively. Moreover, she added that whenever there is an allotment of financial assistance to poor families, the assistance needs to be credited to a joint account with the woman of the household necessarily being the joint holder of the account.

- 7.2.6** Dr. B. A. Shamasundar, Rtd. Professor, College of Fisheries suggested that it is utmost important to prioritize the recommendations and specify the implementation strategy.
- 7.2.7** Dr. Dasappa Seenappa, ascertained that scope for energy generation in oceans is a bit bleak as it is mainly experimental due to the economic feasibility and technology availability etc. and we have to wait for new technology to emerge. However, though the potential is comparatively less, there is still an opportunity/potential. Under the blue economy, we can promote innovative R&D to explore the possibilities. For example, on a small scale, in the case of Reservoirs, it is already proved that solar energy, wind energy and hybrid of solar and wind energy for open cage farming, pen culture etc. have very good potential. Carrying out a Pilot study is very important and economic viability is one constrained factor. Hence, encouraging investment from the private sector for R&D, pilot scale projects that are region specific/location specific/site specific can emerge as a big opportunity and be implemented.
- 7.2.8** Dr. Jayappa Katihally, suggested that the government can pursue installation of pilot solar power plants near islands such as St Mary's and other islands in Uttara Kannada. Pursue wave energy along the Karnataka coast. A gentleman from Udupi has shown a pilot/demonstration of wave energy in Udupi. Tidal energy is not feasible for the Karnataka coast due to lower range since the required tidal range is 6-7m whereas we have about 2-3m.
- 7.2.9** Dr. Shashikala Sitaram highlighted the importance of the imbibing sustainability component from the very beginning of implementing blue economy initiatives to sustainably maximize social benefits. For example, under the ADB funded Sustainable coastal protection and management Investment Program (SCPMIP) in Karnataka, Shoreline Management Organizations (SMO's) were formed in locations where coastal protection works were undertaken to ensure continuity of various initiatives/efforts and act as accountability mechanisms. These SMO members are volunteers of their community who are linked to Panchayat Raj institutions as some of them would be ward members who are part of the panchayat. They also help in selection of the right kind of beneficiaries such as interested youth, the poor, the disadvantaged, the physically challenged and ensure local community participation. Hence formation of new SMO's and strengthening of existing SMO's (formed under SCPMIP) is crucial for upliftment of the coastal communities as they would represent the needs of the community on the blue economy front such as training needs for the local youth and vulnerable communities for alternative livelihoods to maintain social equity. These SMO's can be linked to District level for furthering the blue economy.
- 7.2.10** Dr. Dasappa Seenappa added that it is extremely essential to develop the system in a sustainable manner without affecting livelihoods of poor and lower sections of society. Hence efforts are to be made to enhance their livelihood options.

Identify various stakeholders and carry out capacity building for income generation based on local resources (production and marketing of value-added products) during seasons of non-uniform catch (ban season). Skilling, re-skilling and upskilling of the community.

It is also crucial to retain existing youth and recruitment of new youth for the development of activities in the fisheries sector. Hence local institutions are to be positioned to develop resources and enhance the social benefits.

- 7.2.11** Dr. B. A. Shamasundar advised that instead of converting fish processing waste into aquaculture feed, it would be wise to convert fish processing waste into organic fertilizers, which is in great demand. The same is presently being carried out by some

fish meal plants in the state and is being marketed as a bio stimulant, giving excellent results.

7.2.12 Dr. Vichitra Kumar Shetty informed that at present the fishing harbors are not managed scientifically with some of their Effluent Treatment Plants not being in working condition. The solid and liquid waste should be disposed of and managed appropriately and made compulsory for all fishing harbors.

7.2.13 Dr. Dasappa Seenappa rightly mentioned that in countries such as Denmark, composting of aquaculture sludge is being carried out as the commercial aquaculture systems such as RAS are intensive in nature and sludge removal is part of the process. This sludge is then composted and converted into fertilizer. However, in Karnataka currently aquaculture is small scale, sporadic in nature and distributed in few bits and pieces. Organic aquaculture is currently not being carried out. We are still in the infancy stages. Hence, once intensive aquaculture technologies such as RAS are extensively implemented, as part of sludge management, we can think of converting the sludge into fertilizer.

On the other hand, fish waste gets generated in huge quantities in fish processing plants. Instead of discarding the waste as it is without any value, the same can be sold after value-addition by converting it into fertilizer. Utilizing the fish waste as organic fertilizer is a better solution than converting it into feed. Moreover, the possibility of converting aquaculture sludge into fish feed also is very limited as we do not yet have adequate fish feed industries. The economic feasibility of converting fish waste into fertilizer needs to be worked out.

In the inland sector, Aquatic weeds can also be used for production of organic fertilizer and also base for growing mushrooms. Protection of estuaries can be better implemented with the participation of hobbyists and voluntary organizations who are involved in conservation efforts. Ghost nets are a menace not only in the marine sector but also in the inland sector. Hence, it is important to create awareness among local communities with respect to these things.

7.2.14 Dr. Shashikala Sitaram added that if voluntary conservationists are being involved, industries also can be involved under their CSR initiative to protect ecosystems and create awareness on conservation.

7.2.15 Dr. Jayappa Katihally advised that changes in coastal ecosystems need to be studied periodically through the use of technology, remote sensing data etc. for taking informed actions on their protection and conservation.

7.2.16 Dr. Dasappa Seenappa also agreed that Inland wetlands also face similar issues as their coastal counterparts. The inland wetlands are the derelict water bodies in the state and hence require studies to map the changes and initiate protection and conservation measures.

He also emphasized that the fisheries sector is dependent on secondary and tertiary activities and there is huge potential for entrepreneurship development where adequate support is essential. Hence these initiatives can be categorized/grouped under PMMSY and taken forward with appropriate plan of implementation in place.

7.2.17 Dr. Shashikala Sitaram stressed the need for adequate staffing in Institutions as institutional mapping needs to look at 3F's (Funds, Functions and Functionaries). Hence adequate and competent staff are very much essential. Moreover, training and capacity building should not be restricted to fisher communities only, it should also be

imparted to other stakeholders such as personnel from fisheries department etc. A robust Grievance redressal mechanism and accountability mechanism needs to be put in place for all institutions to ensure transparency.

7.2.18 Dr. B. A. Shamasundar recommended formation of an empowered group to overlook the implementation of the recommendations, as this would be very critical and crucial for the success of the initiatives.

7.2.19 Dr. Vichithra Kumar Shetty suggested that, to strengthen the Coastal Security Police, we need to have a separate police wing for rigorous implementation of the Karnataka Marine Fisheries Regulation Act. Additionally, the Department of Fisheries should be reorganized as the current set-up may not be conducive.

7.2.20 Dr. Rohan Arthur, Senior Scientist, Nature Conservation Foundation provided the following insights:

1. Community groups play extremely important roles in local fisheries management but they are often not acknowledged and given due recognition within government systems. Hence, strengthening these non-formal institutions by providing them a fair amount of agency/administration would help. It has been demonstrated in South America as well as in Kerala, India that if we trust local groups to work with local fisheries departments it is possible to create management plans which work at a very decentralized level.
2. A huge emphasis is given to Aquaculture and Mariculture which needs to be treated with caution due to experiences of people around the world with respect to the intensification of near shore mariculture practices. Mariculture maximizes profits for one group of people while dispossessing certain other groups of people. In addition, there are a host of problems associated with mariculture practices, which need to be given due amount of diligence for any future plan for mariculture as ecological integrity and social equity needs to be ensured.
3. There is a need to re-prioritize mariculture and aquaculture to capture fisheries and recognize that capture fisheries are far less ecologically damaging than intensive mariculture/aquaculture since mariculture leads to pollution, destruction of coastal habitats, entry of invasive species into coastal ecosystems. Hence, there is a need to emphasize that capture fisheries are still going to be the dominant fisheries over the next 10 years and we should focus on how to make capture fisheries more sustainable and equitable.
4. There is an emphasis provided on maximum sustainable yield in the document. However, in tropical fisheries with multi-species groups, MSY does not work. Hence, we need to adopt more ecosystem-based fisheries models which are more realistic. To do this, we need to invest much more into research in these areas and realistic monitoring programs.
5. Climate change has not been adequately addressed in the document. In the coming years, Climate change is going to be the most important factor. Coastal fish populations and coastal infrastructure is going to be heavily impacted because of Climate Change. We do not know what the temperatures of the water, the current etc. would be and hence these factors need to be considered into the sustainability plan.
6. Coastal fisheries in Karnataka cannot be planned in isolation. It has to be managed in conjunction with fisheries in Maharashtra, Goa and Kerala as we manage similar stocks. There has to be cooperation between states to manage fishery resources effectively.

There is a threshold in fish populations beyond which if the fish population falls, then it cannot recover. We need research in this direction to determine this threshold. We need to make a management plan that takes into account these thresholds such that we never reach this threshold. We need to regulate the fish catch, total fish catch allowed and total bycatch allowed.

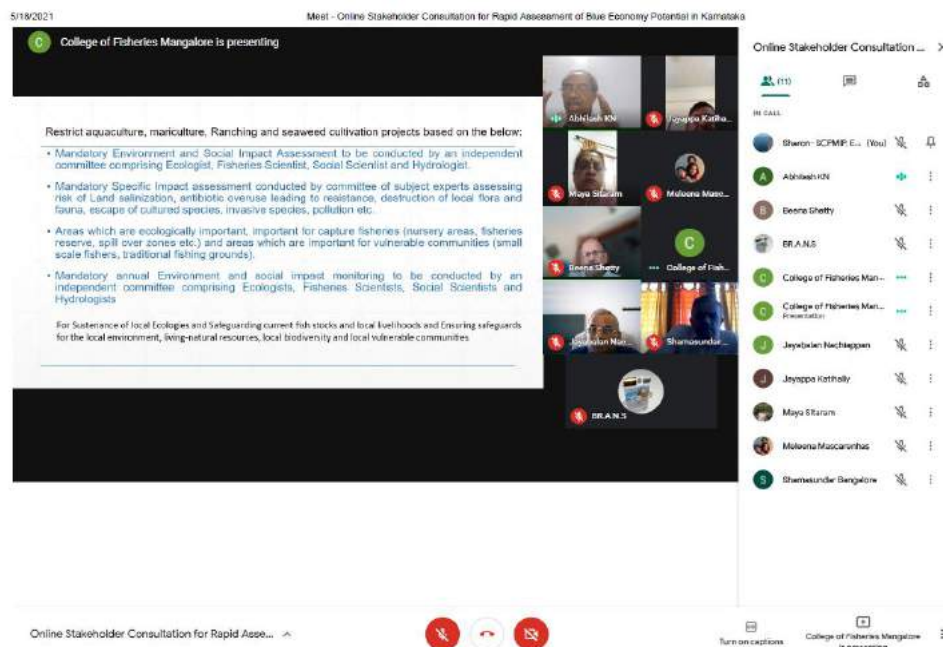


Figure 7. 1: Online Stakeholder Consultation (Morning Session-1)

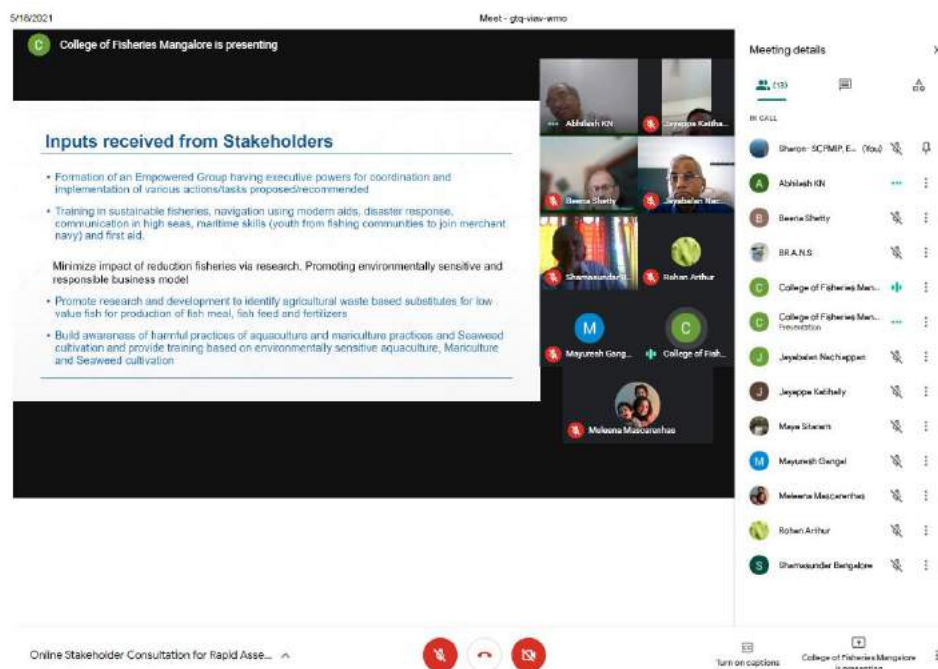


Figure 7. 2: Online Stakeholder Consultation (Morning Session-2)

Date: 18-05-2021**Session 2 (Time 3:00 PM to 06:00 PM)**

Sl. No.	Name	Designation/ Name of Institution/Organization
1	Dr. Vijaykumar Yaragal	Executive Director, National Fisheries Development Board (NFDB)
2	Dr. K.B. Bijumon	Senior Instructor (Fishing Technology), Central Institute of Fisheries Nautical and Engineering Training (CIFNET)
3	Dr. Mini Raman	Scientist G and Head, Marine Ecosystem Division, Space Applications Centre (SAC)-ISRO
4	Dr. Kumaraguru Vasagam	Principal Scientist, ICAR- Central Institute of Brackishwater Aquaculture (CIBA)
5	Dr. Preetha Panikkar	Principal Scientist and Officer-in-Charge, Bangalore Research Centre, Central Inland Fisheries Research Institute (CIFRI)
6	Dr. Gangadhar Barlaya	Principal Scientist (Aquaculture), ICAR- Central Institute of Freshwater Aquaculture (CIFA)
7	Dr. Jomon Thachil	Faculty, Oceanography, Central Institute of Fisheries Nautical and Engineering Training (CIFNET)
8	Mr. Harinath A. V	Superintending Engineer (Civil), New Mangalore Port Trust (NMPT)
9	Dr. M. Neelakandan	Sr. Instructor (Fishery Biology), Central Institute of Fisheries Nautical and Engineering Training (CIFNET)
10	Mr. Ganesh K	Sr. Deputy Director of Fisheries, Udupi District
11	Mr. Harish Kumar	Sr. Deputy Director of Fisheries (In charge), Mangaluru
12	Dr. Vipin P. M.	Senior Research Fellow, Central Institute of Fisheries Technology (CIFT)
13	Mr. Swayam Chowdhary	Assistant Director (Strategic Management), New Mangalore Port Trust (NMPT)
14	Dr. Nandini Kumari C. N	Director, Karnataka Antharaganga Micro Irrigation Corporation Limited (Horticulture, Karnataka State Agricultural produce)
15	Mr. Promad Kumar Dash	Deputy Traffic Manager, New Mangalore Port Trust (NMPT)
16	Mr. Jithendra Bathala	Senior Manager- Environment, Mangalore Refinery and Petrochemicals Limited (MRPL)
17	Mr. Mayuresh Gangal	Research Scholar, Nature Conservation Foundation (NCF)
18	Deputy Director	Public Private Partnership- Integrated Horticulture Development (PPP-IHD)

19	Mr. Mohan Kumar	
20	Mr. Girish M. N	

7.2.21 Mr. Mayuresh Gangal, Research Scholar, Nature Conservation Foundation suggested a coordinated ban across west coast of India states such as Maharashtra, Goa, Karnataka would be a better option than a uniform ban. A coordinated fishery management across all the four states need to be pursued since our fishing methods are not target specific and imposition of total ban may not be feasible. Other ways also can be explored.

Introduction of Turtle excluder devices has been met with serious backlash in Odisha and by-catch reduction devices have not been effective in the UNDP project in Maharashtra. Hence, a better option would be to carry out research studies on such devices before making it mandatory. Fish meal industries should not be promoted in the state.

7.2.22 Dr. Vijaykumar Yaragal, Executive Director, National Fisheries Development Board (NFDB) suggested that the recommendation for boat subsidy needs to be rethought in the light that the number of boats along Karnataka coast has increased higher than that required for the potential available.

He also stated that Turtle excluder devices (TED) is an international issue. Trawl boats will compulsorily need to have TED's as without TED certificate, USA would not accept shrimp imports from India.

7.2.23 Dr. Bijumon, suggested that registration of fishing vessels may be extended to 10 years and that the monitoring of the fishing vessel, its condition, its performance and its safety aspects are to be carried out every year. Also, to control overfishing, registration of gear production unit, boat building yards should be implemented strictly. To better identify fishing vessels of different states, color coding of fishing vessels to be strictly implemented in Karnataka.

Some of the other recommendations are ensuring crews onboard the vessel should be 18 years and above, making sure certified personnel are always onboard for navigation of mechanized fishing vessels, establishing and implementing a proportionate ratio between length of the vessel and power (horsepower) and insurance cover should be given to crews that board the vessel.

7.2.24 Mr. Jitendra Bathala, MRPL suggested that MRPL has installed an experimental floating solar power plant in its premises and hence floating solar power projects can be explored in inland areas.

7.2.25 Dr. Vijaykumar Yaragal recommended that train and flight connectivity to coastal regions from places such as Bidar, Kalaburagi, Yadgiri, Raichur etc. are to be improved to boost the coastal/beach tourism sector.

7.2.26 Mr. Jitendra Bathala proposed that mapping and management of pollution and pollutants can be explored through collaboration with ISRO-SAC. Moreover, strategies to manage plastic waste in its entire life cycle are to be developed and implemented. Auditing of waste generation and management in cities could be carried out in order to

reduce waste flowing to the sea. He also suggested that for ballast water management, instead of KSPCB rules, MoEF or CPCB rules would be more appropriate.

7.2.27 Mr. Mayuresh Gangal highlighted the importance of maintaining environmental flows in rivers. Rivers are supposed to drain a minimum amount into the ocean. Fisher community and livelihood is sustained when these minimum environmental flows are maintained. When considering dams/infrastructure etc. minimum environmental flow has to be ensured/maintained.

7.2.28 Dr. Vijaykumar Yaragal opined that mangrove are blocking the flow along the estuaries in North Karnataka. Hence, ways to flush these riverine stretches near estuaries need to be explored and implemented.

7.2.29 Mr. Jitendra Bathala advised that since small scale industries may not be able to set-up Effluent Treatment Plants (ETP's) on their own. In such a scenario, setting up of a common ETP may be explored to combat pollution. Additionally, regular monitoring of critical parameters at locations where rivers meet the sea is to be carried out in order to monitor the pollutant load reaching the sea.

7.2.30 Mr. Mayuresh Gangal expressed concern that there is a possibility that mangroves can act as weeds and hence instead of planting mangroves in areas where they have never been, it is a better option to plant mangroves in areas where they have been degraded or destroyed. Restoration of mangroves is a better option than introduction of mangroves to new locations.

7.2.31 Mr. Jitendra Bathala proposed a knowledge sharing portal that can be established to disseminate latest knowledge, research, skills, new technologies, business ideas etc. to the fisher communities.

7.2.32 Mr. Mayuresh Gangal added that the Government department / agency can upload data, videos etc. on the knowledge sharing portal in terms of locality etc. as well as popularize and populate the portal.

He also suggested that in the present situation there is no scope for fleet expansion in the coastal fisheries due to the existing overcapacity. Rather, it is important to address the issues of coastal fisheries such as promote value addition, limit the losses due to perishability, improve livelihoods etc. It is extremely essential to stop registration of new mechanized fishing boats for at least a period of 3 to 5 years.

7.2.33 Dr. Vijaykumar Yaragal informed that NFDB has a scheme called Sahaya mitra, wherein a minimum B.FSc graduate is stationed in the harbor/landing center/village, where he can pass on the information, facilitate and guide the fishermen in all aspects. Moreover, NFDB also bears the financial costs of the Sahaya mitra.

7.2.34 Mr. Bijomon added that the Sahaya mitra scheme has been implemented in Kerala and has been a success and hence it can be implemented in Karnataka also. In addition, the Fisheries department can organize outreach/ educational training programs to encourage fishermen communities in sustainable fisheries.

7.2.35 Dr. Vijaykumar Yaragal suggested that to reduce the overcapacity, the applicant has to take advance approval from the Director of Fisheries before construction of a boat and then proceed for registration once approval is accorded. Advance approval should be

made mandatory for construction of new boats. If they have constructed the boat without prior permission approval should not be accorded. A gazette notification should be released such that the public/fisher community is aware of the requirement prior to its implementation.

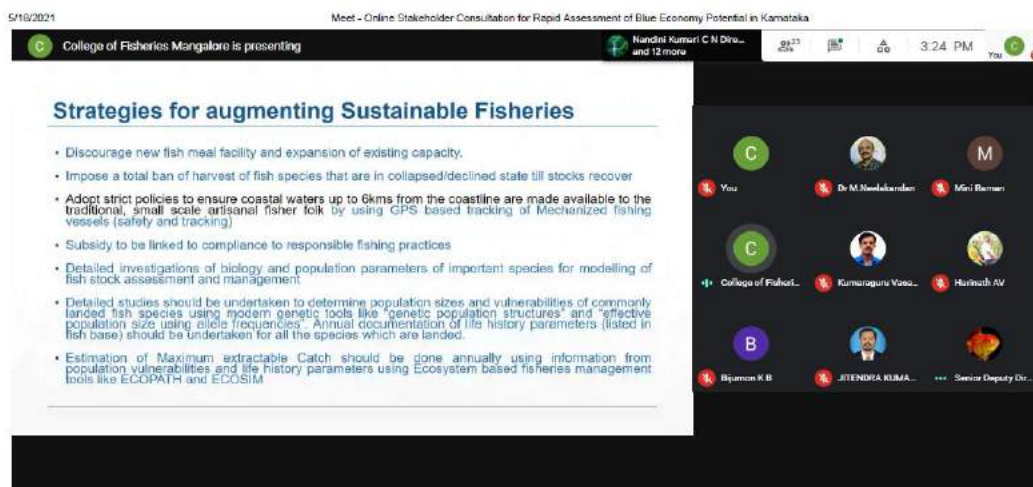


Figure 7. 3: Online Stakeholder Consultation (Afternoon Session-1)

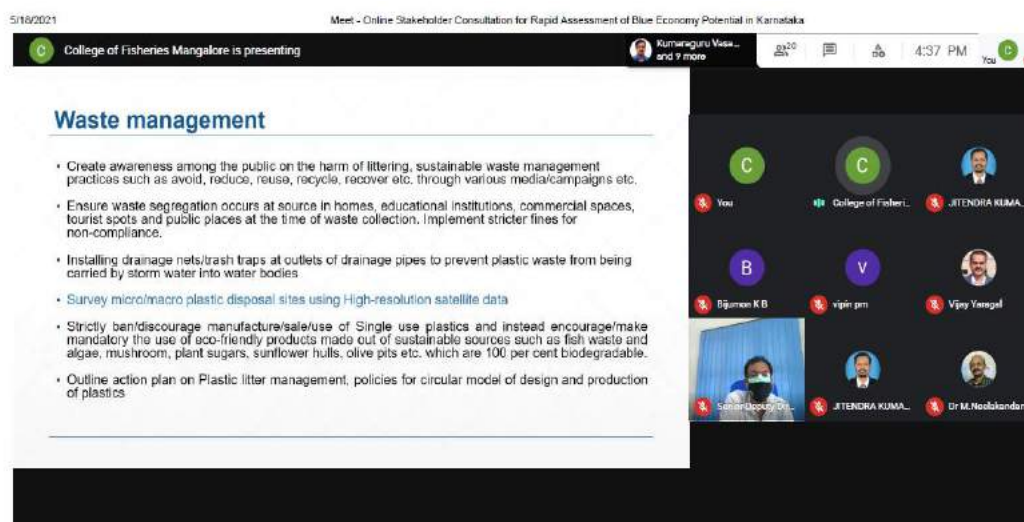


Figure 7. 4: Online Stakeholder Consultation (Afternoon Session-2)

7.3 Summary of Telephonic discussions with stakeholders in Uttara Kannada District

Fisheries related Stakeholders in Uttara Kannada district:

Sl. No.	Name of Association/Union	Designation
1	Trawl Boat Union, Karwar	President
2	Trawl Boat Union, Mudaga	President
3	Motorized and Traditional Fishermen (Nada Doni), Karwar	Member
4	Purse Seine Union, Honnavar	President
5	Trawl Boat Union, Honnavar	President
6	Dutt guru Fishermen Union, Belekeri, Ankola	President
7	Karavali Motorized Purse Seine Boat Union, Ankola	President
8	Purse Seine Boat Union, Bhatkal	President
9	Trawl Boat Union, Bhatkal	President
10	Motorized and Traditional Fishermen (Nada Doni) Union, Bhatkal	Member

Due to the restrictions imposed by the State Government in view of the COVID 19 crisis, stakeholder discussions were carried out telephonically in May 2021. Key representatives from various fishermen associations/unions in Uttara Kannada district were contacted. The status of fisheries in their region, associated problems/concerns, possible solutions and the way forward were discussed. They were co-operative and responded well during the interaction.

7.3.1 The following is the summary of the interactions, their opinions and suggestions on various aspects pertaining to their sector:

1. They very sadly narrated their plight of decreasing fish population and diversity that has greatly impacted their livelihood and made them prone to debt due to comparatively vain fishing expeditions.
2. They acknowledged that most fishermen continue to use illegal fishing methods such as bull trawling, light fishing, catching of juveniles without realizing the depth of the long-term negative impacts of their actions and showing a neglect for the future of their livelihoods.
3. They opined that the increase in the number of mechanized boats, use of high-speed engines and small mesh gears has resulted in worrying signs of completely losing fish offspring before they are old enough to replenish their populations. They said that although the fishermen were provided with cod-end mesh by the Department of Fisheries, most of them are not using it.
4. Most of them were of the opinion that fishing vessels from other states such as Goa, Kerala and Tamil Nadu etc. should be allowed only for deep sea fishing beyond 100m depth as their increased fishing effort in Karnataka waters using various illegal fishing practices even in fishing ban season is a very common sight.

5. They expressed that if these practices continue without implementation of strict counter measures from the central and state government, it will hamper sustainability of the sector as the livelihood of lakhs of people depend on it.
6. Some acknowledged moderate facilities at the harbor such as drinking water, toilets, restrooms etc. whereas others said they were not available/adequate/not maintained especially in locations such as Karwar and Ankola.
7. On being asked if they would like their children to pursue fishing, they expressed that there is no secure future in the sector and fishing is a non-profitable venture if the present trends continue. They believe that without urgent measures to curb overfishing, they may be the last generation to catch food from the oceans.

7.3.2 Suggestions from stakeholders in Uttara Kannada district:

1. One fisherman, by personal experience, strongly opined that a uniform fishing ban season be imposed for the entire west coast from April-July to allow fish breeding and let the breeding fish population thrive.
2. One fisherman suggested that technical fishery training courses (approx. 20 days) be introduced for local fishermen during fishing ban season through panchayats/local government bodies etc. These courses can provide guidance on use of different fishing gear in different seasons and create increased awareness on refraining from illegal fishing methods to preserve and safeguard fish biodiversity and populations.
3. They demanded stricter implementation of existing laws such as ban on mechanized fishing in fish breeding season and use of illegal fishing methods such as light fishing, bull trawling, use of high HP engines etc. They suggested that warnings and subsequent cancellation of fishing licenses, withdrawal of all benefits such as diesel subsidy can be imposed on defaulters etc. and said that only if these stringent measures are effectively enforced, it is possible to revive the sector and safeguard their livelihoods.
4. One fisherman insisted on wireless/Cordless be provided to Nada Doni fishermen as a safety precaution
5. Another Fisherman explained the need for maintenance dredging at the entrance of the channel and breakwater at Honnavar harbor which is essential for the safety of fishers
6. They insisted that the schemes of the Government during fishing ban season are not adequate and do not reach them and hence new avenues are to be thought of to sustain and safeguard livelihoods of traditional fishermen who are vulnerable to the vagaries in the sector.
7. They showed keen interest in learning new skills such as Aquaponics as it can increase their livelihood opportunities especially during the fishing ban season.
8. They expressed the need for basic facilities to be provided and well maintained at all harbors such as restrooms, clean toilets, drinking water amenities etc.

7.4 Summary of Telephonic discussions with stakeholders in Dakshina Kannada District

Fisheries related Stakeholders in Dakshina Kannada district:

Sl. No.	Name of Association/Union	Designation
1	Trawl Boat Fishermen Association, Mangaluru	President
2	Purse Seine Boat Fishermen Association, Mangaluru	President
3	Gill Net Boat Fishermen Association, Mangaluru	President
4	Traditional Nada Doni Fishermen Association, Mangaluru	President
5	Seafood Buyers Association, Mangaluru	President
6	Dry Fish Businessmen Association, Mangaluru	Secretary
7	Fish Marketing and Commission Agent Association, Mangaluru	President
8	S.A.M Fisheries, South Wharf, Bunder, Mangaluru	President
9	Dakshina Kannada & Udupi District Ice Plant Owners Association	President
10	Mangalore Mechanized Fishermen Cooperative Association, Mangaluru	Secretary
11	Mangalore Trawl boat Fishermen Association, Mangaluru	Secretary
12	Mangalore Coastal Minority Fishermen's Primary Co-operative society, Mangaluru	Secretary
13	Karnataka Fisheries Development Corporation	Managing Director
14	Raw Fish Businessmen Co-operative Association, Mangaluru	President
15	Dsouza's Prawns	Proprietor

Tourism related Stakeholders in Dakshina Kannada district:

Sl. No.	Name of the Organization	Designation
1	Mulki Kayaking, Mulki, Mangaluru	Proprietor
2	Mangalore Surf Club, Tannir Bavi, Mangaluru	Proprietor
3	Mantra Surf Club, Mulki, Mangaluru	Proprietor
4	Lia Travels & Tours, Mangaluru	Proprietor
5	Globe Travels, Mangaluru	Proprietor
6	Summer Sands Beach Resort, Mangaluru	Proprietor

Due to the restrictions imposed by the State Government in view of the COVID 19 crisis, stakeholder discussions were carried out telephonically in May and June 2021. Key

representatives from various fishermen associations/unions and tourism sectors in Dakshina Kannada district were contacted.

7.4.1 The following is the summary of their views, issues and suggestions on various aspects pertaining to their sector:

1. Earlier when the prices of fuel were low, fishing used to be a profitable venture. However, with the rise in fuel prices, fishing is no longer working out. Each boat requires around 5000 liters of Diesel for a single fishing trip of 10-12 days (diesel worth approx. INR 5 lakhs) whereas the catches brought in are meager.
2. The sales from Ice Plants have drastically reduced and a lot of problems are being faced due to the COVID situation.
3. Boats from Karnataka entering within 12 NM of Kerala and Maharashtra (Sindhudurg, Malwan etc.) waters are seized and heavily fined (up to INR 5 Lakhs). However, there are no rules/regulations to prohibit or levy a penalty in Karnataka if boats from other states are found fishing in Karnataka waters.
4. Earlier, fishing was carried out only by the Mogaveera community (traditional fishers) and was being pursued within limits. However, in recent years, businessmen (from outside fishing communities) have entered the fishing sector as a result of which, it has become highly industrialized with a soaring number of boats with high-speed engines fishing day and night with all kinds of illegal fishing methods. This has resulted in a drastic decrease in the number of quality fish of commercial importance and a lot of species have drastically declined in strength. The overall rise in the operational costs of fishing has led to a steep decline in boats going fishing leading to loss of livelihoods in the entire supply and value chain.
5. There seems to be no planned approach in construction of harbors in Karnataka as compared to fishing harbors in Kerala and Tamil Nadu. The existing fishing harbors are incapable of handling the mounting number of fishing vessels and boats are subject to more damage.
6. The facilities provided at harbors are inadequate. No regular maintenance of the existing facilities is being carried out.
7. Maintenance dredging of navigation channels is not being carried out regularly, hindering the safe navigation of vessels.
8. The COVID pandemic has severely affected exports in-turn preventing fishermen from getting a fair price for their catch.
9. There is a lack of adequate freezers in the state.
10. The frequency of supply of kerosene to small scale fishers is not constant, but irregular and highly unpredictable. In addition, un-availability of Kerosene in the open market has incapacitated small scale fishers in pursuing their livelihood activities by limiting the number of fishing days.
11. The quantity of Kerosene supplied is very meagre (approx. 200 liters/month or 6 liters/day) compared to the daily requirement (30-40 liters/day).
12. There has been a considerable decline in fuel sales since December 2020. Even if some choose to go fishing, they come back with losses and don't venture out for fishing again.
13. There have been considerable delays in receipt of the eligible Diesel subsidies. Hence subsidized over-the-counter diesel has been requested.
14. Loan waiver for departmental group loans has not been received/realized, whereas loans taken from nationalized banks have been waived off.
15. There has been a lag in implementation of fishing regulations and no system in place to keep a check on compliance of regulations.

16. Political lobbying has been a major contributor in issuance of licenses to new boats which has resulted in an unscientific increase in fishing fleets leading to more unhealthy competition among fishers.
17. Although, since 2012 a complete ban exists on cuttle fishing employing fish aggregating devices such as Chowri, torn nets, decaying material and other marine polluting materials/items along the Karnataka coast, such practices are still being carried out especially by fishermen from other states.
18. The untreated effluent discharged by industries and urban local bodies in rivers and seas have led to reduced fish stock
19. The export market of cuttlefish, squid, prawns, ribbon fish etc. has been affected due to the pandemic and no proper payment has been received by the importers citing the pandemic situation.
20. Beaches that were used for fish drying have been lost over the years due to erosion. Post which, 3 small Islands were given for pursuing their activities. Subsequently, with the onset of the fly menace, the fisheries department proposed solar drying and had offered subsidy schemes for purchase of solar dryers. However, the fishermen were not convinced with the technology as they felt that this would lead to excessive drying of fish and fetch lesser value for the final product. Moreover, as per them, the solar drying technique would not be able to handle the quantity of fish to be dried. The rise in fish meal plants has severely impacted the quantity of fish which they are able to procure for drying purposes, affecting their livelihoods.
21. Due to increase in the surface temperature of marine water, the fishes that are sensitive go deeper or to deep seas. This has impacted fisheries. Moreover, discharge of effluents from industries such as MRPL, BASF and many others near Baikampady has impacted shore-based fishing.
22. In addition to the steady increase in the number of fishing boats, fishing practices such as bull trawling, light fishing, use of small mesh nets and increase in operational costs (fuel, nets, hardware) etc. have led to non-viable and non-profitable fisheries.
23. The policy and subsidies for Aquaculture in the state are not favorable to fish farmers. Commercial tariffs/rates are charged for electricity and input costs such as seeds, feeds etc. are expensive. Hence fish farmers in Karnataka are finding it difficult to make their produce available at competitive prices compared to neighboring states such as Andhra Pradesh or Kerala where the electricity is 60 percent cheaper than in Karnataka and other inputs such as seeds, feeds are provided by the Department of Fisheries of their state at a lesser margin.
24. Aquaculture policies which are framed are usually drafted without knowing and understanding problems at the grass root level without adequate consultation with the relevant stakeholders.
25. The aids given to the Aquaculture sector are mostly negative subsidies which have very little or no benefit to the fish farmers.
26. Industrial pollution is the major cause for fish decline in the state.
27. The current policies for water-based tourism activities, homestays, camping, agro-tourism etc. are vague, arbitrary, cumbersome and impractical. Moreover, there is a policy-culture conflict due to the disconnect between the policies and the ground reality thus hindering progress of aquatic tourism and other allied activities. This results in illegal businesses being run across the state.

28. The fishing harbor proposed in Hejmady would result in adverse consequences on the ecology of the region as it is surrounded by mangroves which is an eco-sensitive area. Moreover, the breakwater that would subsequently come up would hamper surfing activities in the region.

7.4.2 Suggestions from Stakeholders in Dakshina Kannada district:

1. Fishermen need to be trained on the various scientific aspects of fishing such as how different species of fish can be obtained from different depths. Additionally, training to be imparted on using specific combinations of boats and fishing gears for fishing specific types of fish.
2. Areas of fishery abundance to be informed to the fishermen so as to reduce the diesel consumption.
3. Alternate eco-friendly fuels should be considered/developed for engines.
4. The tonnage of fish caught per boat in a year to be capped. The limit to be set for individual boats based on fish stock assessment and number of boats. Once a particular boat has exhausted the assigned limit, the boat needs to be grounded for the rest of the year and cannot be allowed to go fishing.
5. Discourage fish meal plants in the state as they are mainly responsible for increase in catches of juveniles and bycatches, leading to decline in fish stocks.
6. More emphasis and encouragement to be given to promote good quality engines. Engines made in India to be promoted rather than engines made in China.
7. Strengthen Coastal Security Police and equip them with suitable training and infrastructure for strict vigilance in coastal waters.
8. Fishing harbors need to be scientifically planned well to handle maximum fishing vessel traffic.
9. Routine dredging of navigational channels needs to be carried out.
10. More number of freezers are required in the state to preserve fish for a longer time.
11. Carry out studies and increase awareness on ways to enhance breeding season
12. Enforce strict ban on fishing during the spawning period (June-August). Presently there has been dilution in compliance with the fishing ban period and mechanized boats start fishing from August 3rd onwards.
13. Enforce strict compliance and adherence to use of square mesh cod end nets etc.
14. Encourage development of value-added products from fish that can fetch higher value and create more jobs, after suitable market analysis. Marketing and advertising of these value-added products is equally important to promote and boost fish related products and earn foreign exchange earnings. However, the manufacture, sales and marketing of the value-added products should be run by societies and self-help groups rather than a private entity in order to ensure equitable share of benefits to local communities. Presently, under KFDC and Matsya Bandana Pvt. Ltd., fish chips are being manufactured and many other products are in the pipeline.
15. Impose fines on other state boats fishing within 12 NM in Karnataka waters by appropriate mechanism.
16. Stringent measures are to be taken to enforce the ban placed on fishing of cuttlefishes using Fish Aggregating Devices (FAD).
17. Promote sustainable deep-sea fishing.
18. Supply/allotment of subsidized kerosene to Karnataka state to be increased as the state is facing acute shortage of the fuel and availability of subsidized Kerosene to be regularized in order to sustain the livelihoods of traditional fishermen.
19. Non-subsidized kerosene to be made available in the open market so that traditional fishermen can obtain/purchase as much as they can afford.

20. System of reservation to be set-up for candidates from fisher families to obtain admission in College of Fisheries, Mangalore to study B.Fsc/M.Fsc courses.
21. System of reservation to be set-up for candidates from fisher families to be selected for job-oriented courses and jobs in Coast Guard etc.
22. Ensure stringent action is taken on industries disposing untreated effluents to the sea to safeguard their livelihoods.
23. Ensure adequate staffing and filling of vacant positions in the Department of Fisheries to carry out various important functions.
24. Old Ice plants in Malpe, Mangalore, Gangolli, Karwar, Honnavar and Bhatkal to be upgraded/renovated under KFDC to ensure supply of good quality ice to fishermen and quality fish to the consumers. Upgradation/renovation to be fast-tracked as the machines are old (1970).
25. Popularize benefits of eating hygienic fish among the masses to promote good health. Establish fish sale counters, mobile canteens, mobile vans (Matsya Darshini) etc. in all districts and taluk levels
26. Establish 2T-5T Chillers and cold storages in Inland areas for fish farmers to store their catch for a longer time if sales have not been achieved. This will ensure good income generation and protect their livelihoods.
27. Provide small 4 wheelers (up to 500Kg capacity) to fish farmers in Inland areas to enable them to sell fresh fish to neighboring villages.
28. Provide four wheelers fitted with oxygen facility etc. to ensure full-fledged careful seed transportation and reduce seed mortality rate in inland areas.
29. Train and provide subsidies for setting up Aquarium shops, ornamental fishes, seed production, feeds etc.
30. Regular maintenance of toilet facilities at Mangalore harbor to be ensured. The toilet facilities to be provided with adequate drainage systems.
31. Basic necessities such as drinking water facilities and restrooms for laborers to be created at the Mangalore harbor to ensure health and hygiene of workers.
32. Fish marketing vendors who sell fish at wholesale prices to other states have expressed the need for a platform (at least 50 vehicles to be parked at a time for loading) and an overhead slab over the platform for storage (to store boxes due to scarcity of space at the harbor). This will aid in maintaining cleanliness and safeguarding the quality of the fish.
33. Policies for water-based tourism activities, homestays, camping, agro-tourism etc. need to be revamped to make them practical, simpler, friendlier, easy for implementation, activity specific (sport dependent) and ensure inclusiveness by consulting subject experts, social specialists and taking into consideration the ground realities as in foreign countries. Policies would also have to distinguish between different scale and magnitude of same activities, as having a common policy would be impractical.
34. A Feedback box/Grievance redressal mechanism is to be established to communicate the hurdles faced in the sector effectively.
35. The Hospitality and the Tourism sector needs to be heavily promoted, as the sector has tremendous potential to provide alternative livelihood and income generation opportunities to the coastal community by means of water sports, homestays etc. and also help to bring the communities together and keep the beaches clean.
36. An effort needs to be made to organize frequent events such as surf festivals, beach festivals, food festivals on beaches and river banks. These events have to be widely marketed with Public Relation strategies internationally as well as all over India especially in metro cities like Mumbai, Delhi etc. to showcase the pristine natural beauty of Karnataka. This will ensure other alternative livelihoods gaining pace to drive socio-economic benefit.

37. The Government must promote sustainable beach tourism wherein dedicated infrastructure such as adequate access roads, parking facilities, changing rooms, etc. need to be created and maintained. Sustainable beach tourism will provide various kinds of job opportunities for local communities such as lifeguards, food stalls etc.
38. The Government should support beach side and river side resorts that are built with sustainable and eco-friendly building materials such as wooden cottages, bamboo cottages etc. that are easy to construct and dismantle. This would create more jobs to the local communities in the hospitality sector.
39. Promote water sports such as surfing, kayaking, paddle sports and the like which can also boost income of the local community.
40. The fishing harbor proposed in Hejmady needs to be reviewed and shifted from the proposed location. The proposed location is in an eco-sensitive area and is surrounded by mangroves. In addition, the proposed breakwater would also hamper surfing activities in the region.
41. There is an urgency to promote alternative livelihood options for the fishermen community/coastal communities as they are solely dependent on fishing for their income considering that fisheries are set for a downfall as a result of increasing trends in unsustainable fishing practices.
42. There is an urgent need to streamline the mechanism for buyers of fish in order to protect fish farmers from fraudsters. The state Government must initiate a licensing procedure and introduce regulation such that fish farmers are protected from fraudsters who are not likely to make payments distressing the farmers. The licensed buyers registered under the government also need to keep deposits as a guarantee.
43. The government must initiate subsidies on input costs to the fish farmers in the aquaculture sector such as subsidies for seeds, feeds, power requirement, marketing and transportation (Chill packing, freezers, cold storages to co-operatives) to make the farmed products economically viable and competitive in the domestic and export markets. Such subsidies will promote the sector.
44. There is a need for creating a market for fin fish in order to promote the sector.
45. Any policy on Aquaculture and Capture Fisheries is to be drafted with adequate information of the ground level problems and realities, after initiating a dialogue with the relevant stakeholders for possible solutions.
46. The State Fisheries department must be empowered to provide permits to small fish farmers so that they would get licenses with ease.
47. Strategic marketing, providing basic and advanced infrastructure amenities such as well-maintained roads, washrooms, parking facilities, world-class air-conditioned buses as well as attractive brochures and licensed tour guides are the necessities to spur growth in the cruise tourism sector.
48. Scientific ranching of important species must be carried out in protected areas/mangroves which are known to be spawning grounds for most fish species to revive fish stocks.
49. A tourism centric mindset amongst people living around tourism areas is essential to promote and sustain a tourism friendly atmosphere.
Creating awareness on courtesy and importance of maintaining highest levels of cleanliness in tourist areas is extremely crucial.
50. Ensure resorts, hotels etc. compulsorily carry out waste segregation and inhouse composting of wet waste.

7.5 Summary of Telephonic discussions with stakeholders in Udupi District

Fisheries related stakeholders in Udupi district:

Sl. No.	Name of Association/Union	Designation
1	Deep Sea Trawl Boat Association, Fishing Harbor, Malpe	President
2	Fisheries Union, Malpe Fishing Harbor, Malpe	President
3	Purse Seine fishermen's Primary service Co-operative Society Ltd., Kota	President
4	Malpe Trawl Boat Owners Association, Malpe	President
5	Ice Plant and Cold Storage owner's Association, Udupi	President
6	Purse Seine Fishermen's Association, Malpe Harbor, Malpe	President
7	Malpe Trawl Boat, Owners Association, Malpe	President
8	Nada Doni and Yanthrika Meenugarara Prarthamika Sahakari Sangha, Fishing Harbor, Malpe	President
9	Purse Seine Fishermen's Association, Gangolli	President
10	Nada Doni Meenugarara Sangha, Byndoor sector, Byndoor	President
11	Nada Doni Meenugarara Sangha, Gangolli sector, Gangolli	President
12	Yantrika Meenugarara Sangha, Hangarkatta	President
13	Kanni party Association, Malpe	President
14	Malpe Fisherman's Primary Co-operative Society Yard, Malpe	President
15	Deep sea boat owners Primary Co-operative Society, Malpe	President
16	Deep Sea Trawl boat, Tandelas Association, Malpe	President
17	Scheduled Caste Women's Primary Co-operative Society, Thottam	President
18	Gill net boat owners Association, Malpe	President
19	Akhila Karnataka Karavali Meenugarara Kriya Samithi, Uchila	President
20	Mogaveera Mahajana Sangha, Uchila	President
21	Sea Food Exports and allied industries Association C/o Tholar ocean products Pvt. Ltd., Kota	President
22	Malpe Yantrika (Trawl) Doni Meenugarara Prarthamika Sahakari Sangha, Fishing Harbor, Malpe	President
23	Malpe Fish Merchant Association, Malpe Fishing Harbor, Malpe	President
24	Shri Durganidhi Fisherwomen Co-operative Society, Paduthonse Bengre	President
25	S.K and Udupi district Co-operative fish Marketing Federation Ltd., Mulihithulu	President
26	Yeroor Fishermen Co-operative Society, Yeroor	President
27	Manipura Meenugarara Vividyodesha Prathamika Sangha	Secretary

Tourism related Stakeholders in Udupi district:

Sl. No.	Name of the Organization	Designation
1	Kadal Centre For Sup, Surf, Yoga & Kayaking, Malpe	Proprietor
2	The Shaka Surf Club, Kodi Bengre	Proprietor
3	Panchajanya Cruise (House Boat), Kodi Bengre, Udupi	Proprietor
4	Soans Holidays (India) Pvt. Ltd.	Proprietor
5	Royal Fortune Tourist Boating, Kundapur	Proprietor
6	Gangothri Holiday Cruise (House Boat), Kundapur	Proprietor

Due to the restrictions imposed by the State Government in view of the COVID-19 pandemic, stakeholder discussions with key representatives from various fishermen associations/unions/tourism stakeholders in Udupi district were carried out telephonically in May-June 2021.

7.5.1 The following is the summary of the interactions, their opinions and suggestions on various aspects pertaining to their sector:

1. They expressed their concerns on reduced fishing days due to frequent cyclones and the COVID-19 pandemic that has brought uncertainty in the sector and impacted their livelihood.
2. No cleanliness is maintained in the Harbors. Basic facilities such as drinking water, clean toilets are not adequate and not maintained properly, where available. This poses a hurdle in the health and hygiene of the workers in the harbor.
3. Many fishers expressed worry about the decreasing number and diversity of fish in the seas over the recent years. An increase in the number of mechanized fishing fleets, use of high-speed engines up to 600 HP, bull trawling, light fishing, use of small mesh fishing nets to achieve increased fishing effort has led to unsustainable fisheries. They opined that the fisheries sector is experiencing a slow death and if these practices continue without restraint, in the next 5 years there would be an end to marine capture fisheries.
4. The fishing ban duration which is from beginning of June to end of August is generally flouted due to political pressure and trawl/purse seine fishing boats begin to fish from August 1st onwards which results in high juvenile catches which are tomorrow's fishery wealth.
5. There is no designated land within the Malpe port area for fisheries related activities. Increased demand has welcomed multiple stakeholders who have been allotted land for private purposes threatening the livelihood activities of traditional fishers, especially women fishers that use the land for fish drying purposes.
6. Although there are adequate ice plants in the state, a great majority of the stakeholders do not handle fish hygienically nor maintain the quality of fish after catch either because they don't bother or due to lack of awareness.
7. Although most fishers know the ill effects of unsustainable fishing practices, they are compelled to continue such practices due to high pressures of repaying loans. Moreover, the existing market demand in fishmeal plants for juveniles/trash fish, has encouraged low value bycatch and targeted capture of juveniles to meet the demand.
8. The demand for trash fish from the fish meal industries along the coast has driven the quantity of bycatch landed (Chalt). If the demand was not there, a lot of juvenile fish would have thrived.

9. Since the fish meal industries prefer the use of Indian oil sardines, there has been a considerable decrease of this species throughout the coast of Karnataka.
10. There are several underlying factors that are posing a threat to enforcement of sustainable fishing practices such as bribes, influencing for licenses, etc. If these are not addressed, sustainable fishing would be a distant dream.
11. Other state boats often use various fishing styles that are banned i.e., use of coconut shell waste and waste nets to target cuttle fish that come to lay eggs.
12. Fishermen from other states such as Goa, Maharashtra, Kerala and Tamil Nadu often fish in Karnataka waters i.e., within 12 NM, using illegal fishing methods and operating even during the fishing ban season in the state. Still no action is taken against them. Whereas, when fishermen from Karnataka fish in other state waters, they are severely penalized with actions such as seizure of boats and fish catch, imposing of penalty etc. Most of the fishermen opined that they be given exclusive rights to fish within 12NM of Karnataka's waters and fishermen from other states should not be allowed to fish therein. However, few fishermen opined that since they go to other states for fishing, fishermen from other states should also be allowed.
13. Although the value of exports over the years are showing big numbers and an increasing trend, it is not the quantity of quality fish that has increased but it is due to the surge in prices due to decrease in the availability of fish. The quantity of catch of commercially important fish species has reduced drastically.
14. Presently, 50 percent of the boats are idle in the harbor and have not gone fishing knowing that it is not going to work out or be profitable.
15. Significant increase in diesel prices has added an additional strain on the already flimsy marine fisheries sector making fishing non-profitable and fishermen incurring heavy losses.
16. Use of specified fishing nets (35 mm cod end square mesh), although encouraged, is not being practiced due to the fact that the smaller size diamond mesh fishing nets are still manufactured and easily available. Moreover, these handmade diamond small mesh nets aid in juvenile/bycatches that seem more profitable to the fishermen due to increasing demand from Fish Meal and Fish Oil plants and are hence widely used.
17. Fishing has become like a big industry, no matter how much fish is caught, it is not enough.
18. Fish meal industries that are located along the coast often dispose of untreated wastewater during high tide which has an adverse impact on the fishery in the region.
19. Due to the lack of an engineering wing in the Department of Fisheries, there has been a lag in execution of infrastructure and maintenance related activities.
20. All suggestions and recommendations provided during meetings remain mostly in the reports and their implementation at the ground level hardly takes place resulting in no benefit to the fishers.
21. Under PMMSY, the kerosene subsidy that was provided to nada doni fishers have been withdrawn, causing worry to traditional fishers
22. A lot of plastic waste has been spotted in the seas while fishing due to littering and mismanagement of plastic wastes.
23. Since there is no supply of potable water/R. O water in the harbor, almost all the fishers use packaged/bottled drinking water which results in plastic waste being generated which is then thrown into the sea, resulting in sea pollution. Although there is some awareness among fishermen on the impacts of plastic waste on marine life, the generated plastic waste is not brought back and there is no system in place for collection and segregation of waste in minor ports and harbors.
24. Earlier, fishing was carried out sustainably, only during the day by small boats and only by people from the Mogaveera community. However, now, fishing is being carried out

day and night employing illegal methods. Moreover, currently, about 60 percent of the people involved in the sector are businessmen-investors and only 40 percent are born fishermen. The born fishermen do not have enough money to invest and compete with big businessmen.

25. Since several industrialists and business minded people have entered the fisheries sector, they often loot the oceans and do not care about the sustainability aspects of fishing or about the livelihood of small-scale fishermen. The fishermen opined that if the business minded rampant fishing continues, they see no future for the fisheries, or for them and their children in this sector
26. Most of the traditional fisher folk have abandoned traditional fishing methods and have joined mechanized boats as laborers. Hence, they do not get any benefits such as subsidies, which are enjoyed by the owners of mechanized boats. The benefits reach only those who are willing to invest by taking loans and no benefits percolate to the workers.
27. Currently most of the boats use China-made engines of much higher capacity (500-600HP) whereas the permitted capacity by the state government is 350HP. Moreover, the higher capacity engines are expensive and of poorer quality than Indian made engines. Since there is no regular check on the capacity of engines used in boats, there is an unhealthy competition among fishers as each boat wants to outrun the other for a better catch.
28. Government officials, responsible for enforcement of rules are not sufficiently staffed and empowered for the same.
29. The Department of Fisheries is ill equipped with lack of facilities and staff to enforce the rules and to impose strict penalties on violators. The coastal security police force also lacks adequate facilities for patrolling and hence implementation of laws is ineffective.
30. Many species of fish that they used to catch earlier are not visible now. Over the years, there has been a decrease in the quantity of fish due to several unsustainable fishing practices.
31. Water pollution arising from industries, agriculture and plastic litter has significantly impacted the fisheries of the region.
32. Municipal solid wastes are often discarded into rivers from bridges
33. Many industries are disposing their untreated, often poisonous effluents to the sea which has impacted fish stock.
34. The fishermen were informed that the loans will be waived off especially for women but the same has not come into effect.
35. There are hardly any significant facilities for fishermen such as subsidies for their children's education, health insurance benefits etc.
36. Although the fishermen have been provided with 35mm cod end mesh, they are not using it as medium size Mackerel passes through those nets.
37. Around 500 women were trained in value added products by NETFISH, however more encouragement is required to promote entrepreneurship.
38. Few decades back, one family had one boat, however as the Government supported new boats by means of subsidy, without restraint, most fishermen diverted their profits into licensing new boats by resorting to illegal means. Now increasing fuel prices, increased number of boats and decreased fish catch has made their life miserable.
39. Traditional boats wait for Monsoon ban season to fish where there is no competition from mechanized boats.
40. Fishermen do not have patience and they do not think about tomorrow, around 30 Kg Juveniles fetch INR 450-500, whereas if the same fish were allowed to mature, it would have resulted in 1 Ton of fish with a value of at least INR 2 lakhs.

41. A lot of migrant laborers are employed at fishing harbors in all 3 coastal districts due to the large number of boats.
42. The poor fisherwomen who had enrolled themselves to the “Kendriya Puraskratha Ulitha Yojane” (Central Reward Savings Plan), were in distress during the pandemic as they did not receive the amount they were supposed to receive on time and some received with a lot of delay. These uncertainties have made the fisherwomen lose trust in schemes.
43. Presently there are no schemes, tax relaxation, compensation etc. available from the Government to promote Houseboats/cruise boats as compared to Kerala where 55 percent subsidy is provided, 0 percent taxes, compensation benefits and also some aid for running costs such as electricity and water requirement.
44. Most of the training provided for alternate livelihoods often require a lot of investment and also come with associated risks. Hence most poor women feel that they should be given training to pursue alternative livelihoods which require low initial investments or be given loans at 0 percent rate of interest.

7.5.2 Suggestions from Stakeholders in Udupi district:

1. Provide knowledge to fishermen on breeding times/seasons of different fish species and subsequently impose a ban in different areas and seasons to maintain fish stocks to a sustainable level
2. Carry out high vigilance at sea to curb illegal fishing practices
3. Use RADAR for detecting fishing boats in the sea and monitor fishing in restricted areas
4. Industrial effluents must be scrupulously evaluated by the Government to keep an evidence-based check on water pollution by various industries.
5. A fish stock assessment should be carried out and only a sustainable tonnage of fishery resources is to be allowed for extraction
6. Reduce the number of plastic wastes entering the oceans by implementing appropriate waste management plans as plastic deposition in seas will not allow even the bottom level grass to grow and thus impact the food chain.
7. Create regular awareness sessions to all fishermen especially deep-sea fishers on hygienic handling of catch, methods to appropriately maintain quality of the fish after catch, advantages on use of 35mm square cod end meshes, handling of diesel oil to avoid spills, segregating plastic waste on board for disposal at the harbor etc.
8. Most of them opined that a change in mindset/self-restraint practices by all fishermen towards sustainable fishing practices can revive the sectors.
9. Strict control in issuing new licenses to boats is essential to bring fishery resources to sustainable levels
10. Enforce uniform fishing ban across the west coast by the Central Government from June to August to avoid conflict of interest by fishermen of different states
11. A request has been made to the Government to not allow any further increase in the number of ice plants and only permit renovations of existing ice plants as the supply is exceeding the demand. Furthermore, many ice plants have closed down recently due to decreasing demand and present ice plants are selling half their capacity.
12. A technical advisory committee that is broad minded, with members well acquainted with the fishing industry needs to come in force to regulate and take decisions related to enforcement of sustainable fishing practices.
13. Enforce phase wise reduction in the number of fishing fleets and also restrict licenses to new ones to achieve sustainable harvesting levels to safeguard the livelihood of traditional fishers who depend only on fisheries for their sustenance. Apparently, some

fisher families also own a staggering 10-20 fishing boats which needs to be regularized and minimized to ensure inclusiveness.

14. There has to be uniform sustainable fishing norms all across the west coast established by the central government and scope for amendment should solely lie therein. These norms can be implemented from next year as fishermen will get time to accustom to the new norms and be prepared to adhere to the same.
15. Fishermen should be encouraged to purchase Indian make engines not exceeding 350 HP instead of buying China-made high-speed engines up to 600 HP.
16. The net making firms are to be strictly monitored to manufacture only approved type and size of fishing nets such as 35mm square mesh fishing nets to further sustainable fishing in the state.
17. Establish an engineering wing in the Department of Fisheries to execute the infrastructure and maintenance aspects in the sector.
18. The revenue generated in the harbor/port could be used for the development and maintenance of that port.
19. There is a need for strict action/litigation to be filed against violators of norms to bring unsustainable fisheries under control.
20. Potable water needs to be made available and hence can be done by diesel supplying companies as CSR activities.
21. Plastic waste collection depot at every harbor for receipt of plastic waste generated by fishing vessels and responsible disposal of the same by recycling etc.
22. Fishermen youth are given a chance to put forth ideas and solutions at seminars as sometimes only seniors are given a chance for voicing out their opinions and the youth feel neglected.
23. Heavy fines as well as a case should be filed against all the boats violating fishing guidelines and also on those who purchase the catch (middlemen, industry etc.). Also, discontinue subsidy to violating boats. This can significantly reduce the number of offences.
24. Companies/Societies/Corporations who provide diesel to fishermen can afford to provide free potable water to fishermen in reusable bottles to reduce plastic bottle waste.
25. The fishing ban during monsoon i.e., June 1st- August 31st must be strictly adhered to revive fish stocks.
26. Establish and encourage use of uniform power boats by Indian engine manufacturers for different classes of boats such as Trawlers, purse seiners depending on the length of the boat (Indian Make- to encourage "Make in India" concept).
27. Create awareness among fishers on reducing the use of plastics and management of plastic waste.
28. The Department of Fisheries are not given the power to implement laws on sustainable fishing and the unsustainable practices are driven by political lobby.
29. Introduce fish cutting, packing industries in Uttara Kannada district as it lags behind compared to Udupi and Dakshina Kannada districts as this will lead to good income generation and a fair price for the fish.
30. The Department of Fisheries must intervene in fish marketing and ensure a uniform rate for various fishes in all 3 coastal districts and also maintain a minimum rate for each species i.e., when the prices are low, they can be protected from vagaries.
31. Ice boxes can be provided to poor fishmonger women who can store the unsold fish and fetch a better rate the next day instead of selling fish at a loss.
32. The Government must take stringent action and not allow industries to dispose of untreated effluents in the sea.
33. Discourage subsidies towards new boats to regulate rampant rise in fishing fleets.

34. Provide Walkie-talkie to traditional fishermen for better communication during unforeseen events.
35. During disasters such as floods, cyclones etc. fishermen often go to help those impacted and most of the time spent for ropes, life jackets etc. from their pocket for relief measures and hence these basic amenities should be made available by the government as emergency preparedness.
36. Unless subsidies for new boats are stopped, it is very difficult to control unsustainable fishing as the Fisheries Department itself encouraged more boats via subsidies.
37. The Department of Fisheries should have their own dredgers for carrying out routine dredging in channels for safe navigation as done in Kerala state. Presently a tender has been awarded and the work is not carried out satisfactorily.
38. Even if a skill development program has been imparted, there is very little follow up to check on-ground implementation and hence a robust evaluation and monitoring strategy needs to be in place.
39. Develop infrastructure on select beaches such as Toilets, changing/shower rooms.
40. Provide freezers for fishing villages, fishermen/fisherwomen societies to protect them from selling catches at a throw away price.
41. Beach tourism should be promoted to develop local communities and safeguard their local culture.
42. Provide technical training on the type of nets for different species of catches and such other useful information.
43. Train fisherwomen in various alternate skills such as aquaculture, aquaponics, manufacture of cloth bags, baking, eco-friendly cutlery etc. and ensure information on such training has reached the masses.
44. The Government must support loans to fisherwomen directly through co-operative societies on zero interest rather than through nationalized banks to support fisherwomen.
45. The Government must initiate some schemes to help poor and vulnerable fisherwomen who are severely affected due to the pandemic.
46. Make PAN number mandatory for registration of fishing fleets as multiple numbers of fishing fleets are being registered in the names of relatives, friends etc. but are being controlled by one person. This is leading to income disparity between the rich and poor.
47. Provide subsidies especially to Women Entrepreneurs to start up tourism activities such as houseboats to maximize social benefits to the local community from allied activities that would be generated by promoting tourism.
48. Provide compensation for losses to infrastructure during natural disasters to house boats etc.
49. Creating infrastructure such as Aquariums, Mangrove boardwalks etc. near to coastal areas will automatically attract more tourists and open new avenues to boost other kinds of tourist activities such as homestays, watersports etc.
50. Licensing for business opportunities such as homestays, water sports activities, land conversion formalities should be made convenient and hassle free.
51. Promote jaggery making in Basroor village in Kundapura to promote socio-economic development.
52. Identify areas of historical importance near coastal and backwater areas and promote these as heritage sites to attract more tourists. This will also attract more tourism avenues in and around those regions leading to socio-economic development.
53. Introduce certificate training courses on tourist guides skilled in life saving techniques.
54. Carry out frequent inspections to check the power of engines (350HP) on mechanized boats as presently most fishing fleets operate up to 600-700 HP engines.

55. Take strict action on violations pertaining to banned fishing practices such as bull trawling, light fishing. The challan as warnings could be issued immediately with fine amount increased with every warning whereas payment of fines could be attached to renewal of licenses to avoid dilution or infringement of fine payment.
56. Separate funds should be budgeted/earmarked every year for maintenance of Infrastructure to promote tourism in the state.
57. Training to poor uneducated fisherwomen must include low investment alternative livelihood options such as making of jewelry, handcrafted items, creative card making, making reusable cloth bags etc. To be more fruitful, training should be based on local level interests of these women and markets available wherein women in a village could be given training options to choose from prior to organizing training.
58. Promote river tourism in line with Kerala model/strategy to tap the enormous potential that this sector offers for socio-economic development of adjoining communities. The Government must encourage houseboat businesses and attract more investment in this sector by providing subsidies for running costs (subsidy for electricity, potable water, diesel etc.) rather than for the initial investment, provide good infrastructure support (jetties, dredging of channels etc.) and advertisement/marketing support. This would create a lot of alternate livelihoods to communities and job opportunities for the youth in the hospitality segment.
59. Training programs could be given to the youth to promote the tourism/hospitality sector in a sustainable manner i.e., lifeguard training, sustainable tourism, environmental management, adventure tourism and related safety skills, outdoor adventure guide, customer service skills, leadership skills, communication skills, generic management skills etc.



SUMMARY OUTLINE BLUE ECONOMY PLAN

The recommendations from the brief status papers and inputs from various stakeholders of the blue economy have been assembled into a “**Summary Outline Blue Economy Development Plan**”. This plan addresses the challenges, opportunities and potential in each sector to holistically pursue blue economy goals along with the required institutional arrangements, skill development and capacity building efforts that are crucial for enhancing and sustaining these goals.

The recommendations are outlined giving maximum emphasis to environmental sustainability, ecological integrity and social equity. Implementation of recommendations in this plan would require the collated efforts of various stakeholders such as the Central and State government departments, various research institutes, NGOs, Local Governments, local committees etc.

The plan outlines the recommendations segregated into the following 10 broad sectors namely:

- Sector-1: Sustainable harvesting of Living blue resources** from Marine and Inland waters: This includes recommendations to support the lives and livelihoods of numerous fisherfolks in the state by curbing unsustainable harvesting of aquatic life forms and implementing strategies to conserve them for long-term socio-economic benefit from living blue resources.
- Sector-2: Water based Tourism and Ecotourism to maximize social benefits:** It comprises recommendations that provide direct and indirect employment opportunities to local communities especially women and marginalized communities.
- Sector-3: Pollution Control & Management of water resources:** This consists of recommendations to protect the state’s water resources from environmental and ecological degradation, conserve the rich biodiversity they support and in turn safeguard the livelihoods of the people who depend on them
- Sector-4: Resource conservation & Waste Management:** It involves recommendations to conserve water resources effectively and implement strategies to minimize the flow of solid wastes/plastics into water bodies in rural and urban areas.
- Sector-5: Conservation of priority ecological resources:** These recommendations pertain to conservation of eco-sensitive areas such as coastal, marine & estuarine areas, Western Ghats etc. and protection of endangered/threatened species such as turtles, whales, sharks, dolphins etc.
- Sector-6: Scientific extraction of Non-living blue resources:** This section of recommendations encompasses scientific extraction and potential for utilization of non-living resources with actions mainstreamed for absolute minimum damage to ecology and environment
- Sector-7: Marine Area Management:** This entails recommendations to promote efficient management of coastal areas including suitable coastal protection measures.
- Sector 8: Maritime Transport & Development:** It outlines the recommendations that pertain to port and transport based socio-economic development and income

generation as well as pollution management from water-based transport/ship generated wastes.

Sector-9: Disaster Management: These recommendations are related to Disaster Management and mitigation in the blue economy context such as emergency preparedness for Oil spill disasters etc.

Sector-10: Establishment of a “Blue Economy Training Institute and Research Centre/s”: These recommendations pertain to establishing an institute to carry out various skilling, up-killing and capacity building programs in every blue economy sector.

Each of the recommendations under the various sectors provides the suggestion, benefits envisaged, implementation priority (High, Medium, Low), responsible institutions and tentative outlay for preparation of specific action plans and robust implementation strategy by the task force committees.

Sector 1: Recommendations for Sustainable harvesting of Living Blue Resources

The following recommendations pertain to sustainable harvesting and conservation strategies for living blue resources in Marine and Inland waters to support the lives and livelihoods of numerous fisherfolks in the state by curbing unsustainable harvesting of aquatic life forms and implementing strategies to conserve them for long-term socio-economic benefit from living blue resources.

1.1 Sustainability in Capture Fisheries (Marine and Estuarine)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Initiate active dialogue with neighboring west coast states (Kerala, Goa, Maharashtra, Tamil Nadu) towards a coordinated fisheries regime and streamline uniform/near-uniform policies, regulation and incentives.	Minimizes the impacts of un-coordinated harvest regimes and minimizes conflicts Safeguard fish stocks of commercially important fish species	High	Dept. of Fisheries	Govt
2	Carry out periodic detailed investigations of biology and population parameters of important species (Stock/resource assessment). Estimate Maximum Extractable Catch using information from population vulnerabilities (Using modern genetic tools such as “genetic population structures” and “effective population size using allele frequencies”) and life history parameters using Ecosystem based fisheries management tools like ECOPATH and ECOSIM.	Fish stock assessment and management Promotes sustainable levels of fish stocks Reduces overexploitation of fishery resources	High	Dept. of Fisheries, CMFRI, College of Fisheries	Govt. & Private
3	Encourage and promote passive methods of fishing such as lining and gillnetting and disincentivize active methods of fishing by discontinuing benefits (Subsidies, schemes) given for repair of Trawl and purse seine fishing (vessels and gear)	Regulates rampant rise of fishing fleet and ensures sustainability of fishery resources	High	Dept. of Fisheries	Govt. & Private
4	Create an agency at State level to standardize fishing vessel design, construction and engine power.	Avoids national and state level conflicts among	High	Dept. of Fisheries	Govt.

	Establish proportionate ratio between length of the fishing fleet and the power (horsepower) and implement the same stringently Implement controlled license measures for craft-gear combination and engine speed length ratio	fishers Achieves successful output from national and state level planning in fisheries Produce commercial fishing vessels to international standards with improved efficiency, reduced maintenance minimal carbon footprint and economical fishing operations			
5	Regulate the number of fishing fleets to the optimum level in a phased manner. Consider withdrawing subsidies and discontinuing registration for new mechanized fishing fleets for an initial period of five years. Enforce strict compliance of registration of fishing vessels with a validity of 10 years and fleet strength to be maintained at 1,312 for multi-day fleet (MDF), 729 for single-day fleet (SDF), 182 for mechanized purse seiners and 2,330 for Out board (OB) crafts as per CMFRI Marine Fisheries Policy Series-5 (To be revised periodically as & when sustainability studies carried out)	Regulates rampant rise in fishing fleets and curbs overfishing Reduced overcapacity	High	Dept. of Fisheries, CMFRI	Govt.
6	Implement strict registration of gear production units and boat building yards with regular inspection of gears and boats manufactured	Controls overfishing	High	Dept. of Fisheries	Govt.
7	Use Marine Spatial Plan (MSP) to resolve inter-state and inter-sector conflicts	Supports efficient fishery administration	High	Dept. of Fisheries, SAC-ISRO	Govt.

8	Color coding of fishing vessels to be strictly implemented in Karnataka to better identify fishing vessels. Random monitoring of each fishing vessel to be carried out annually for a compliance check on fishing gears used, mesh policy restriction on trawl (cod net size of at least 35 mm) and purse- seine nets (mesh size at least 30mm), use of Turtle Exclusion Devices (TED), engine capacity, its condition, its performance and its safety aspects Ensure heavy fines are imposed on violators including permanent cancellation of permits for repeated violations	Helps to differentiate between state fishing fleets and other state fishing fleets if violating norms Keeps a check on level of compliance by fishing fleets towards sustainability aspects and effectiveness of enforcement measures Increased sustainability of fish stocks, conserves endangered species and by-catch reduction	High	Dept. of Fisheries	Govt.
9	Use of cutaway top belly trawl and semi and pelagic trawl system to allow escapement of juveniles	Promotes optimum level of fish stocks	High	Dept. of Fisheries	Govt.
10	Implement and enforce catches of Minimum Legal Size (MLS) as per CMFRI guidelines and/or Minimum Legal Weight (MLW) for commercial species following the example of Kerala				Govt.
11	Reduce the number of existing fish meal plants and completely curb setting up of new fish meal plants in the state	Juvenile/bycatch reduction (As long as there is a market for bycatches, efforts towards reduction fisheries will continue)	High	Dept. of Fisheries	Govt.
12	Strictly implement closure of fishing operations by mechanized fishing fleets during peak spawning period (3 Months- June to August)		High	Dept. of Fisheries	Govt.
13	Establish and encourage use of uniform power boats by Indian engine manufacturers for different classes of boats such as Trawlers, purses seiners depending on the length of the boat (Indian Make- to encourage "Make in India" concept).	Promotes sustainable fishing and reduces the impact of drag in trawlers	High	Dept. of Fisheries	Govt.
14	Establish community based and community run fish protection and harvest zones along the inland and estuarine waters based on guiding principles provided by the FAO's Voluntary Guidelines on Small Scale Fisheries (2014) and the FAO Code	Stronger stake to local communities in harvesting and sustainable management of wild fish	Medium	Dept. of Fisheries	Govt.

	of Conduct for Responsible Governance of Fisheries (2012).	stocks			
15	Promote deep sea fishing with selected nets to diversify fishing activities.	Prevention of unhealthy competition and rift among fishermen	Medium	Dept. of Fisheries	Govt. & Private
16	Map and create a database on Invasive Alien Species from the Coastal & Marine resources	Protecting the marine environment from transfer of harmful aquatic organisms contained in ballast water	Medium	CMFRI	Govt.
17	Carry out ranching with high quality seeds of commercially important species and endangered indigenous species with high caution i.e., only after appropriate ESIA studies	Revive stocks of commercially important fish species	Low	Dept. of Fisheries	Govt.

1.2 Mariculture and Brackish water Aquaculture

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Identify probable mariculture sites with Marine Spatial Planning (MSP) and carry out experimental studies on Mariculture to explore its effects on near shore ecosystems and communities with suitable Environment and Social Impact Assessment (ESIA) studies. No Mariculture project, Inland or Marine should be permitted in the areas which are ecologically important, important for capture fisheries (nursery areas, fisheries reserve, spill over zones etc.) and areas which are important for vulnerable communities (small scale fishers, traditional fishing grounds)	Sustenance of local ecologies and safeguarding current fish stocks and local livelihoods	High	Dept. of Fisheries, SAC-ISRO, RGCA, CAA, CIBA, NaCSA	Govt. & Private
2	Carry out a pilot study using multi-sensor remote sensing data and in-situ data to evaluate water quality parameters and identify suitable areas for mariculture, seaweed culture and coastal aquaculture	Sustainable source of income and Increased employment opportunities for coastal communities	High	Dept. of Fisheries, CMFRI, SAC	Govt. & Private

3	Carry out Pilot studies as well as Environment and Social Impact Assessment (ESIA) studies for the following: Introduction of monoculture technology (Seabass, Pearl spot, Groupers, Milkfish, Mullet, Lutjanus, Mud crab) Introduction of polyculture technology (Fish and shrimp) Pond and canal culture of seaweeds (e.g., Gracilaria) in shrimp farming areas Seaweed polyculture in association with mollusks and fishes	Study impact of Mariculture activities on local ecosystems and livelihoods of small-scale fishermen Maximize productivity, harvest and profits	High	FRIC(M), College of Fisheries, Private Entrepreneur (PPP Mode)	Govt. & Private
4	Initiate subsidies on input costs to fish farmers such as subsidies for seeds, feeds, power requirement, marketing and transportation (Chill packing, freezers, cold storages to co-operatives)	Promotes the sector and makes the farmed products economically viable and competitive in domestic and export markets	High	Dept. of Fisheries	Govt.
5	Promote and support area expansion and intensification of fin and shell fish with huge export potential such as shrimps, mud crab, sea bass, pangasius and tilapia	Foreign exchange earnings	High	Dept. of Fisheries	Govt.
6	Support establishment of Nucleus Breeding Centers (NBCs) in the state for priority shrimp species like <i>Penaeus monodon</i> , <i>Penaeus indicus</i> and <i>Litopenaeus vannamei</i> , etc.	Specific Pathogen Free (SPF) seed for prawn cultivation Lesser export rejection and foreign exchange earnings	High	Dept. of Fisheries	Govt.
7	Post suitable ESIA's, promote Mariculture of commercially important species in clean sheltered coastal waters between promontories, cliff, along the islands of the state and pocket beaches through cage culture (seabass, lady fish, pearl spot, lobster, cobia) and raft culture (edible oysters, mussels, seaweeds)	Sustainable source of income and Increased employment opportunities for coastal communities	Low	Dept. of Fisheries, FRIC (M)	Govt.

	Provide technology extension services and infrastructure for culturing of bivalves and other potential species. Set-up pilot/ demonstration mariculture farms through private partnership with in-depth training to fish farmers				
8	Explore the possibility of vertical ocean farming in the offshore regions based on physical (wind, waves, currents and temperature) and biological (Nutrients, O ₂ and carbon) to farm native species after suitable ESIA studies	Increased job creation and income generation Reduce impact of marine degradation and climate change	Low	Dept. of Fisheries, CMFRI, College of Fisheries	Govt. & Private

1.3 Value Added Products- (Marine and Estuarine- Capture and Culture Fisheries)

Sl. No	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Encourage entrepreneurs to process fish/shellfish where adequate preservation and transportation facilities are not available such as salted fish, smoked fish, fish pickle etc.	Employment and income generation Socio-economic development	High	Dept. of Fisheries, CIFT, NIFPHATT	Govt. & Private
2	Strengthen production of existing value-added seafood products such as seafood-based pickles, crackers, chips, curry pastes, wafers, chutney powder, canned seafood etc. for domestic and export markets Provide subsidies and incentives for undertaking these ventures	To meet the domestic & export demand Earn foreign exchange earnings			Govt. & Private
3	Develop new value-added fish and seafood products with Indian taste, flavored with Indian spices such as Ready to Eat (RTE) and Ready to Cook (RTC) products such as sauces, noodles, fillets/flaps, fingers, sticks, bites, burger fillets, cutlets, breaded and battered seafood, sausages, nuggets, kababs, salami,				Govt. & Private

	steaks etc. after detailed market analysis				
	Provide subsidies and incentives for undertaking these ventures				
4	Implement new innovative technologies for production of fish feed pellets from fish processing waste such as the improved method by ICAR-CIFT	Reduces the environmental impact of fish waste disposal and cost of fish farming while increasing foreign exchange earnings and job opportunities	High	Dept. of Fisheries, CIFT	Govt. & Private
5	Encourage establishment of quality fish feed mills by utilizing the agro waste and fish meal produced in the state. These raw materials can also be utilized for manufacturing animal feed.	Holistic development of Aquaculture/Poultry	Medium	Dept. of Fisheries, CIFT, NIFPHATT	Govt. & Private
6	Encourage upgradation of existing Fish Meal and Fish Oil (FMFO) industries to produce fish feed and animal feed in the state	Reduces the environmental impact of fish waste disposal and cost of fish farming while increasing foreign exchange earnings and job opportunities	Medium	Dept. of Fisheries CIFT, NIFPHATT	Govt. & Private
7	Policy for segregation and collection of fish processing waste from various fish markets/processing plants for production of organic fertilizers and marketed as Bio-stimulant	Curtails haphazard disposal of fish processing waste and associated hazards to the environment and aquatic life	Medium	Dept. of Fisheries, CIFRI	Govt.
8	Explore improving harvesting techniques and post-harvest processing technologies for seaweeds Invest in technologically sophisticated extraction plants (agar, carrageenan, algin etc.) nearby cultivation areas to utilize the cultured sea weed resources efficiently for export markets	Efficient use of resources	Low	Dept. of Fisheries, NFDB, CIFT, NIFPHATT	Govt. & Private

1.4 Export (Marine and Estuarine- Capture Fisheries)

Sl. No	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Pursue and promote eco-labelling and certification schemes for export products	Increased income generation & foreign exchange earnings	Medium	Dept. of Fisheries, CMFRI, MPEDA	Govt. & Private
2	Train exporters on HACCP and Quality control standards of various countries	Increased Market reach	High	MPEDA	Govt. & Private
3	Pursue Ecological and Origin Certification programs	Increased foreign exchange earnings		MPEDA	Govt. & Private

1.5 Infrastructure and Logistics Development- (Marine and Estuarine- Capture and Culture Fisheries)

Sl. No	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Procurement of department owned dredger with required staff for capital and routine maintenance dredging of all Ports & Fishing harbors wherein good quality dredged sand is to be used for beach nourishment of adjacent beaches	Safe navigation of fishing boats	High	Dept. of Fisheries	Govt.
2	Initiate upgradation/renovation of ice plants under KFDC in Malpe, Mangaluru, Gangolli, Karwar, Honnavar and Bhatkal since they are quite worn out (1970).	Ensure good quality ice is supplied to the fishermen and quality fish to the consumers.	High	Dept. of Fisheries	Govt.
3	Provide Coastal security police force/proposed Police wing under Dept. of Fisheries with appropriate facilities and equipment adequate infrastructure and technology such as speed boats, wireless talkies, search lights, RADAR, etc. along with necessary training.	Ensure a robust security Enforce legislation, reduce coastal crimes and curb illegal activities	High	Dept. of Fisheries, Coastal Security Police Force	Govt.
4	Develop and strengthen logistical cold chain and requisite infrastructure for processing, storage, value addition, packaging,	Meet present/future needs Reduces post-harvest	High	Dept. of Fisheries,	Govt. & Private

	transportation and marketing of fish and fisheries products such as processing plants, cold storages, ice plants, freezing and packing plants, fish and fisheries products transportation vehicles including refrigerated and insulated vehicles, ice flaking and ice crushing units, ice/fish holding boxes, post-harvest modern handling of fish and fish processing equipment and warehouses.	losses Enhances the sales and value of the high-quality fishes landed. Ensures quality and hygienic fish to the consumers		CICEF, NFDB, KFDC	
5	Establish mobile fish and live fish markets, modern wholesale fish markets, supermarkets, retail fish markets and outlets with user stakeholder inputs keeping gender requirements in mind				Govt. & Private
6	Develop and strengthen appropriate networking of roads, rails and airline connectivity for cold chain				Govt.
7	Establish better sanitation facilities at fishing centers, fish markets, processing centers etc.	Maintain health and hygiene of fishers	High	Dept. of Fisheries	Govt. & Private
8	Update Master plan for development of Fishery Harbors (FHs) and Fish Landing Centers (FLCs) Conduct Post Evaluation Studies at the existing FHs and FLCs to evaluate the utility of existing facilities and assess the requirements of additional facilities	Effective and efficient infrastructure facilities	High	Dept. of Fisheries, CICEF	Govt.
9	Establish state-of-the-art warehousing, freight aggregation and cargo consolidation infrastructure and implement a cost-effective national multimodal network integrated on a digital grid.	Reduction in logistics and transportation costs	High	Dept. of Fisheries PWD, NFDB, FIDF (Fisheries Infrastructure Development Fund)	Govt. & Private
10	Establish fish cutting, packing industries in Uttara Kannada district as it lags behind compared to coastal districts of Udupi and Dakshina Kannada	Good income generation and a fair price for the fish in tandem with other coastal districts	High	Dept. of Fisheries	Govt. & Private
11	Ensure maintenance of various infrastructure and facilities through earmarked funds	Maintains hygienic environment in fishing	High	Dept. of Fisheries	Govt.

		harbors			
12	Carry out a pilot study using available high resolution satellite land use land cover maps and other ground-based observation for site suitability for developing green fishing harbor Develop scientifically-planned green fishing harbors (Green Harbors Initiative) and well-planned landing centers. Modernize/upgrade the existing fishing harbors to suit the present and future needs	Green harbors for offsetting carbon footprint, effective monitoring of pollution	Medium	ISRO (SAC, NRSC) KRSRAC, Dept. of Fisheries, Dept. of ID, P&IWT NFDB, CICEF, Fishermen Associations etc.	Govt.
13	Promote deep sea high value fishery using modern fishing vessels with on-board processing facilities (Cleaning, freezing, packing)	Maintains quality of high-value fishery	Medium	Department of Fisheries	Govt. & Private
14	Establish exclusive hatcheries of species such as Shrimp, Seabass, Pearl spot, Groupers, Milkfish, Mullet, Lutjanus, Mudcrab, <i>Macrobrachium rosenbergii</i> in locations such as Mangaluru, Mulky, Udupi, Kundapura, Bhatkal Kumta, Ankola, Karwar) and/or prioritize existing hatcheries to propagate selected breeds of indigenous fish species	Availability of quality fish seeds Conservation of indigenous fish species	Medium	Dept. of Fisheries, FRIC(M), NFDB, College of Fisheries, CIFA, CIFRI, Private Entrepreneur (PPP Mode)	Govt. & Private

1.6 Marketing of Fish and Fish Products- (Marine and Estuarine- Capture and Culture Fisheries)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Strengthen fish marketing mechanisms to protect fishers and fish farmers from the vagaries of middlemen and traders. Support and promote e-markets and e-trading of fish and fish products	Safeguard the interests of fishers and consumers.	High	Dept. of Fisheries	Govt. & Private
2	Establish fish sale counters, mobile canteens, mobile vans etc. in all districts and taluk levels (Matsya Darshini) and introduce different fish value added products such as Fish burger, fish fry, fish ball, fish sausage, fish chakli, Kurkure etc.)	Popularize benefits of eating hygienic fish among the masses to promote good health. Increase in income generation of fishers	High	Dept. of Fisheries, Private Entrepreneurs, Fisheries Societies	Govt. & Private
3	Carry out detailed market study/analysis to develop new value-added seafood products such as Ready to Eat (RTE) and Ready to Cook (RTC) products along with a branding cum marketing campaign in the domestic and international markets for existing and new value-added seafood products	Socio-economic development, Increased Job creation and Income Generation		Dept. of Fisheries, CIFT, NFDB, NIFPHATT, College of Fisheries	Govt. & Private
4	Organize food festivals across the state to increase awareness among fish consumers about different varieties of seafood value-added products available and their nutritional values	Helps to gauge the demand of RTE and RTC sea food products Increase in sales and income generation	High	Dept. of Fisheries, KFDC, CIFT, NIFPHATT	Govt. & Private
5	Establish fish outlets in populated areas maintained and managed by private entrepreneurs with special preference given to women	Enhanced livelihood opportunities and increased income generation	High	Dept. of Fisheries KFDC, NFDB	Private
6	Establish collection and marketing centers and common depuration units to improve quality as well as price of farmed products		High	Dept. of Fisheries KFDC, NFDB	Govt. & Private

1.7 Sustenance of Fishermen Livelihoods- (Marine and Estuarine- Capture and Culture Fisheries)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Implement Minimum Support Price (MSP) for each species of fish landed Update MSP on a regular basis	Safeguard the fishers to a minimum profit for the harvest that would sustain their livelihoods	High	Dept. of Fisheries, KFDC	Govt.
2	Provide Walkie-Talkie to traditional fishermen for better communication during unforeseen events	Prevent loss of life	High	Dept. of Fisheries	Private
3	Demarcate vulnerable areas in terms of their levels of severity in available Hazard maps and plan activities accordingly. Provide safe housing to the fishing communities	Prevent loss of life and protect livelihood of fishing communities	High	Dept. of Fisheries, Dept. of ID, P&IWT, KSPCB, Dept. of Ecology & Environment, KSRSAC	Govt.
4	Provide freezers for traditional fishers/Nada Doni societies/fisherwomen societies	To protect their catches from being sold at a throw away price	High	Dept. of Fisheries	Govt. & Private
5	Ensure certified personnel are always present on board for navigation of mechanized fishing vessels. Ensure crews that aboard the vessel are above 18 years of age and are given insurance cover	Safety of fishermen on board and protecting their livelihoods	High	Dept. of Fisheries	Private
6	Provide on time financial assistance during fishing ban to the families of active traditional fishers (ensuring assistance needs to be credited to a joint account with the woman necessarily being joint holder of the account)	Livelihood and nutritional support for traditional and socio-economically backward fishers	High	Dept. of Fisheries	Govt.
7	Provide assistance for insurance cover to traditional boats and fishing vessels of the marine fishermen with valid license for	Alleviates economic burden on vulnerable	High	Dept. of Fisheries,	Govt.

	incidents which occur in permitted period and permitted area for that particular fisherman/ fishing vessel	fisherfolks		NABARD	
8	Increase the quantity of subsidized kerosene to the traditional fisherfolk and also regularize the availability of the same. Initiate availability of non-subsidized kerosene in the open market to traditional fisherfolk	Sustain Livelihoods of Traditional fisherfolk	High	Dept. of Fisheries, Karnataka Food and Civil Supplies Corporation Limited	Govt.
9	Map common places in the fishing villages for net mending, fish drying, processing etc. Ensure such areas are protected, provide alternate options such as raised platforms, solar dryers, net mending sheds etc.	Promote traditional fisheries and communities	High	Dept. of Fisheries Dept. of Ports & IWT	Govt.
10	Reserve seats (B.Fsc/M.FSc) for kins of fisher families in College of Fisheries, Mangaluru and reservation in jobs such as Marine security services like Navy				Govt.
11	Introduce welfare programs for traditional fishers and 'Safety net' for migrant laborers				Govt.
12	Ensure new ventures such as manufacturing of value-added fish and fish products are carried out by societies and self-help groups rather than private entities	Promotes social equity and gender inclusiveness	High	Dept. of Fisheries, College of Fisheries, KFDC, NIFPHATT	Govt. & Private
13	Extend micro financing to Non mechanized fishing operations for procurement of raw materials and maintenance of boats and gears	Prevent exploitation of fishing communities by the middle men, brokers, money lenders	High	Dept. of Fisheries	Govt. & Private
14	Consider providing necessary policy, legal and organizational support for recognizing and protecting the territorial use rights of traditional and small-scale fishing communities in the state.	Protection of access and user rights of traditional fishers	Medium	NITI Aayog, Dept. of Fisheries, ICSF	Govt.
15	Recognize existing traditional fisheries management institutions to assign adequate agency for protection of traditional rights of	Protection of fishermen's rights and livelihoods	Medium	Dept. of Fisheries	Govt.

	fisheries, conservation of Local Ecological Knowledge (LEK) and coastal cultural practices.				
16	Provide financial support to NGOs and other governmental organizations working towards ecological security, conservation of aquatic biodiversity, welfare, safety and livelihood of fishermen/fisherwomen in coastal areas	Socio-economic and environmental development	Low	Department of Fisheries KFDC, NFDB	Govt.

1.8 Institutional Arrangement- (Marine and Estuarine- Capture and Culture Fisheries)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Form a special Police Wing under Director of Fisheries with adequate staffing for enforcement of the Karnataka Marine Fisheries (Regulation) Act, 1986, Inter and intrastate disputes etc.	Ensures a robust security mechanism for the coastal region Reduces coastal crimes	High	Dept. of Fisheries	Govt.
2	Create an engineering unit under the control of Director of Fisheries for harbors, landing centers, fisheries roads, fish markets & fish farms	Ensures smooth planning and execution of fishing infrastructure	High	Dept. of Fisheries	Govt.
3	Form a technical advisory committee with members well acquainted with the fishing industry to regulate and take decisions related to enforcement of sustainable fishing practices. (Regulate the number of fish meal plants, ice plants, no. of fishing fleets in the coastal districts etc.)	Helps conserve marine fishery resources in a scientific way	High	Dept. of Fisheries, CMFRI, College of Fisheries Mangaluru	Govt.
4	Create a statistical unit with required enumerators to collect marine fish data and other important fisheries data in the state	Will help to know the real picture of marine catches so as to plan for conserving marine fish resources	High	Dept. of Fisheries	Govt.
5	Recruit/ Replenish technical staff in Department of Fisheries	Ensures managerial roles and responsibilities are not	High	Dept. of Fisheries	Govt.

		hampered			
6	Implement Sahaya Mitra scheme (NFDB), in harbors/landing centers/villages	Facilitate, guide and train fishermen on all aspects	High	Dept. of Fisheries	Govt.
7	Creation of Harbor Management Societies with required staff	Ensures proper management and development of fishing harbors and fish landing centers	High	Dept. of Fisheries	Govt.
8	Adequate staffing and legal empowerment of Coastal Security Police Force	Enforce legislation, reduce coastal crimes and curb illegal activities	Medium	Coastal Security Police Force/Proposed police wing under Dept. of Fisheries	Govt.

1.9 Enforcement Measures – (Marine and Estuarine- Capture and Culture Fisheries)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Strictly ensure coastal waters up to 6 km from the coastline are made available to the traditional, small scale artisanal fisher folk by using GPS based tracking of Mechanized fishing vessels (safety and tracking)	Protects livelihood of traditional, small-scale artisanal fisher folk, alleviates poverty 2and underemployment among 3artisanal fisherfolks.	High	Dept. of Fisheries, Coastal Security Police Force, Proposed separate Police wing under Dept. of Fisheries	Govt.
2	Strictly enforce existing ban on use of all types of destructive fishing methods including small mesh size gears (including its manufacture), light fishing, bull trawling, FAD based cuttlefish fishery and impose strict fines on violations including cancellation of licenses, subsidies etc.	Promotes optimum levels of fish stocks	High		Govt.
3	Impose a ban on harvest of Spawners and brooders				Govt.
4	Make Permanent Account Number (PAN) number	Minimize income disparity	High	Dept. of	Govt.

	mandatory for registration of mechanized fishing fleets as multiple numbers of fishing fleets are being registered in the names of relatives, friends etc. actually operated by a single person	between the rich and poor marginalized fishermen		Fisheries	
5	Develop a robust Monitoring, Control and Surveillance (MCS) regime including necessary infrastructure facilities (AVMS). Use RADAR for monitoring fishing in restricted areas and carry out high vigilance at sea to curb illegal fishing practices Encourage fishermen to use Kadalapp, fix bugs in the app and train them appropriately	Ensure safety and security of fishermen and their vessels at sea.	High	Coastal Security Police Force/ Proposed separate Police wing under Dept. of Fisheries	Govt.
6	Strictly enforce the use engine capacity at 350HP in mechanized fishing fleets (In accordance to fleet length). Presently most of the mechanized fishing fleets are using engine capacities up to 600-700HP irrespective of fleet length.	Prevents bycatches and promotes sustainability of fish stocks	High		Govt.
7	Link subsidies and benefits to fishing fleets compliant with sustainable fishing practices and withdraw licenses of violators indiscriminately	To effectively control unsustainable fishing practices	High		Govt.
8	Strictly enforce the 3-month (June-August) fishing ban for mechanized fishing vessels with no scope for dilution	Promotes optimum levels of fish stocks	High	Dept. of Fisheries	Govt.
9	Strictly monitor all net making firms in the state by conducting frequent and random checks on their operations to ensure manufacture of only approved type and size of fishing nets Ensures only approved type of fishing nets are used by fishermen in the state	Ensures			Govt.

1.10 Capacity Building (Human Resource Development in (Marine and Estuarine- Capture and Culture Fisheries)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Provide skill development training during fishing ban and off seasons. (Sustainable fishing practices such as importance of using square mesh cod end etc., knowledge on different breeding time of different species, use of different gears in different seasons for target catch, negative impacts of banned/unsustainable fishing practices on fish biodiversity populations such as overfishing, bull trawling, light fishing and use of diamond mesh size cod end, effects of abandoned equipment (ALDFG) and their impact on marine life etc.)	Promotes sustainable fishing practices Increased fish stocks	High	Dept. of Fisheries, NFDB	Govt. & Private
2	Training on Square mesh fabrication to fishermen as well as net manufacturers (Converting existing diamond mesh cod end to square mesh cod end)	Reduces bycatches and promotes sustainable fishing	High	Dept. of Fisheries, NETFISH	Govt. & Private
3	Create regular awareness sessions to all fishermen especially deep-sea fishers on personal hygiene, cleaning and sanitation of fish contact surfaces, hygienic handling of catches, ice handling, methods to appropriately store to maintain quality of the fish after catch (Fish Quality Management), handling of diesel oil to avoid spills, segregating plastic waste on board and managing ALDFG for disposal at the harbor etc.	Maintains high quality fish catches fetching higher returns Minimizes pollution and safeguards the environment	High	Dept. of Fisheries, College of Fisheries	Govt. & Private
4	Provide awareness and hands on training to fishing communities especially women on production, packaging and marketing of value-added fish/shellfish products for the Domestic and international markets	Employment and income generation Foreign exchange earnings	High	Dept. of Fisheries, College of Fisheries	Govt. & Private
5	Undertake capacity building of the Fisheries department personnel including personnel to identify violations and take punitive actions.	Effective enforcement of laws and regulations	High	Dept. of Fisheries, College of	Govt.

				Fisheries	
6	Strengthen capacities of the Coastal Security Police Force/Proposed special Police Wing under Director of Fisheries for proper implementation of KMFR act, Inter and intrastate disputes etc.	Ensures a robust security mechanism for the coastal region	High	Dept. of Fisheries, College of Fisheries	Govt.
7	Create awareness and capacity building on integrated fish farming/polyculture and aquaponics in urban and rural areas	Provides alternate livelihood opportunities Additional income generation & socio-economic development	High	Dept. of Fisheries RDPR, UDD, NFDB, CRAFT (Centre for Research in Alternative Farming Technologies)	Govt. & Private
8	Augment SAC Geospatial Trainings such as TREES/ SMART for Marine Applications	Increase in experienced personnel to meet the need for marine applications, geospatial R & D and job creation	High	SAC(ISRO), Dept. of Fisheries, FISHNET, SDEL, KFDC, NFDB	Govt.
9	Provide awareness programs on exporting of fish, value added products and eco-labelling. In addition, establish testing programs and carry out stringent product testing in addition to awareness programs and technical support.	Boost in export Employment & income generation Foreign exchange earnings Reduction in export rejection	High	Department of Fisheries, MPEDA, CMFRI, CIFT, NETFISH, NFDB	Govt. & Private
10	Develop and promote marine and inland Ornamental fisheries and plants for domestic and export market by conducting awareness programs, as well as by providing financial and technical support especially to youths on production of ornamental fishes, aquarium fabrication and trading,	Employment & income generation	High	Department of Fisheries, KVK's, MPEDA, NFDB, CMFRI, CIFRI,	Govt. & Private

	aquarium maintenance etc.			SDEL, NABARD, CIFE, NETFISH, CIFA, Ornamental Fisheries Training and Research Institute (OFTRI)	
11	Promote the concept of “In-season fish” among fishermen, chefs and consumers to create awareness on maintaining sustainability of commercial fishes and endangered species For example: Founders of “In Season Fish” (www.inseasonfish.com) have coupled love for seafood with environmental conservation. They provide an eco-friendly seafood guide by partnering with restaurants, players in the seafood industry and the government	Promotes sustainable value chain	High	Dept. of Fisheries	Govt. & Private
12	Assist fishermen to increase scientific knowledge, develop research capacity and transfer of marine technology	Promotes co-management	High	Dept. of Fisheries	Govt. & Private
13	Promote entrepreneurship in the marine and inland fish/shellfish/mollusk farming sector after ESIA studies by conducting awareness programs, training and by providing technical support	Employment & income generation	Medium	Dept. of Fisheries CMFRI, CIFRI, KFDC, RGCA, SDEL, NFDB, CIBA, CIFA	Govt. & Private
14	Provide mandatory training on environmentally sensitive aquaculture and mariculture practices for stakeholders involved in aquaculture, Mariculture and Seaweed cultivation and build awareness on harmful impacts of aquaculture, mariculture, seaweed culture as well as inland and marine ranching activities if not carried out scientifically	Encourages environmentally sensitive and responsible aquaculture business model	Medium	Dept. of Fisheries, CMFRI, CIFRI, KFDC, RGCA, SDEL, NFDB, CIBA, CIFA	Govt. & Private

1.11 Promotion of traditional practices such as Gazanis

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Promote and encourage the Gazani farming through funding (such as National Adaptation fund for Kerala for promoting Kaipad and Pokkali in coastal wetlands of Kerala)	Encourages youth and farmers/fishers to practice preserve traditional farming High employment opportunities to the local community especially women folk Sustainable socio-economic development of coastal communities	High	Department of Fisheries, CAA, CIBA	Govt.
2	Carry out capacity building on Gazani farming (traditional, eco-friendly and organic integrated rice and shrimp farming) along with educational tour for farmers to similar saline tolerant traditional paddy variety cultivation areas				Govt. & Private
3	Improve and maintain infrastructure for transportation of produce and provide insulated boxes for preservation of shrimps				Govt. & Private
4	Establish Seed Banks and ensure timely supply of quality seeds on a consistent basis (Kagga rice and Shrimp seeds)	Timely availability of quality fish seeds	High	Dept. of Agriculture, Dept. of Fisheries	Govt.
5	Allocation of funds for construction/repair of critical infrastructure required to carry out farming in gazani lands such as bunds, sluice gates etc. and their regular maintenance Scientific plantation of mangroves is also crucial.	Protects crops from sudden flood due to unexpected climatic variations	High	Dept. of Agriculture, Dept. of Fisheries	Govt.
6	Ensure better price/bare minimum sale price for Kagga rice as a lot of human effort is involved	Promotes all-inclusive growth and equity benefits to the local communities	High	Department of Fisheries	Govt.

1.12 Resource Management in Inland waters (Inland Capture and Culture Fisheries)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Streamline policy for leasing of water resources and ensure timely leasing of tanks and ponds before Kharif rains to facilitate stocking of fish seed	Increased fishery production and productivity	High	Dept. of Fisheries/ Panchayats	Govt.
2	Encourage fishery production in unutilized, underutilized and non-conventional water bodies wherever feasible by scientific management	Increased fishery production, employment and income generation	High	Dept. of Fisheries	Govt. & Private
3	Explore integrated development of water bodies (reservoirs, tanks, lakes, ponds, streams and rivers) by fisheries coupled with tourism, water sports, agriculture, horticulture, poultry, dairy etc. after suitable ESIA Studies	Effective utilization of water bodies Employment and income generation	Medium	Dept. of Fisheries/ Panchayats	Govt. & Private
4	Encourage Public private partnership for integrated development of Inland water bodies	Socio-economic development			Govt. & Private
5	Develop a reliable data base (Remote sensing and GIS) for inland tanks and ponds. Carry out SWOT analysis for each district and develop district specific strategies and action plans	Supports informed decision making and aids in preparation of district specific strategies	Medium	Dept. of Fisheries	Govt.
6	Carry out renovation of existing ponds/tanks (ha),	Revive fish culture in Ponds/Tank	Medium	Dept. of Fisheries	Govt.
7	Construction of ponds in water logged areas	Efficient utilization of resources	Medium	Dept. of Fisheries	Govt.

1.13 Inland Aquaculture

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Provide subsidies on input costs to fish farmers such as subsidies for seeds, feeds, power requirement, marketing and transportation (Chill packing, freezers, cold storages to co-operatives)	Promote the sector and makes the farmed products economically viable and competitive in domestic and export markets	High	Dept. of Fisheries	Govt.
2	Promote development of Value-added products such as Ready to Eat (RTE) and Ready to Cook (RTC) with Indian flavorings for both domestic and export markets	Foreign exchange earnings	High	Dept. of Fisheries	Govt. & Private
3	Promote breeding of exclusive fish species of commercial importance and selected indigenous fishes after ESIA studies	Increased job creation and income generation	Medium	Dept. of Fisheries	Govt. & Private

1.14 Frontier Aquaculture Technology- (Inland Culture Fisheries)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Promote Organic aquaculture (fish, prawn, etc.) for niche markets & exports and support certification of the same	Quality fish & fish products Improved income generation	High	Dept. of Fisheries, NaCSA	
2	Facilitate, promote, incentivize, support and handhold new farming systems that have greater production and productivity potentials with environmental sustainability such as Aquaponics, Closed Recirculating Aquaculture System (CRAS) (Growing of Shrimp and high value fishes), Bio-floc etc. after suitable ESIA studies	Employment and income generation socio-economic development	High	Dept. of Fisheries, CIFA, CIFRI, FRIC(M),	
3	Enhance incentives for propagation of indigenous ornamental	Sustainable	High	Dept. of	

	fish for domestic/ export markets	Ornamental Fisheries sector in the state		Fisheries, Ornamental Fisheries Training and Research Institute (OFTRI)	
4	Construction of new grow-out ponds, new rearing ponds and supply of inputs like feed, seed, carbon sources for fish culture and bio floc technology in fish production	Employment and income generation socio-economic development	Medium	Dept. of Fisheries, CIFA, CIFRI, FRIC(M),	
5	Promote diversification in Fresh water aquaculture from Indian major carps to late maturing fast-growing species, indigenous/endemic varieties and scampi	Improved income generation	Medium	Dept. of Fisheries, CIFA, CIFRI	

1.15 Fish Seed Availability and Transportation- (Inland Capture and Culture Fisheries)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Formulate and implement strategy for the state to achieve self-sufficiency in fish seed production Establish adequate marine and freshwater finfish, shellfish brood banks, hatcheries and nurseries to ensure adequate seed supply in the state and encourage the local entrepreneurs to undertake the same	Employment & income generation Eliminate dependency on other states for fish seed	High	Dept. of Fisheries, RGCA, CIFA, CIFRI, CMFRI, NFDB, RGCA, CAA	Govt. & Private
2	Carry out detailed study and establish appropriate numbers of hatcheries, brood fish/stock banks in each of the districts of Karnataka	Assured local supply of fish seed and brood stock	High	Dept. of Fisheries, CIFA, CIFRI, NFDB, NETFISH	Govt. & Private
3	Facilitate and support synchronizing quality seed availability and other inputs in accordance to rainfall and water filling of tanks	Increased fishery production and productivity	High	Dept. of Fisheries/ Panchayats	Govt. & Private

4	Upgrade existing government farms into integrated fish seed farms	Increased supply of quality fish seed	High	Dept. of Fisheries	Govt.
5	Promote private participation in seed production, seed hatcheries, seed rearing units in support of quality fish seed production Incentivize private seed production farms to upgrade infrastructure for higher capacity, technology including seed buy-back for govt. schemes etc.	Increased supply of quality fish seed	High	CIFA, CIFRI	Govt. & Private
6	Strengthen infrastructural facilities in support of stock enhancement and seed stocking	Timely availability of quality fish seeds	Medium	Dept. of Fisheries	Govt. & Private
7	Provide support for stocking of reservoirs with quality fingerlings of Indian Major Carps and other suitable species after ESIA studies	Timely availability of quality fish seeds	Medium	Dept. of Fisheries	Govt.
8	Provide support for creation of in-situ hatcheries and fingerlings rearing units for production of quality fingerlings (carps and indigenous species) for stocking -(Seed)	Timely and local availability of quality fish seeds	Medium	Dept. of Fisheries, NFDB, CIFRI	Govt. & Private

1.16 Infrastructure and Logistics Development- (Inland Capture and Culture Fisheries)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Develop Inland fish landing centers, marketing and processing infrastructure Establish fish processing plants with requisite infrastructural facilities at production centers of freshwater fishes.	Meet present/future needs	High	Dept. of Fisheries	Govt. & Private
2	Support to be provided for ornamental fish cultivation through interventions such as establishing production units, introduction of commercially important exotic species, import of breeding technology, extending technological, marketing and logistical support to entrepreneurs, etc.	Income generation	High	Dept. of Fisheries	Govt. & Private
3	Promote Farmer Producers Organizations to build community	Effective utilization of	Medium	Dept. of	Govt. &

	farming assets and post-harvest infrastructure and networks with other stakeholders across supply-value chain	assets Income generation		Fisheries	Private

1.17 Marketing of Fish and Fish Products- (Inland Capture and Culture Fisheries)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Introduce efficient transportation like refrigerated and insulated Trucks and wagons for rapid disposal of harvest to distant destinations of demand places Provide small 4 wheelers (up to 500Kg capacity) to fish farmers in Inland areas	Enables fisherfolk to sell fresh fish from rivers, reservoirs, tanks, fish farms etc. to neighboring villages	High	Dept. of Fisheries	Govt. & Private
2	Initiate a licensing procedure to regularize buyers for farmed produce to protect fish farmers	Protect fish farmers from fraudsters	High	Dept. of Fisheries	Govt.
3	Support development of cold chain and infrastructure for hygienic handling of fish produce Efforts need to be made towards innovations in packaging for increased shelf life and product differentiation	High quality of fish to consumers Reduces wastage	High	Dept. of Fisheries	Govt. & Private
4	Strengthen marketing infrastructure with development of new hygienic fish markets in the near and around areas of catchments	Income generation	High	Dept. of Fisheries	Govt. & Private

1.18 Sustenance of Fishermen Livelihoods- (Inland Capture and Culture Fisheries)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Access rights of all the inland fisherfolk fishing in natural and man-made water bodies should be recognized and any activity which alters these access rights and livelihood of fisherfolk should be strictly prohibited	Ensures livelihood security of fishers	High	Dept. of Fisheries	Govt.
2	Establish 2T-5T Chillers and cold storages in Inland areas for fish farmers	Ensures good income generation to fisherfolk and protect their livelihoods	High	Dept. of Fisheries	Govt. & Private
3	Initiate entrepreneurship development by categorizing/grouping sectors under PMMSY and have a plan of action for implementation	Provide alternate livelihood opportunities	High	Dept. of Fisheries	Govt.
4	Ensure Fish farmers are provided with adequate fishing gears based on the type of resource and targeted fish species	Ensures livelihood security of fishers	High	Dept. of Fisheries	Govt. & Private
5	Provide insurance coverage for fishers and create other basic amenities for the fisher community such as drinking water facility & community halls.		High	Dept. of Fisheries	Govt. & Private

1.19 Capacity Building- (Inland Capture and Culture Fisheries)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Undertake training and quality assurance to monitor the hatcheries and seeds.	Assured local supply of fish seed and brood stock	High	Dept. of Fisheries	Govt. & Private
2	Establish Krishi Vignan Kendras in every district along with mobile vans to provide technical assistance to fish farmers in all aspects of fisheries such as soil testing, water quality management, disease mitigation, marketing strategy etc.	Improved production, productivity and income generation	High	Dept. of Fisheries	Govt.

3	Educate the fishing community about the effects of abandoned equipment and their impact on marine life Arrange for collection of ALDFG for further recycling	Minimizes impacts of litter and ALDFG on Aquatic life	High	Dept. of Fisheries	Govt. & Private
4	Create awareness and capacity building on integrated fish farming/polyculture and aquaponics in urban and rural areas	Provides alternate livelihood opportunities Additional income generation & socio-economic development	High	Dept. of Fisheries RDPR, UDD, NFDB, CRAFT (Centre for Research in Alternative Farming Technologies)	Govt. & Private

1.20 Enforcement Measures- (Inland Capture and Culture Fisheries)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Strengthen checks and control on stocking of banned varieties of fish such as African catfish, bighead carp, etc.	Reduced impact on fishery stocks including endemic species	High	Department of Fisheries/ Panchayats	Govt.
2	Curb illegal trade of native/ endemic ornamental fishes and strengthen the monitoring mechanism	Promotes sustainable ornamental fisheries in the state	High	Department of Fisheries, MoEF&CC and MPEDA	Govt.
3	Enforce regulation on transboundary import of seeds, feeds and ornamental fish species Develop institutional mechanisms to ensure compliance of quarantine measures for the trade of ornamental fishes.			MoEF&CC, CIFA, CIBA and NBFGR	Govt.
4	Support conservation of indigenous fisheries resources through regulatory and management regimes	Conservation of indigenous fish species	High	Dept. of Fisheries	Govt.
5	Formulate new regulations under inland fisheries act to	Promotes sustainable	High	Dept. of Fisheries	Govt.

	penalize the unregulated transboundary import of fish brooder and seed	inland fisheries in the state			

1.21 Sustainability in (Inland Fisheries)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Regulate mesh size of nets and fishing during closed season	Prevention of exploitation of small sized stocked species and over exploitation of resource	High	Dept. of Fisheries	Govt.

1.22 Policy- Marine/Estuarine and Inland Fisheries Sector (Capture and Culture)

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Revise the Fisheries (Regulation) Act, 1986 to regulate marine fisheries with enhanced powers to the Department of Fisheries Impose hefty fines for violations and litigation for repeated violations, including permanent cancellation of licenses to boat owner as well as industry that has purchased catch from violators	To make the Act more relevant, effectively curb unsustainable fishing practices and make illegal fishing a cognizable offence	High	Dept. of Fisheries	Govt.
2	Pursue coordinated fishing regulations by central authority for the entire west coast of India in consensus with state fisheries departments (Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu) such as coordinated fishery management like uniform ban period for mechanized boats during peak spawning period, curtailing destructive fishing practices, impose gear wise fishing restrictions to protect	Reduced fishing of Spawners Promotes optimum levels of fish stocks	High	Dept. of Fisheries (West Coast states), Ministry of Fisheries, Animal Husbandry &	Govt.

	breeding periods of majority of fish caught in that gear type in consultation with National governmental and Non-governmental Scientific Research bodies etc.			Dairying, Govt. of India	
3	Draft a policy to limit the catch of fish species that are in a collapsed/ declined state to local consumption and prevent their export (catches less than 50 percent of historical maximum) until recovery of the stock to healthy levels	Enable recovery of collapsed fish stocks so that future earnings are assured	High	Dept. of Fisheries, CMFRI, MPEDA	Govt.
4	Draft a Policy for pollution management (E.g., fitment of bio toilets in mechanized fishing vessels, segregation of ghost gears/plastics on board and collection of the same in the harbors and landing centers etc.)	Increased hygiene, prevention and spread of diseases, prevention of pollution of oceans and seas and protection of marine ecology	High	Dept. of Fisheries, KSPCB	Govt.
5	Draft a Policy on Fisheries sector (Aquaculture and Capture) by consulting relevant stakeholders	Adequate information on ground level problems to address the same	High	Dept. of Fisheries	Govt.
6	Draft policies to ensure environmental flows in all regulated rivers of Karnataka and ensure minimum environmental flows when considering dams/infrastructure etc., Determine Monthly minimum environmental flow of all the regulated rivers in consultation with expert Hydrologists Manage existing water infrastructure by accounting for the river flow requirements of these small-scale fisheries in all the major east and west flowing rivers of Karnataka	Ensures ecological security and integrity of freshwater ecosystem and livelihood security of fishers	High	Dept. of Fisheries, Water Resource Dept.	Govt.
7	Develop a protocol for ranching to be circulated by the Department of Animal Husbandry, Dairying and Fisheries (DAHDF) to all State governments that also includes state governments to carry out suitable Environment and Social Impact Assessments (ESIA) prior to carrying out ranching activities to ensure minimum ecological damage	To avoid stocking of fishes from unknown sources in the open waters or rivers for any purpose	High	ICAR research institutes, Dept. of Fisheries, DAHDF, NBFGR and MoEF&CC	Govt.

	Make suitable provisions to create basic infrastructure facilities, such as hatcheries, nurseries, fry/advance fingerling raising centers etc.				
8	Provide support and prepare Best Management Practice (BMPs) protocols and guidelines for cage culture, intensive aquaculture in marine areas, reservoirs, ponds and lakes after suitable ESIA studies etc.	Insulates Inland/Marine/Estuarine water bodies against unsustainable aquaculture practices such as hyper-intensive aquaculture, higher stocking density beyond carrying capacity, import of exotic fishes' seed without clearance, illegal import of feeds and accessories and culture practices	High	Dept. of Fisheries, CIFA, CIBA, NFDB, DCFR and CAA	Govt.
9	Formulate water lease policy for mariculture activities in the state as per the approved Marine Spatial Plan (MSP)	Minimizes conflicts Ensures Mariculture activities are streamlined carried out sustainably	High	Dept. of Fisheries, CMFRI	Govt.
10	Draft a policy for the trade of ornamental fishes Needs to include framing and implementing guidelines to hobbyists and ornamental fish keepers as to hold and dispose of stock to avoid species reaching natural water bodies. Promote Sustainable Ornamental Fisheries sector in the state Ensure quarantine requirements are enforced strictly for trans-boundary import of seeds, feeds and ornamental fish species.	Promotes Sustainable Ornamental fisheries in the state Ensures quarantine requirements are enforced strictly for trans-boundary import of seeds, feeds and ornamental fish species	High	Dept. of Fisheries, CIFRI, NFDB, Ornamental Fisheries Training and Research Institute (OFTRI)	Govt.

	Prevent Illegal trade (including online trade) of native/endemic ornamental fishes	Prevents Illegal trade (including online trade) of native/endemic ornamental fishes			

1.23 Women Empowerment and Community Development

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Encourage women/vulnerable section of fishers to take up Crab culture, mussel culture and seaweed farming (<i>Gracilaria edulis</i> and <i>Gelidiella acerosa</i>) by training them and providing microfinance for running costs Establish producer organizations to help them market their produce through value addition.	Encourages Entrepreneurship among women/vulnerable section of fishers Provides alternate livelihood opportunities and additional income generation	High	Dept. of Fisheries, FRIC(M) CMFRI, NFDB, KFDC, CIFT, NIFPHATT	Govt. & Private
2	Foster women empowerment through skill development and creation of occupational opportunities to provide employment & entrepreneurship opportunities to women Organize training programs for fisherwomen in various alternate skills such as aquaponics, manufacture of cloth bags, baking, eco-friendly cutlery etc. and ensure information on trainings have reached the masses		High	Dept. of skill development and entrepreneurship and livelihood	Govt. & Private
3	Support loans to fisherwomen directly through co-operative societies on zero interest rather than through nationalized banks	Lessen financial burden on fisherwomen	High	Dept. of Fisheries	Govt.
4	Initiate schemes to help poor and vulnerable fishers and fisherwomen who have been severely affected due to the COVID pandemic.	Safeguard livelihood of fishers	High	Dept. of Fisheries	Govt.
5	Provide financial assistance to fisherwomen to purchase ice boxes	Increased income generation and improved livelihood	High	Dept. of Fisheries	Govt.
6	Establish Self-Help Groups, Voluntary Agencies and Social		High	Dept. of	Govt.

	Welfare Organizations for women fishers/vulnerable communities and link them to financial credit and bank financing facilities for upgrading their equipment, infrastructure and technology			Fisheries, NABARD	
7	Strengthen social security measures like pension scheme, insurance etc. especially to women fisher folk and marginalized fish workers. Improve literacy and entrepreneurship skills of women and their health needs taking into account occupational hazards	Protects them from vagaries in the sector	High	Dept. of Fisheries	Govt.
8	Ensure vulnerable fish workers and women fisher folk are provided access to coastal space to sustain their livelihoods for fish drying etc. Identify traditional market areas and improve facilities there.	Safeguard livelihood of fishers	High	Dept. of Fisheries, Dept. of Ports & IWT	Govt.
9	Ensure poor fisherwomen receive the scheme amounts on time to protect their livelihoods	Safeguard livelihood of fisherwomen	High	Dept. of Fisheries	Govt.
10	Partner Fisherwomen societies with NGOs to boost a robust source of income to several underprivileged women	Boost self-confidence and improve livelihoods of vulnerable women	High	Dept. of Fisheries	Govt. & Private

1.24 Research & Development- Marine and Inland Fisheries

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Determine threshold (Maximum extractable catch) for various commercially and biologically important fish species	Ensures sustainability in fish stocks	High	Dept. of Fisheries	Govt.
2	Establish Marine Biotech Parks for bio-prospecting of various species of seaweeds, mangroves, potential aquatic plants & animals, seafood by-products/wastes etc. for production of bioactive compounds/synthetic molecules for commercial applications	Increased applications for seaweed Bioactive substances can be utilized in various biotechnological, nutritional,	High	Dept. of Electronics, IT, BT, S&T	Govt. & Private

		pharmaceutical, and biomedical applications. Employment, income generation, Socio-economic development			
3	Support Research and Development for adoption of new finfish/shellfish/mollusk farming technologies such as aquaponics, Integrated Multi-Trophic Aquaculture (IMTA), Closed Recirculating Aquaculture System (CRAS) etc. suitable to local conditions after suitable ESIA studies	Employment & income generation	High	Dept. of Fisheries CMFRI, CIFRI, NFDB, RGCA, CIBA, CIFNET, NBFGR, CAA, CIFT, CIFA, CIFE	Govt. & Private
4	Promote research and development to identify agricultural waste-based substitutes for low value fish for production of fish meal, fish feed and fertilizers	Minimizes the impact of reduction fisheries via research	High	Dept. of Fisheries	Govt. & Private
5	Support development of Specific Pathogen Free (SPF) Polychaetes through breeding/genetic improvement programs	Pathogen free inputs for culture fisheries	High	Dept. of Fisheries	Govt. & Private
6	Support genetic improvement programs for finfish and shellfish having economic value like Sea Bass, Tilapia, Prawns, Shrimps	Higher quality finfish and shellfish	High	Dept. of Fisheries	Govt. & Private
7	Develop edible seaweed products suitable for the Indian palate and popularize the same amongst the public	Meets the food and nutritional security requirement	Medium	Dept. of Fisheries	Govt. & Private
8	Explore plantation of microalgae in the salinity intruded areas of the three coastal districts	Alternate utilization of salinity intruded areas	Medium	Dept. of Electronics, IT, BT, S&T Forest Dept.	Govt. & Private
9	Carry out pilot study to evaluate the techno-economic feasibility of integrating freshwater aquaculture and vermicomposting	Avoids adverse impacts of aquaculture sludge disposal on the environment and promotes sustainable Aquaculture management.	Medium	Dept. of Fisheries	Govt. & Private
10	Explore techno-economic feasibility and viability of				Govt. &

	converting the aquaculture sludge and fish wastes into organic fertilizer Carry out pilot studies to evaluate composting of aquaculture sludge and fish wastes to organic fertilizers based on locally available bulking agents such as rice/wheat straw, green grass, cardboard waste and woodchips derived biochar, sawdust, perlite, and activated carbon etc.				Private
11	Carry out Pilot study to evaluate land application of thickened and stabilized Aquaculture sludge				Govt. & Private
12	Explore alternate eco-friendly fuels for fishing engines such as propane (LPG), Natural Gas (CNG) and Biobutanol by use of innovation and technology Develop suitable engines for these alternate fuels	Reduction in fuel costs as well as Greenhouse Gas (GHG) emissions	Medium	Dept. of Energy, Dept. of Fisheries	Govt. & Private
13	Pilot project to research fuel saving techniques and gas emission reductions in traditional boat engines as pursued at Malaga (Spain)			Dept. of Energy, Dept. of Fisheries	Govt. & Private
14	Carry out studies and increase awareness on ways to enhance fish breeding season for seed production E.g., Use of artificial rain	Enhance seed production	Medium	College of Fisheries	Govt. & Private
15	Carry out experimental studies on ranching to explore its effects on near shore ecosystems and communities after mandatory Environment and Social Impact Assessment (ESIA) by an independent committee. No ranching project, Inland or Marine should be permitted in the areas which are ecologically important, important for capture fisheries (nursery areas, fisheries reserve, spill over zones etc.) and vulnerable communities (small scale fishers, traditional fishing grounds).	Sustenance of traditional fisheries and communities Safeguarding current fish stocks	Low	Dept. of Fisheries	Govt.
16	Detailed studies need to be undertaken to develop pingers and excluder devices	Avoid by-catch of Sharks/Whales/Dolphins/	Low	Dept. of Fisheries	Govt. & Private

		Turtles and conserve them			
17	Explore commercial scale production of biofuel from microalgae produced in the salinity intruded areas	Reduced dependence on fossil fuels Sustainable production of fuel	Low	Dept. of Electronics, IT, BT, S&T	Govt. & Private

Sector-2: Recommendations for Water-based Tourism and Ecotourism to maximize social benefits

The following recommendations pertain to augmenting water-based tourism and Ecotourism to maximize social benefits from direct and indirect employment opportunities for local communities especially women and marginalized communities.

To ensure environmentally sustainable and socially equitable water-based tourism activities in the state, it is advised to carry out initial as well as periodic (annual) Environmental and social Impact Assessment (ESIA) in tourist areas to identify adverse impacts, carrying capacity etc. and mitigate those impacts.

2.1 Coastal/Riverine/Estuarine/ Mangrove Tourism

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Ensure tourism activities are undertaken as per the Marine Spatial Plan (MSP) to safeguard areas listed as ecologically important along with prior approval from local gram-panchayat, Fisheries society etc. Carry out initial and annual ESIA (Environmental and Social Impact Assessment) by an independent committee of experts	To ensure natural ecological processes and the land use activities of vulnerable fishing communities are not impacted	High	Dept. of Tourism/ KSTDC	Govt.
2	Promote coastal tourism and create awareness on eco-friendly activities such as beach walks, beach trails, non-motorized water sports such as kayaking, surfing, Stand-Up-Paddling (SUP) etc.	Minimum ecological impact on fragile ecosystems	High	Dept. of Tourism/ KSTDC	Govt. & Private
3	Acquire Blue Flag certification for maximum number of beaches in Karnataka	Promotes clean, green and safe beaches Increased tourist footfall.	High	Dept. of Tourism/ KSTDC	Govt.
4	Provide financial assistance schemes, especially to young entrepreneurs and women to encourage their innovative start-up ideas such as houseboats, homestays etc. in riverine/coastal tourism sector to provide quality accommodation, hygiene and security to tourists	Increased livelihood options for coastal communities	High	Dept. of Tourism/ KSTDC	Govt. & Private

5	Create infrastructure that will attract tourists near Coastal areas such as developing areas of historical importance near coastal and backwater areas and promote these as heritage sites, For E.g.: Aqua gallery, Aqua Parks, Mangrove boardwalks (as in river Sharavati in Honnavar) etc. Provide appropriate training to the local youth to be self-employed as tour guides	Increased tourist footfall Opens new avenues to boost other kinds of tourist activities such as homestays, water sports etc. Income generation and livelihood opportunities	High	Dept. of Tourism/ KSTDC/ Private Entrepreneurs	Govt. & Private
6	Promote river tourism in line with Kerala model/strategy by encouraging houseboat businesses and providing good infrastructure support (jetties, dredging of channels etc.) in addition to granting subsidies for running costs (subsidy for electricity, potable water, diesel etc.) rather than for the initial investment.	Creates alternate livelihoods to communities and job opportunities for the youth in the hospitality segment.	High	Dept. of Tourism/ KSTDC	Govt. & Private
7	Promote sustainable Mangrove tourism in estuaries such as Byndoor, Sharavati, Gurupur-Netravati, Shambhavi, Kalyanpur and Souparnika rivers etc. to encourage birdwatching by kayaking, boating, stand up paddling etc.	Promotes income generation for the local VFCs (Village Forest Committees) Creates awareness on marine and estuarine diversity that needs to be conserved	High	Dept. of Tourism/ KSTDC	Govt. & Private
8	Promote Mangrove Apiculture (beekeeping) as an income generator and Mangrove conservation tool– following case studies from Bon Phool in West Bengal and Nai Nang in Krabi, Thailand	Alternate livelihood opportunities for coastal communities	High	Dept. of Forest	Govt. & Private
9	Introduce and promote recreational fishing activities such as Angling (fishing with rod, line and hooks) and Big Game fishing (speed-boats used to catch large open-water species such as Tuna, Sharks etc.) at locations such as Panambur, Mulki, Malpe, Murudeshwara, Gokarna, Karwar etc.	Alternate livelihood opportunities for fishers Increased tourist footfall of recreational fishing enthusiasts	High	Dept. of Tourism/ KSTDC, Dept. of Fisheries, Fisheries	Govt. & Private

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				Associations	
10	Promote beach tourism and allied activities by providing infrastructure at beaches: roads, beach benches, Parking facilities, toilets, petty shops, solid waste management etc. Allocate separate funds in annual budget to maintain these facilities to promote tourism in the state	Creates employment and income generation to local communities Maintaining good facilities will attract regular tourist footfall	High	Dept. of Tourism, KSTDC	Govt. & Private
11	Develop cruise tourism with coastal circuit of Dakshina Kannada, Udupi and Uttara Kannada districts proposed under Swadesh Darshan Scheme	Enhanced tourist footfall and employment generation	High	Dept. of Tourism	Govt. & Private
12	Implement Dolphin tourism at feasible areas of specific coastal villages to promote community-based conservation and develop livelihood programs for the locals				Govt. & Private
13	Provide basic and advanced infrastructure amenities such as well-maintained roads, washrooms, parking facilities, world-class air-conditioned buses as well as licensed tour guides in the Cruise Tourism Sector	Enhanced Tourist Experience Increased tourist footfall	High	Dept. of Tourism/ KSTDC	Govt. & Private
14	Introduce water sports such as scuba diving, snorkeling, canoeing, parasailing, jet skiing, paragliding, speed boating and other adventure sports in select beaches, riverine, estuarine areas which are not eco-sensitive as per approved Marine Spatial Plan (MSP)	Increased tourist footfall and boosts income of the local community	Medium	Dept. Of Tourism/ KSTDC	Private
15	Promote coastal tourism by encouraging beach side and river side resorts that are built with sustainable and eco-friendly building materials such as wooden cottages, bamboo cottages etc. that are easy to construct and dismantlable.	This would create more jobs to the local communities in the hospitality sector	Medium	Dept. of Tourism/ KSTDC	Govt. & Private
16	Improve and increase connectivity via Train, flights to coastal areas in Karnataka from places such as Bidar, Kalaburagi, Yadgiri, Raichur etc.to promote coastal tourism in the state	Increase tourist footfall to coastal areas	Medium	Transport Dept.	Govt.
17	Provide some relief packages to riverine and coastal tourism stakeholders having valid registration during untoward incidents such as in Kerala for houseboats due to COVID 19 pandemic	Protect livelihoods	Medium	Dept. of Tourism	Govt.
18	Form a coastal and riverine tourism stakeholders committee	To advise and guide on	Medium	Dept. of	Govt.

	which includes sub-committees for hospitality, service and activities sector with pioneers/subject matter specialists on board	continuous improvement strategies, decision making etc.		Tourism	
19	Policy for 'Plastic free' certification of hotels/tourism destinations/travel agencies to promote eco-friendly tourism	Drastic reduction in flow of plastics to water bodies along with low waste management costs	Medium	Dept. of Tourism, KSPCB	Govt.
20	Promote Mammal-watch programs in suitable sites that hold potential to generate revenue and employment (Dolphin spotting etc.)	Income generation for local coastal communities	Medium	Department of Tourism	Govt. & Private

2.2 Eco-Tourism

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Identify and promote eco-tourism destinations/eco-trails in the state such as hill stations, waterfalls, wildlife sanctuaries, bird sanctuaries, inland water ways etc. For E.g., In Madikeri, Kalaburagi, Shivamogga etc.	Socio-economic Development Creates livelihood opportunities Increased tourist footfall	High	Dept. of Tourism, Karnataka Ecotourism Board and Forest Dept.	Govt. & Private
2	Promote eco-tourism through community participation and introduce activities such as campfires, wildlife safaris, adventure sports, morning trails, rock climbing, zip lining, river crossing, burma bridge, backwater cruises, water zorbing, nature camping, backwater boat safaris etc. in eco-farms/eco-tourism destinations	Increased awareness towards conservation of Biodiversity and natural environments Ensures well-being of native individuals, generates valuable revenue and livelihood opportunities	High	Dept. of Tourism/ KSTD and Forest Dept.	Govt. & Private
3	Encourage and empower Women self-help groups such as "Streesakti" in coastal Karnataka and other places to support ecotourism and allied activities.	Women empowerment, poverty reduction and income generation	High	Directorate of Employment & Training,	Govt. & Private

	Promote adoption of “Kudumbasree” model of Kerala in ecotourism			Dept. of Tourism/ KSTDC and Forest Dept.	
4	Promote ecotourism ventures at locations where Dune creation and plantation works have been carried out for coastal protection under SCPMIP such as in Kodikanyana in Udupi district and Kadle beach in Uttara Kannada district	Employment and income generation for the local community especially youth and Women	Medium	Dept. of Tourism, Karnataka Ecotourism Board and Forest Dept.	Govt. & Private
5	Introduce glass sky walk bridge, nature safari camps, air cycling, zip line, butterfly park and other activities in ecotourism destinations	Create awareness about nature among tourists especially children	Low	Dept. of Tourism/ KSTDC and Forest Dept.	Govt. & Private

2.3 Inland Tourism

Sl. No	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Introduce and promote coracle rides, canoeing, river rafting, kayaking, boating (both motorized and non-motorized), Jet skiing, Water skiing, wakeboarding, Sport/Game fishing, aquaria in inland waters such as lakes, reservoirs and dams	Increased tourist footfall Increased Socio-economic benefits, income generation to the local community	High	Dept. of Tourism/KSTDC/ Water Resource Department	Govt. & Private
2	Promote/Encourage development activities such as homestays, resorts, petty shops, restaurants, handmade crafts, homemade delicacies and other businesses in and around rivers and estuaries in a planned and phased manner along with stakeholder consultations	Ensures holistic socio-economic development	High	Dept. of Tourism/ KSTDC	Govt. & Private

2.4 Policy Support

Sl. No	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Formulate a strong policy for starting water-based tourism ventures by entailing eligibility criteria, required certifications, detailed methodology for obtaining licenses etc. as per the scale and magnitude of the venture separately for hospitality (Homestays, camping, houseboats), various water sports (surfing, kayaking, Stand Up Paddling (SUP)) etc. in consultation with specific subject matter experts. The methodology for obtaining licenses for businesses should be made simple, transparent, practical (E.g.: considering the culture of the region for homestays), activity specific (E.g.: depending on the sport) All information should be available on the website of the Department of Tourism.	Transparent and clear norms for new tourism stakeholders Encourages and promotes sustainable and responsible water-based tourism in the state Provides alternative livelihood and income generation opportunities to the coastal community by means of water sports, homestays etc.	High	Dept. of Tourism/ KSTDC	Govt.
2	A Feedback box/Grievance redressal mechanism is to be established	To communicate the hurdles faced in the sector effectively	High	Dept. of Tourism/ KSTDC	Govt. & Private
3	Formulate thorough rules to be followed by water-based tourism stakeholders during operations of various tourism activities such as safety of tourists, waste management, precautions on tourism during monsoon, preventing any kind of damage to the ecology etc.	Ensures safety of Tourists as well as protects the ecology and environment	High	Dept. of Tourism/ KSTDC	Govt.
4	Carry out an annual assessment of infrastructure (Homestays, houseboats etc.), facilities, equipment's (gears, safety equipment's etc.) involved in water-based tourism activities to improve and maintain hygiene and safety standards including a check on various other relevant certifications and their periodic	Monitoring mechanism to ensure top notch quality tourism experiences to tourists including ensuring their safety	High	Dept. of Tourism/ KSTDC	Govt.

	renewals etc.				
5	Policy and other Support to convert fishing vessels into tourist houseboats, museums, restaurants, photo-shoot destinations, boating trips etc. and decommissioned Warships as warship museums	Minimizes the hazards associated with dismantling decommissioned ships/traditional fishing fleets Alternate livelihood for fishing communities Reduces the impact of overfishing	Medium	Dept. of Tourism/ KSTDC and Dept. of Fisheries	Govt. & Private

2.5 Marketing Water-based Tourism

Sl. No	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Promote, market and popularize Karnataka's blue tourism sectors such as Houseboats, Surf schools, homestays, Cruise tourism in the domestic and international arena by using Public Relation strategies and strategic marketing initiatives	Increased domestic and international tourist footfall and foreign exchange earnings	High	Dept. of Tourism/ KSTDC	Govt. & Private
2	Host frequent National/International Surf festivals, kite festivals, Angling carnivals, beach festivals, food festivals, bird festivals etc. on beaches and river banks at various locations and widely advertise them with Public Relation strategies nationally and internationally	Promotion of beaches, local culture and cuisine	High	Dept. of Tourism/ KSTDC	Govt.
3	Promote, market and popularize white water rafting in the regions of Honnemaradu, Kemphole, Kodagu, Sitanadi, Dandeli etc.	Increased tourist footfall	High	Dept. Of Tourism/ KSTDC	Govt. & Private
4	Promote and popularize sport fishing/big game fishing in angling destinations such as Dandeli, Kali River, Tungabhadra, Kabini Reservoirs etc.	Increased tourist footfall	High	Dept. of Tourism/ KSTDC	Govt. & Private

2.6 Use of Coastal protection works as generators of recurrent income

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Promote beach tourism/ecotourism opportunities at locations where coastal protection works have been carried out under SCPMIP such as in Ullal, Someshwara, Udyavara, Yermal Thenka, Kodi Bengre, Maravanthe, Bailur, Kadle etc.	Provides recurring income to the local community especially women Socio-economic development	High	Dept. of ID, P&IWT Dept. of Tourism	Govt. & Private

2.7 Island Development- As per the information collected for purposes of this rapid assessment, there are around 101 onshore and near-shore islands in Karnataka. The details with elevation and area in sq. meter of each island are provided as Chapter 3 Annexure 1.

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Detailed study to be carried out for holistic development of potential islands for Island tourism etc. along with robust ESIA studies (Chapter 3 Annexure 1)	Creates livelihood opportunities and promotes socio-economic development	High	Dept. of Tourism/KSTDC	Govt.
2	Strengthen and encourage sustainable Island tourism of the few islands in the state that attract tourist seasonally such as Devbagh Island, Kurumgad Island, Sadashivgad, Anjadiv Islands, Basavaraja Durga Island, Madlimagadg Island (Oyster Island), Netrani Island and St. Mary's Island		High		Govt.

2.8 Capacity Building/Skill Development – Tourism

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Promote and train enthusiasts in coastal communities on bee-keeping and honey production in mangrove areas as it has high economic value	High Income generation for local communities	High	Forest Dept./ Dept. of Horticulture	Govt. & Private
2	Provide professional training and skill development to encourage entrepreneurship in the eco-tourism sector for women and vulnerable communities	Increased Socio-economic benefits, income generation to the local community	High	Directorate of Employment & Training and Forest Dept.	Govt. & Private
3	Provide local youth in coastal areas with training/skill development to promote the tourism/hospitality sector in a sustainable manner such as lifeguard training, sustainable tourism management, adventure tourism and related safety skills, outdoor adventure/nature guides, customer service skills, leadership skills, communication skills, generic management skills along with general etiquettes etc. Imbibe a hospitable attitude that is welcoming for tourists	Alternate livelihood options for youth in the fishing community	High	Dept. of Skill development, entrepreneurship and Livelihood	Govt. & Private
4	Introduce training programs to poor uneducated fisherwomen in low investment alternative livelihood options such as designing Jewelry, handcrafted items, wealth from waste, making reusable cloth bags, scented candles etc. To be more fruitful, training should be based on local level interests of these women and markets available wherein women in a village could be given training options to choose from prior to organizing training. Utilize the present institutional arrangement (taluk level, panchayath level-Kaushalkar) to arrive at training needs in a particular village	Alternate livelihood for women in the fishing community	High	Dept. of Skill development, entrepreneurship and Livelihood	Govt. & Private
5	Provide awareness on CRZ regulations to coastal	Minimizes violations of	High	Dept. of	Govt.

	communities and various tourism stakeholders to create awareness on permissible and non-permissible activities in CRZ areas along with	CRZ regulations		Ecology and Environment, Dept. of Tourism	
6	Organize trainings/coaching classes for tourism stakeholders especially new players on lifesaving techniques, emergency response drills etc. during monsoon (Off season)	Increases safety of tourists	Medium	Dept. of Tourism	Govt. & Private

Sector-3: Recommendations for Pollution Control and Management

The following recommendations pertain to pollution control and management strategies for coastal, marine and inland water resources of the state. This would help protecting the state's water resources from environmental and ecological degradation, conserving the rich biodiversity they support and in turn safeguard the livelihoods of the people who depend on them.

3.1 Pollution Management in Coastal, Marine, Estuarine and Riverine water bodies

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Strictly monitor discharges from various industries on a regular basis to ensure their Effluent Treatment Plants (ETP) are adequate and well-functioning Impose heavy fines on violations	Ensure to keep pollution under check and protect seas from environmental degradation	High	KSPCB	Govt.
2	Regularly carry out water quality monitoring for critical parameters as prescribed by the CPCB at locations where rivers meet the sea (where industrial pollution load is maximum) The results shall be made available on the website of the KSPCB				Govt.
3	Carry out mapping and management of pollution and pollutants (micro/macro plastic disposal sites etc.) with high-resolution satellite data and take action on violations and carry out suitable mitigative measures	Preservation of ecology Reduction in Plastic pollution	High	ISRO-SAC, KRSAC, KSPCB	Govt.
4	Organize periodic and effective beach cleaning and river cleaning as part of Swachh Bharat Abhiyan through public participation	Reduction in ALDFG and marine plastics in the sea Alternative source of income Clean Beaches	High	KSPCB, Urban Development Dept. (UDD), Rural Development and Panchayat Raj (RDPR)	Govt. & Private
5	Enforce upgradation and modernization of Effluent Treatment Plants in Fish meal and Fish oil Units to meet discharge water quality standards	Reduced Environmental Impact	High	KSPCB, Dept. of Forest, Ecology and	Govt.

				Environment, IFMFOEA	
6	Create adequate on-shore facilities for segregation and collection of worn-out fishing nets/gears, ghost gears, plastics in marine and inland waters either generated or caught by fishermen and incentivize them on their co-operation. Along with on shore efforts fishermen should be encouraged to collect ghost nets in the water if found and deposit in safe disposal units installed in fishing harbors/landing centers These plastics can be reused/recycled into various consumer products such as bags, t-shirts, sun-glasses, footwear, swimsuits, skateboards, surfboards etc. and also generate fuel	Reduction in ALDFG and marine plastics in the sea Alternative source of income Clean Beaches	High	Dept. of Fisheries, KSPCB	Govt. & Private
7	Ensure Common Effluent Treatment Plants (CETP's) are set up for small scale industries	To minimize the pollution load entering water bodies	High	KSPCB	Govt.
8	Ensure all industries and resorts follow the waste management hierarchy and have a robust Waste Management Plan for handling and appropriately disposing all streams of waste, especially treating wet waste generated inhouse		High	KSPCB	Govt.
9	Enforce measures to reduce plastic pollution from seas, coastal and land-based activities, by invoking extended producers' responsibility for recycling plastics and packaging materials to reduce marine and coastal litter	Eliminates flow of solid wastes and plastics into the ocean	High	KSPCB	Govt.
10	Explore the use of biodegradable nets to avoid ghost fishing	Minimizes ALDFG and marine litter	High	Dept. of Fisheries	Govt. & Private

3.2 Capacity Building- Pollution Management

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Build awareness on impacts of pollution, environmental degradation and their implications on marine ecology for personnel from small scale industries, large scale industries and general public	Inculcates a holistic vision to human and industrial waste management strategies especially in coastal areas	High	KSPCB, Dept. of Forest, Ecology and Environment	Govt. & Private
2	Create awareness among fishers and coastal communities on harmful impacts of plastics in aquatic environment and appropriate management of plastic waste (Waste Management Hierarchy) 'Swachh Prithvi, Swachh Sagar'	Minimize pollution and environmental degradation	High	KSPCB, Dept. of Fisheries	Govt. & Private
3	Create awareness among the coastal communities on the importance of green infrastructure such as mangroves, wetlands, salt marshes etc.	Preservation of coastal habitats, mangroves and salt marshes	High	Forest Department, Urban Development Dept. (UDD), Rural Development and Panchayat Raj (RDPR),	Govt. & Private
4	Strengthen Coast guards who are empowered with oil spill mitigation & their facilities in order to make their facilities as Tier 1	Faster Response to Oil Spill Disasters	High	Indian Coast Guard	Govt.
5	Introducing mandatory subjects on Environment Education/Climate Change etc. in schools and colleges especially in professional courses	Raises awareness on environmental/climate change issues	Medium	Department of Collegiate Education, Primary and Secondary Education Department	Govt.

3.3 Policy- Pollution Management

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Outline action plan on Plastic litter management at Urban/Village Panchayath level with clear allocation of roles and responsibilities with monitoring mechanism in place Segregate different types of plastic and tie up with suitable private recyclers	Effective control on pollution and mismanagement of plastic waste	High	KSPCB, Urban Development Dept. (UDD), Rural Development and Panchayat Raj (RDPR), Dept. of Forest, Ecology and Environment	Govt.
2	Enact and enforce strong policies that push for a more circular model of design and production of plastics	Maintains plastics at their highest value for the longest time possible Improves the economy and prevents detrimental environmental impacts of mismanaged plastic waste	High		Govt.
3	Strictly ban/discourage manufacture/sale/use of Single use plastics and instead encourage/make mandatory the use of eco-friendly products made out of sustainable sources such as fish waste and algae, mushroom, plant sugars, sunflower hulls, olive pits etc. which are 100 percent biodegradable	Reduces the dependency on petroleum-based plastics and associated pollution concerns Preservation of ecology	High		Govt.
4	Initiate awards for NGOs, institutions, companies who fund clean-up/upcycle/recycle projects. (For E.g.: Adopt a Highway scheme in the US)	Encourage beach clean-ups Reduced pollution	Medium	KSPCB	Govt.

Sector-4: Recommendations for Resource Conservation and Waste Management

The following recommendations pertain to conserving water resources effectively and implementing strategies to minimize the flow of solid wastes/plastics into water bodies in rural and urban areas.

4.1 Resource Conservation and Waste Management

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Introduce mandatory Rainwater harvesting in Institutions/ Hospitals, Domestic and Commercial Buildings	Conservation of water resources and alleviate the water shortage crisis in future	High	Urban Development Dept. (UDD), Rural Development & Panchayat Raj Department (RDPR)	Govt.
2	Install drainage nets/trash traps at outlets of drainage pipes to prevent plastic waste from being carried by storm water into water bodies	Eliminate flow of solid wastes and plastics into the ocean	High		Govt.
3	Ensure waste segregation occurs at source in homes, educational institutions, commercial spaces, tourist spots and public places at the time of waste collection. Implement strict fines for non-compliance Enforce mandatory inhouse composting of wet waste in hotels, resorts, hospitals, educational institutions etc.	Maintains cleanliness Improves community health standards Supports sustainable lifestyle and responsible waste disposal	High	Urban Development Dept. (UDD), Rural Development & Panchayat Raj Department (RDPR)	Govt.
4	Impose strict fines on illegal disposal of municipal solid waste, poultry waste etc. in water bodies/pathways		High		Govt.

5	All Panchayats and Corporations have to be trained and funded on collecting segregated waste and appropriate disposal of waste (Composting, Recycling etc.)	Protects the terrestrial and marine environment on adverse impacts of irresponsible waste disposal	High		Govt.
6	Carry out an audit on waste generation and management in cities to reduce waste flowing to the sea	Reduces the flow of plastics flowing to the sea	Medium	Urban Development Dept. (UDD), Rural Development & Panchayat Raj Department (RDPR)	Govt.
7	Carry out research related to understanding of pathways from source to sink, especially plastic litter and spatial and temporal distribution of marine litter		Medium	Urban Development Dept. (UDD), Rural Development & Panchayat Raj Department (RDPR), KSPCB, KSRSAC	Govt.

Sector-5: Recommendations for Conservation of Priority Ecological Resources

The following are the recommendations pertaining to conservation of eco-sensitive areas such as coastal, marine & estuarine areas, western ghats etc. and protecting endangered/threatened species such as turtles, whales, sharks, dolphins etc.

5.1 Institutional Arrangement for conservation of Priority Ecological Resources

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Positioning of advisories or committees for each of the ecological priority resources Involve these experts in capacity building of fishers, local communities etc.	Conservation of eco-sensitive areas such as coastal, marine & estuarine areas, western ghats etc. and protecting endangered/threatened species such as turtles, whales, sharks, dolphins etc.	High	Dept. of Fisheries/ Karnataka Biodiversity Board (KBB)/ Karnataka State Coastal Zone Management Authority	Govt.

5.2 Conservation of Marine and Estuarine ecological resources

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Develop ecosystem based Marine Spatial Plan (MSP) for the entire coast of Karnataka Identify and establish Marine Protected Areas (MPAs), areas of seasonal fishing closures and biodiversity hot spots as per Marine Spatial Plan	Protection of wild fish stock Conservation of native/endemic fish species and their genetic diversity	High	Dept. of Fisheries, CMFRI, College of Fisheries	Govt.
2	Demarcate places of fish breeding and habitats of threatened species within the marine areas and	Ecosystem restoration	High		Govt.

	coastal backwaters as protected zones (fish refugia's) Declare fish refugia's as "No-Go zones" especially to trawlers and other intensive gear fishing operations	Protection of sensitive habitats			
3	Strictly monitor and regulate sand mining/removal/dredging in estuaries and promote use of alternate construction materials	Protection of estuarine ecology Protection of sea coast from erosion	High	Dept. of Mines and Geology, Coastal Security Police Force, Dept. of Ecology and Environment	Govt.
4	Promote judicious exploitation of living resources based on the understanding of recruitment levels Implement measures to minimize overexploitation-including mesh size regulation to avoid juvenile capture Declaring closed period in time and space to protect natural recruitment and regulate fishery activities	Sustainable management and conservation of fish stocks	High	Dept. of Fisheries,	Govt.
5	Regulate pollution from Ships and land-based industries	Conservation of coastal and estuarine ecological habitats	High	Dept. of Ecology and Environment, KSPCB	Govt.
6	Strict implementation of CRZ regulations to safeguard the integrity of coastal and estuarine habitats			Dept. of Ecology and Environment, Forest Dept.	Govt.
7	Restrict tapping wild marine seed resources and develop new and more sustainable capacities across activities of fisheries	Conserves fish biodiversity	High	Dept. of Fisheries	Govt.
8	Changes in coastal ecosystems to be periodically mapped/studied using technology, remote sensing data etc. Plans to be developed for their protection and conservation.	Conservation of coastal ecosystems	High	Dept. of Ecology and Environment Dept. of Forests	Govt.

9	Eco-sensitive areas such as Netrani Island to be declared as protected areas	Conservation of eco-sensitive areas	High	Dept. of Ecology and Environment	Govt.
10	Form Biodiversity Management Committee with involvement of local Village community to keep vigil on damaging anthropogenic activities at local level along with adequate financial assistance to these committees.	Conservation of coastal and estuarine ecological habitats	Medium	Dept. of Ecology and Environment, Forest Dept.	Govt.
11	Identify and conserve "fisheries heritage sites" such as Mahseer angling, coracle fisheries, bivalve fisheries along the Karwar-Kumta-Aghanashini estuaries	Conservation of ecological and social heritage	Medium	Forest Dept.	Govt.
12	Identify habitats of endangered species in marine and estuarine areas and demarcate them as marine and riverine sanctuaries	Conserve endangered species	Medium	Forest Dept., Karnataka Biodiversity Board (KBB)	Govt.
13	Hill streams above 3000 m Mean Sea Level (MSL) to be declared as ecological sensitive zones in which developmental activities (including water abstraction) must be avoided	Conservation of coastal ecosystems	Medium	Dept. of Ecology and Environment	Govt.
14	Frame policy guidelines for hobbyists and ornamental fish keepers about holding and disposal of stock to avoid these species from reaching natural water bodies	Prevention of threat by the invasive species	Medium	Karnataka Biodiversity Board (KBB)	Govt.

5.3 Conservation of Inland ecological resources

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Establish community based and community run fish protection zones and harvest zones along inland waters	Stronger stake to local communities Sustainable management of fish stocks and ecology	High	Dept. of Fisheries	Govt.

2	Environmental flow requirements to be made mandatory as a part of Environmental Impact Assessments (EIA) for river valley projects.	Conservation of fish biodiversity Reduction in biodiversity loss	High	Dept. of Ecology and Environment, Karnataka Power Corporation Ltd. (KPCL)	Govt.
3	Carry out ecosystem assessment for major river stretches, reservoirs, lakes & wetlands in Karnataka and prepare ecosystem health card based on water quality index, habitat index and living resources index	Conservation and restoration of water resources	High	Dept. of Ecology and Environment, Karnataka Biodiversity Board (KBB)	Govt.
4	Carry out detailed study and develop plans to restore affected stretches of rivers and lakes through existing National River and lake conservation programs	Conservation and restoration of water resources	High	Dept. of Ecology and Environment, Karnataka Biodiversity Board (KBB)	Govt.
5	Periodic desilting of inland water bodies to be carried out by dredging without widening or deepening the river and causing adverse impacts on the river's ecology, productivity and flow	Restoration/maintenance of natural capacity of inland water bodies including ecology and productivity	High	Water Resource Dept. (WRD)	Govt.
6	Assess impact of inland fish harvesting for aquarium trade and derive conservation efforts	Conservation of endemic fish diversity of Karnataka	High	Dept. of Fisheries	Govt.
7	Monthly minimum environmental flow of all regulated rivers to be established and strictly maintained.	Ensures ecological security and integrity of freshwater ecosystem and livelihood security of fishers.	High	Water Resource Dept. (WRD)	Govt.
8	Establish new fish sanctuaries and promote active management of existing fish sanctuaries	Conservation of fish biodiversity	Medium	Dept. of Fisheries, Forest Dept.	Govt.

5.4 Recommendations for conservation of Migratory Birds

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Restore degraded habitats of migratory birds such as wetlands, mudflats, estuaries to support birds on every step of their staggeringly long journeys Protect these habitats from the pressures of land reclamation, pollution and other human disturbances	Conservation of habitats important for migratory waterbirds	High	Dept. of Ecology and Environment,	Govt.
2	Encourage the sectors that have invested in coastal ecosystems, such as shellfisheries, aquaculture and salt extraction, to incorporate conservation objectives in their wetland management, and facilitate restoration of coastal wetlands		High	Forest Dept.	Govt.
3	Consider the Soaring Bird Sensitivity Mapping Tool during project planning stage which shows areas where it might be inappropriate to locate wind farms and power lines	Prevent migrating birds from colliding with the rotating blades of wind turbines and power lines	High	KREL	Govt.
4	Raise awareness among tourists in bird sanctuaries, mangrove areas etc. on various species of birds and the need for conserving them and their critical habitats	Increased awareness on conservation of Migratory birds and their habitats	Medium	Dept. of Tourism, Karnataka Biodiversity Board (KBB)	Govt. & Private
5	Embed conservation in school curriculums and create awareness among communities, schools, hunting organizations to champion zero tolerance of illegal killing of migratory birds.	Inspire young people and the next generation to grow up connected to nature and foster them to become conservationists	Medium	Forest Dept., Dept. of Collegiate Education, Primary and Secondary Education Dept.	Govt. & Private

5.5 Recommendations for conservation of Whales and Sharks

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Introduce an immediate suspension on fishing of Sharks, Whales, Rays and Skates. Duration of the suspension to be fixed after detailed fish stock assessment studies	Conservation of Sharks, Whales, Rays and Skates	High	CMFRI, Dept. of Fisheries	Govt.
2	Conduct regular awareness programs among fishermen, chefs and consumers on ill effects of rampant fishing of sharks, their endangered/threatened status, their role in the ecosystem etc. Interventions are required both at consumer level to decrease demand for shark products and at the level of fishing communities to bring in sustainable fisheries and ecosystem-based management which would conserve critical marine mammals, including sharks.	Conservation of Sharks and	High	CMFRI, Dept. of Fisheries	Govt. & Private
3	Use of excluder devices and pingers to be made mandatory in trawl fisheries after detailed studies on developing efficient ones Adequate training to be provided to fishermen on the effective use of excluder devices and pingers Track efficiency of these devices and carry out continuous research on improving these devices to protect endangered/threatened marine mammals	Minimize by-catches of marine mammals	High	CMFRI, Dept. of Fisheries	Govt. & Private

4	Train and equip Coastal Security Police Force to regulate and minimize Illegal Fishing and Over Exploitation of endangered and threatened species. (Unauthorized foreign fishing vessels/poaching in Indian waters) Impose strict fines on unauthorized foreign fishing vessels poaching in Indian waters and fishermen not using by-catch reduction devices	Protection of endangered and threatened species		Dept. of Fisheries, Coastal Security Police force	Govt.
5	Organize public awareness campaigns on conservation of endangered marine mammals such as Sharks, Whales, Rays, Skates, Dugong, Bottlenose Dolphins, etc. in schools, colleges, coastal tourist areas etc.	Conservation of endangered marine mammals	Medium	CMFRI, NGOs working on conservation of endangered & threatened species, Dept. of Fisheries, Karnataka Biodiversity Board (KBB)	Govt.
6	Encourage fishermen to provide information on sighting threatened marine mammals	Review of existing legislation and formulation of new legislation based on new research information available	Medium		Govt.
7	Adopt modern techniques to study the behavior and migration pattern of marine mammals in the seas to formulate and enhance suitable conservation strategies to protect the marine mammals	Protection and conservation of endangered marine mammals	Medium		Govt.

5.6 Recommendations for conservation of Coral Reefs

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Control and regulate commercial fisheries, underwater diving and amateur collection of corals around coral reef ecosystems especially Netrani	Conservation of coral reefs Ecosystems and their unique biodiversity	High	Dept. of Fisheries/ Karnataka Biodiversity	Govt.

	Island.			Board (KBB)/ Karnataka State Coastal Zone Management Authority	
2	Protect and conserve the Netrani Island and other coral reef ecosystems in the state by declaring them as a Marine Protected Areas (MPA) under the Biodiversity Act 2002.		High		Govt.
3	Ensure safe and responsible diving and snorkeling activities is practiced to protect the fragile coral ecosystems such as by instructing tourists to avoid touching reefs and avoiding anchoring boats on reefs. Moreover, tourists need to be informed on reef-friendly approach to sun protection as some ingredients in sunscreen can be harmful to or even kill corals.	Protect coral ecosystems from degradation	High	Diving Institutes and Tour operators	Private
4	Prohibit sale of living coral and collection of fishes from these ecosystems for ornamental purposes.			Dept. of Fisheries	Govt.
5	Create awareness on importance of Coral ecosystems on marine capture fisheries, coastal protection etc. and the ways to protect them such as curtailing marine litter, steps towards reducing global warming etc.	Increased awareness on ecosystem services of Coral ecosystems and strategies on their conservation	High	Karnataka Biodiversity Board (KBB), CMFRI	Govt.
6	Carry out regular assessment to evaluate the trends and patterns of use and health of coral reefs as it is an essential tool for the development of effective management strategies.	Helps in analyzing punitive measures to be taken	High	Karnataka Biodiversity Board (KBB), CMFRI	Govt.

5.7 Recommendations for conservation of Mangroves

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Ensure protection of existing mangrove ecosystems and removal of deleterious impacts Protection of mangrove flora and fauna by banning the extraction of mangrove wood; address the issue of encroachment, destruction and reclamation of mangrove areas with a legal enforcement of protection rules against exploitation of mangroves for fuel wood, timber, paper, charcoal etc. that violates Coastal Zone Regulation Notification, 2011 and 2019.	Conservation of Mangroves	High	The Forest, Environment & Ecology Department under the supervision of Chief Conservator of Forest (Mangrove Cell), District level authorities under the support of Department of Home affairs	Govt.
2	Degraded mangrove areas to be identified and intensive measures undertaken to restore degraded/destroyed mangroves.	Conservation of Mangroves	High	Dept. of Forests	Govt.
3	Mangrove planting and maintenance should be undertaken as per natural zonation in mangrove ecosystem Avoid monoculture of mangroves species during afforestation measures, giving importance to <i>Avicennia</i> spp. and <i>Sonneratia</i> spp.				Govt.
4	Carry out awareness campaigns on Mangroves to coastal communities Training to be provided to local communities on management and restoration of mangroves	Conservation of Mangroves	High	Dept. of Forests	Govt.
5	Annual monitoring of mangroves using remote sensing in coastal and estuarine ecosystems to be undertaken	Conservation of Mangroves	High	Dept. of Forests	Govt.

6	Promote mangrove management and reforestation activities by adequate funding to Panchayats, Village Self-Help-Groups and Village level organizations Under the coordination of different departments, set up Mangrove Co-management Committees and Mangrove Protection and Employment Generation Scheme as done in Maharashtra to make people's livelihood dependent on and linked to the mangrove cover so that people will voluntarily come forward to save the mangrove cover	Ensures people's participation in conservation of Mangrove cover	High	Dept. of Forests, Dept. of Environment & Ecology, Dept., Fisheries, Dept. of Tourism	Govt.
8	Identification of potential mangrove areas for declaration as national parks and sanctuaries	Income generation, Conservation of Mangroves	High	Dept. of Forests	Govt.
9	The rare population of <i>Bruguiera gymnorhiza</i> in Venkatapur estuary to be protected	Conservation of Mangroves	High	Dept. of Forests	Govt.
10	Promote mangrove plantation in abandoned aquaculture ponds	Conservation of Mangroves	Medium	Dept. of Forests	Govt.

5.8 Recommendations for Conservation of Coastal Wetlands

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Wetlands, salt marsh areas, eco sensitive coastal areas as mapped in the CZMP and declared as CRZ IA should be protected in line with CRZ notification 2019	Conservation of coastal eco-sensitive areas	High	Dept. of Ecology and Environment	Govt.

2	Carry out studies to map wetlands (coastal and inland), low lying coastal areas, and potential coastal stretches that are prone for inundation during monsoon/cyclones/sea level rise	To initiate protection and conservation action plan for coastal and inland wetlands that are faced with long term degradation	High	Dept. of Ecology and Environment, Karnataka Forest Dept.	Govt.
3	Develop guidance for the wise use of wetlands in relation to coastal and inland aquaculture to prevent direct (habitat loss, wild harvest of species) and indirect (pollution, contamination of wetlands, impact of novel compounds, genetic modification) impacts of aquaculture Build on aspects of COP9 Resolution IX.4 (2005): productive and sustainable use of fisheries resources	Sustainable management of Wetlands	High	Dept. of Ecology and Environment, Karnataka Forest Dept	Govt.
4	Ensure agriculture in coastal wetlands are sustainably managed as poorly managed agriculture can negatively impact wetlands leading to changes in the ecological character of a wetland and the possible permanent loss of its benefits to people		High	Dept. of Ecology and Environment, Karnataka Forest Dept	Govt.
5	Conserve wetlands from intensive agricultural and aquaculture activities (Shrimp farming) which can disturb wetland functions and ecosystem services	Conserves coastal wetlands to provide various wetland ecosystem services	High	Dept. of Ecology and Environment, Karnataka Forest Dept	Govt. & Private
6	Introduce combined production systems (agri-pisciculture) to several stretches of coastal low-lying area and estuarine areas where fish provide fertilizer for the rice and help to control insect pests and weeds in the fields, while the rice provides shade and habitat for the fish	Climate change adaptation strategy Conservation of coastal wetlands to provide alternative livelihoods to coastal communities	High	Dept. of Fisheries	Govt. & Private

5.9 Recommendations for Conservation of Turtles

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Launch frequent surveys to keep a tab on turtle population and nesting habitats jointly with local communities and maintain a database Develop a mechanism by which these nests can be saved from predation and carry out a nest protection program Ecotourism may be considered for active community participation to support long term conservation of turtles -Train local communities to become local tourist guides and guide turtle walks	Conserve turtle nesting habitats Alternate income generating activities for local communities		Forest Dept., Dept. of Ecology and Environment	Govt.
2	The hatchery programs operated earlier by the Karnataka Forest Department may need to be re-established with active community participation Shifting eggs from their initial location will alter the natural sex-ratio and success rate of incubation. Hence, protecting the eggs in situ for two weeks after deposition and then relocating would help embryonic development of eggs as well avoid egg poaching	Enhance Turtle population		Forest Dept., Dept. of Ecology and Environment, NGOs working on marine turtle conservation such as Dakshin Foundation (TAG) etc.	Govt.
3	Initiate education and awareness programs on turtle conservation for coastal communities, local school teachers, nature clubs in schools and colleges.	Conservation of ecological biodiversity and turtle		Forest Dept., Dept. of Ecology and Environment, NGOs working on marine turtle conservation such as Dakshin Foundation (TAG) etc.	Govt.

4	Carry out tagging of turtles to create a database on various aspects such as their biology, population size, migration, nesting females, time interval between nesting and nesting sites	Provides information about the different species of turtles Helps in regional and sector-based conservation		Forest Dept., Zoological Survey of India, Wildlife Institute of India (WII), Research organizations	Govt.
5	Initiate co-management and integration of the activities by state government departments such as local panchayat, port Authorities, CRZ authorities and the forest officials for effective conservation of sea turtles as presently most of them like work in isolation	Conservation by effective Co-management		Forest Dept., RDPR, Port Authorities, Dept. of Ecology and Environment	Govt.
6	Revive turtle nesting areas that have disappeared on account of erosion and anthropogenic activities along the Karnataka coast especially in Mangaluru, Mukka, Apsarakonda, Dhareshwar region following the manual on best practices for safeguarding sea turtle nesting beaches. Avoid seawalls/hard measures for protection of coasts from erosion and choose soft solutions such as dune building and plantation to protect coasts from long term erosion	Scientific conservation of turtle nesting areas		Forest Dept., Dept. of Ecology and Environment	Govt.

5.10 Recommendations for Conservation of Dolphins

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	In line with the nation's Dolphin project for the conservation and protection of the Dolphins in the rivers and in oceans of the country, scientific conservation methods along with existing stakeholders need to be taken up.	Conservation by Co-management Will strengthen conservation of Dolphins and track	High	Forest Department, NGOs involved in Conservation of Aquatic biodiversity and endangered species	Govt.

	Conduct an initial baseline survey of the species along each district followed by identification and selection of dolphin congregation areas, where monitoring could be carried out annually The state Forest Department along with NGOs should actively take part in conservation and protection of Dolphins	progress of measures taken as they are good indicators of the ocean biome Create employment opportunities and will also help to attract tourism			
2	Intensify conservation efforts by reducing the flow of plastic to the oceans, minimizing pollution load and ALDFG, establishing monitoring network, population estimation, habitat conservation for dolphin hot spots, strengthening marine stranding network and developing livelihood by building eco-tourism projects around conservation of the species	Prevents marine litter Will strengthen conservation of Dolphins Create employment opportunities	High	KSPCB, Dept. of Tourism	Govt.
3	Carry out studies on habitat of dolphins and their migratory routes	Dolphin conservation and by-catch reduction	Medium	CMFRI, College of Fisheries	Govt.
4	Fishermen should be educated about the importance of dolphins, their significant role in the balance of the ecosystems Strictly enforce usage of by-catch reduction devices (BRD's) and high efficiency fishing practices to reduce non-targeted catch of endangered fish species		Medium	Dept. of Fisheries, College of Fisheries, CMFRI	Govt. & Private

5.11 Recommendations for conserving of priority ecological resources of the Western Ghats

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Promote fish sanctuaries in areas of Western Ghats providing fish species protection	Conservation of fish species that are vital elements of biodiversity	High	Karnataka forest department, Western Ghats Ecological Expert Panel (WGEEP), Nature conservation foundation	Govt.
2	Notify Coastal & Marine areas of biodiversity importance (e.g., key fish breeding sites, migratory routes, etc.) as Biodiversity Heritage Sites (BHSs) as per the Biodiversity Act, 2002	Protection of sensitive ecosystems to conserve biodiversity	High	Forest Dept., Western Ghats Ecological Expert Panel (WGEEP)	Govt.
3	Ensure dams are well managed during constructing new hydroelectric power projects to protect riverine ecosystems and their endemic and threatened biota Construction of large dams should carry out an assessment to identify species at risk to such developments, undertake a full and comprehensive environmental impact assessment, and follow the framework set out in the World Commission on Dams report (World Commission on Dams 2000). Appoint appropriate agencies/Institutes in the country with adequate expertise to suggest the most suitable, location-specific fish passes (fish ladders, fish locks, fish lifts, diversion channels and so on) keeping in mind the swimming and migratory habits of target species, hydrodynamics and the nature of hydraulic structures to meet the requirements of the dams/barrages. This	Reduce flood cycles and help fish biodiversity conservation Reduce flood cycles and help fish biodiversity conservation Fish passes in dams are an effective tool for facilitating upstream and downstream migration of fish species	High	Water Resource Dept (WRD), Karnataka Power corporation limited (KPCL)	Govt.

	component must be included in Draft Project Proposal (DPP) of dam projects.				
4	Take measures to control sand mining and encourage alternatives to river sand for construction purposes Strictly enforce the “Sustainable River sand/boulder mining management guidelines, 2016”, published by the MoEF&CC, to ensure environmentally sustainable mining Carry out an integrated environmental assessment; a management and monitoring program for the sand extraction processes; physical, chemical and biological studies on the impacts of instream mining on a river basin scale etc.	Minimizes the impacts of Sand mining such as reducing erosion impacts etc.	High	Department of Mines and Geology, Dept. Environment & Ecology	Govt.
5	Initiate a combination of strategies such as improved enforcement of pollution laws; best management practices for crop and livestock production, use of robust effluent treatment plants by industries etc. to prevent pollution in Western Ghats	Conserves fish biodiversity and improves water quality	High	Karnataka State Pollution Control Board (KSPCB), Dept. of Ecology & Environment	Govt.
6	Formulate a national/state level policy on the introduction of exotic species and their management Formulate guidelines for hobbyists and ornamental fish keepers about holding and disposal of stock to avoid these species from reaching natural water bodies Detailed investigations on the spread and impact of invasive species in the drainages of the Western Ghats are urgently needed as at least 300 exotic	Prevents and minimizes the impacts invasive alien species Protection of native, small and endemic species	High	Dept. of Ecology & Environment, Wildlife Crime control Bureau, Karnataka Biodiversity Board (KBB)	Govt.

	aquarium species are imported and traded in India, without any regulation				
7	Ensure to follow the provisions contained in the BD Act, 2002 when developing pharmaceutical products based on available seaweeds and sea grasses and aquatic animals and other life forms. This entails that research institutions/companies who access the country's biological resources from the EEZ for research/commercial utilization/bio-survey/bio utilization purposes should seek prior approval of the National Biodiversity Authority/ SB.	Controlled use of seaweeds, sea grasses, aquatic animals and other life forms for development of pharmaceutical products	High	Research institutes, Department of Ecology and Environment	Govt. & Private
8	Set up community and conservation reserves outside the existing terrestrial protected area network in the Western Ghats to act as refugia or closed areas for fishing to reduce biodiversity loss and protect individual or multiple threatened species	Conserve biodiversity of the Western Ghats by Co-management	High	KBB	Govt.
9	Carry out risk assessment studies for 'sleeper species', species that are yet to demonstrate their invasive capacity, but are deemed to have the potential to spread and have adverse impacts	Prevention of threat by the invasive species	Medium	Dept. of Fisheries	Govt.
10	Amend India's Wildlife (Protection) Act (WPA), 1972 (with amendments in 2002), to include protection of smaller and less charismatic taxa including freshwater fishes.	Conservation of smaller and less charismatic Taxa	Medium	MoEF&CC	Govt.
11	Set up Live gene banks to hold live animals or cryopreserved gametes, and contribute to conservation of threatened species by captive breeding and restocking in species specific recovery programs E.g.: Live Gene Banking (LGB) of Fishes of the Western Ghats by NBFGR	To build the biodiversity of threatened species	Medium	NBFGR, Aquatic Biodiversity Conservation Society	Govt.

12	Use Flagship species as a marketing strategy to create awareness and build public participation in conservation actions. For E.g.: The concept of 'state fish' was mooted by the National Bureau of Fish Genetic Resources, which 16 states have subsequently adopted (Devi 2010).	Awareness creation for effective conservation of biodiversity	Medium	Karnataka Biodiversity Board (KBB), Biodiversity Conservation Organizations	Govt.
13	Promote education and community engagement for conservation of freshwater fish resources, especially endemic species by means of stewardship and knowledge building. An integrated approach of awareness, capacity building, and monitoring and policy interventions is the key to conserving the freshwater fishes of Western Ghat.	Co-management for better conservation	Medium	Dept. of Fisheries, Karnataka Biodiversity Board (KBB), NGO's	Govt.
14	Initiate mapping of indigenous fish species, their habitats and production trends and document the available inland aquatic bio-resources through People's Biodiversity Registers (PBRs) and electronics database.	Database creation and management	Medium	Karnataka Biodiversity Board (KBB), Research Institutes	Govt.
15	Promote the regeneration of riparian vegetation along the river basins of the Western Ghats by planting of indigenous tree species along the river margins can protect and stabilize the river margins. Strict laws need to be developed and implemented to curb tree felling and deforestation in the Western Ghats ecoregion along with other social forestry and afforestation programs	Climate and environmental benefits, sources of food and medicines	Medium	Dept. of Forest, Karnataka Biodiversity Board (KBB)	Govt.
16	Carry out in-depth studies on the life history traits, population and ecology of the biodiversity of fishes in the Western Ghats and outline action plans to conserve these species	Conservation of key threatened species and their habitats	Medium	Karnataka forest department, Western Ghats Ecological Expert Panel (WGEEP), Nature conservation foundation	Govt.

17	Captive breeding and ranching of endangered and threatened species with robust ESIA studies	Reclaiming fish biodiversity aids food chain dynamics, nutrient cycling, and ecosystem resilience	Low	Department of Fisheries, ICAR Institutes pertaining to fisheries, Department of Ecology and Environment,	Govt.
18	Create an inventory of economically important cultivable native species for propagation through in-situ conservation, hatcheries and brood banks.	Conservation of native species	Low	Dept. of Fisheries	Govt.

Sector-6: Recommendations for scientific extraction of Non-living blue resources

This section of recommendations encompasses scientific extraction and potential for utilization of non-living resources with actions mainstreamed for absolute minimum damage to ecology and environment.

To ensure environmentally sustainable and scientific extraction of non-living resources, it is advised to carry out initial as well as periodic (annual) Environmental and social Impact Assessment (ESIA) in potential areas.

6.1 Offshore and Near-Shore Energy- The preliminary evaluation has ruled out techno-economic feasibility, viability and potential of offshore wind energy, solar energy, osmotic power and ocean thermal energy in the state considering the present technologies. Hence, the following recommendations pertain to wave energy that has been experimented in the state and ocean current energy that needs to be explored.

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	The economic feasibility of the technology developed by Susi Global Research Centre to be established. Support Susi Global Research Centre (technically and financially) for advancement and refinement in technology.	Reduced dependence on fossil fuels Locally available power	High	KREL	Govt. & Private
2	Explore Wind and Solar energy for powering Islands during their developmental phase	Reduced dependence on fossil fuels Locally available power	Low	KREL	Govt. & Private
3	Detailed study to be undertaken to establish the potential and viability of utilizing Ocean Current Energy in the offshore regions of Karnataka	Reduced dependence on Fossil Fuels/ Locally available power	Low	Dept. of Energy, NIOT	Govt. & Private

6.2 Rare Earth Minerals and Lime shell Deposits

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Efforts can be made to increase the production capacity and towards the discovery of new lime shell deposits	Increased employment and income generation	Medium	Dept. of Mines and Geology	Govt. & Private
2	Placer mineral potential in Karnataka could be further studied in detail. Available technologies in placer mining can be fine-tuned to suit existing geo-mining conditions	Socio-economic Development	Low	Dept. of Mines and Geology	Govt.

6.3 Expansion of Salt Pans for Industrial Use

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Specific low-lying areas marginal to estuaries and tidal reaches characterized by natural saline incursion can be selected for developing new salt pans	Increased employment and Income generation	Medium	Salt Commissioner	Govt. & Private

6.4 Undersea Communication Channels and Cables

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Establish cable landing stations in Mangaluru	Socio-economic Development	Medium	Dept. of Electronics, IT BT and Science & Technology	Govt. & Private

Sector-7: Recommendations for Marine Area Management

The following are the recommendations pertaining to Coastal and Marine Area Management in the Blue Economy context that promotes efficient management of coastal areas including suitable coastal protection measures.

7.1 Coastal and Marine Area Management

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Prepare ecosystem-based Marine Spatial Plan (MSP) and Coastal Master Plan (CMP) for identification of critical areas needing special attention and those offering potential for development in collaboration of government and non-government research institutes. Identify areas which are ecologically important (Ecologically important ecosystems, Critical Ecological habitats, protected areas Marine Protected Areas, Fish Sanctuaries), important areas for capture fisheries (Fisheries reserves, Community run fisheries reserve, Spill over zones) and areas important for vulnerable communities and non-mechanized fisherfolks. (Territorial User Rights for Fishing (TURFs) and Traditional Fishing areas).	Helps maintain sustainability of oceanic resources Promotes efficient management of coastal areas and encourages development by accommodating the legitimate interests of the economic sectors and in the process reducing/eliminating possible conflicts	High	Dept. of Ecology & Environment, Dept. of ID, P&IWT, KSPCB, MoEF&CC, NCSCM, Government and Non-Government research institutes, Local fisheries societies, RDPR, UDD, Fisheries Unions	Govt.
2	Demarcate vulnerable areas in terms of their levels of severity in available Hazard maps and plan activities along the coast accordingly	Climate change resilience for the coast and protection of the coastal community against coastal hazards including rising sea levels	Medium	Dept. of Ecology & Environment, KRSAC	Govt.
3	Carry out a pilot study using high resolution satellite images and classified images of mangrove distribution, LULC, CRZ available with	Prevent/ Reduce ecological damage	High	SAC, KRSAC, NRSC, Dept. of Fisheries, KSPCB	Govt.

	KRSRAC, NRSC, SAC at various time frame as baseline data to evaluate the status of coastal zone, mangrove habitats, construction activities etc. for policy decisions				
4	Implement environmentally sound and eco-friendly shore protection measures such as dune building and plantation (Green Wall) instead of construction of seawalls	Easy access to the sea for fishermen, Aesthetics of the beaches are maintained, Natural resources (mainly hard rocks) are conserved which are essential for various developmental activities		Dept. of Ecology & Environment, PWD, Department of Tourism, Fishermen Association, Revenue Dept. (Disaster Management-DDMA, Dakshina Kannada, Udupi & Uttara Kannada), Dept of Fisheries, Dept. ID, P&IWT	Govt.
5	Identify locations along the coast suitable for shore protection measures (SMP 2020) that are environmentally sound and eco-friendly such as dune building and plantation (Green Wall) rather than seawall, considering the climate change scenario. Implement these measures with participation of coastal communities including nursery development	Climate change resilience of the coast and protection of the coastal community against coastal hazards including rising sea levels. Contribute to the economic upliftment of the local community through the medicinal, nutritional and industrial value of vegetation as well as employment and income generation for the local community especially youth and Women	High	Dept. of ID, P&IWT	Govt.
6	Consider the coastal protection guidelines provided in the "Reference Manual on Climate Change Adaptation Guidelines for Coastal Protection and Management"	Sustainable coastal protection Prevention of long-term erosion	Medium	Dept. of ID, P&IWT	Govt.
7	Encourage implementation of appropriate coastal		Medium	Dept. of ID, P&IWT,	Govt.

	protection measures as per the Shoreline Management Plan 2020 with preference to soft measures such as dune building, planting over walls, groins etc.			Dept. of Ecology & Environment	
8	Use decommissioned ships for installation as offshore reef for shore protection after technical feasibility studies using numerical models and studies on long-term and short-term ecology and environment impact	Cost efficient shore protection if technically and environmentally feasible	Low	Dept. of ID, P&IWT	Govt.

7.2 Capacity Building- Coastal and Marine Area Management

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Build capacities for successful implementation of Coastal and Marine Spatial Planning (CMSP) by international collaborations with CMSP	Transfer of technology from global leaders	High	Dept. of Ecology & Environment, KSRSAC, SAC, NIAS	Govt.
2	Create awareness among coastal communities on the latest CRZ Notification	Minimize violations of CRZ norms	Medium	Dept. of Ecology & Environment, RDPR, UDD	Govt.

7.3 Institutional Arrangement

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	The ICZM team shall be adequately staffed, trained and budgeted to provide solutions based on an interdisciplinary approach for coastal zone management	Effective coastal zone management	Medium	Dept. of Ecology & Environment	Govt.

Sector-8: Recommendations for Maritime Transport and Development

The following recommendations pertain to port and transport based socio-economic development and income generation as well as pollution management from water-based transport/ship generated wastes.

8.1 Ports and Transport Based Development

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Pursue development of National Waterways such as Gurupur River (NW-43), Netravati River (NW-74), Kali River (NW-52), Sharavati River (NW-90)	Cost Efficient Transportation Income Generation	High	Dept. of ID, P&IWT	Govt.
2	Pursue and Implement infrastructure projects to significantly improve hinterland connectivity to NMPT from cities like Mysuru, Madikeri, Hassan, Shivamogga and Chitradurga.	Increased income generation Decreased logistical costs	High	PWD/South Western Railway	Govt.
3	New players need to be attracted to operate feeder services to NMPT in order to bring it in line with other ports	Faster service	High	NMPT	Govt.
4	Promote Coastal Economic Zones (CEZ's) in coastal districts of the state	Employment generation and Socio-economic development	High	Department of Commerce and Industry	Govt. & Private

8.2 Pollution Management -Water based transport

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Introduce dedicated facilities with adequate infrastructure for receipt and management of Ballast water from foreign and coastal vessels	To establish and enforce a strict mechanism to prevent environmental pollution from Ships.	High	Dept. of Ports & IWT, NMPT	Govt.

	Formulate Standard Operating Procedures for management of Ballast water in line with KSPCB rules and MARPOL convention	Protect aquatic environments from the impacts of invasive species, discharge of untreated ship generated effluents and solid and hazardous waste etc.			
2	Ensure vessels have advanced onboard wastewater treatment systems that are adequate and functional and follow the regulations in Annex IV of MARPOL		High	Dept. of Ports & IWT, NMPT	Govt.
3	Ensure vessels have approved garbage management plan as per Annex V of MARPOL		High	Dept. of Ports & IWT, NMPT	Govt.

Sector-9: Recommendations for Disaster Management and Mitigation

The following recommendations pertain to Disaster Management and mitigation in the blue economy context.

9.1 Policy – Disaster Management

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Draft Oil Spill Mitigation Plans for Udupi and Uttara Kannada districts by referring to innovative approaches and best practices in oil spill mitigation	Emergency preparedness for Oil Spill Disasters	High	District Disaster Management Authority (DDMA) (Udupi & Uttara Kannada)	Govt.

9.2 Capacity Building – Disaster Management

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Create awareness to fishermen on disaster response communication in high seas, first aid and Sea Safety & Navigation using modern aids	Ensures safety of fishermen on board	High	Revenue Dept. (Disaster Management-DDMA, Dakshina Kannada, Udupi & Uttara Kannada)	Govt. & Private
2	Organize trainings for coastal communities on the District Disaster Management Plan and their role in disaster risk reduction and disaster mitigation efforts	Increased awareness to communities on their role in emergencies	High		Govt.

9.3 Institutional Arrangement– Disaster Management

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Form a unified wing for better coordination and mitigation of oil spills and other disasters originating from Ships. Members from KSPCB, MRPL, NMPT, Coastal Guards, Coastal Police etc. could be members of the wing	Better coordination between different agencies	High	Revenue Dept. (Disaster Management-DDMA, Dakshina Kannada, Udupi & Uttara Kannada)	Govt.
2	Initiate Community-Based Disaster Risk Mitigation Program Form disaster response teams in coastal villages, inclusive of women and train them periodically on rescue operations, first aid etc. Provide each team with requisite disaster management kits	Better emergency preparedness and response	High		Govt.

Sector-10: Recommendation for Institutional capacity building and Human Resource Development in Blue economy context

It is recommended to establish “**Blue Economy Training Institute and Research Centre/s**”, in order to streamline and accord due focus to promote skill development and facilitate growth in every blue economy sector. This Institute would be required to facilitate the capacity building recommendations that are entailed in the Summary Blue Economy Development Plan (SBEDP) by engaging the various responsible institutions.

Moreover, a Training Assessment Program (TAP) needs to be carried out district wise for farmers, fisherfolks, women, authorities related to the various blue economy sectors in line with the various recommendations outlined in the SBEDP. Tailor made training programs could be introduced after carrying out detailed market studies to identify gaps in specific skills that can boost a sustainable blue economy in the state.

The stakeholder consultation has revealed a serious gap in training needs and those currently provided (especially to fisherwomen). The Institute needs to be equipped with experts to carry out such detailed market studies. It is also essential to forecast skills which would be required in the future by collecting data through skill surveys and determining skill gaps in respect of all blue economy related sectors to meet the demand and supply of skilled human resources. A robust monitoring mechanism and grievance redressal mechanism should be the core of this Institute for transparency in promoting the Blue Economy sector.

The Government of Karnataka has set up the Department of Skill Development, Entrepreneurship, and Livelihood in 2016 to enable the youth to acquire necessary skills for employment and livelihood promotion. The vision and mission of the department is in line with the goals this proposed institute is foreseen to achieve.

Establishing the proposed institute will help to provide particular focus to skilling in all the established and emerging the blue economy sectors. The Institute could plan for the training needs of the local communities by identifying skill gaps and providing various trainings to create livelihood opportunities. The Institute can also carry out targeted marketing and involve in continual improvement in the sector based on inputs from customer experiences/satisfaction.

The proposed Sagarmala project would also lead to creation of Special Economic Zones (SEZs) along the coastline of the state as already established in Dakshina Kannada i.e., close to the major port in the state (NMPT). These industries would create a plethora of job opportunities. To bridge the demand and supply gap, the industries (including contractors and sub-contractors) could plan their manpower requirement, skills required in the candidates etc. beforehand (prior to 6months) and inform the Blue Economy Training Institute. The institute could then plan to provide skill training for that job role to suitable candidates giving preference to women wherever feasible and disadvantaged/underprivileged persons or communities.

The College of Fisheries, Mangaluru has set up a **Skill Development Centre and Safety Training Centre** under the Mangaluru Smart City Mission with funding of INR 4.75 crores. This skill development center aims to provide the state of art training facilities, skill development and hands on training to local unemployed youth, school and college drop-outs and home- makers, primarily from the fishing and farming

communities to enhance employment opportunities in local industries as well as outside ventures with standardized certification process. In addition to long term training, short term and vocational training are also proposed to be imparted to the desirable beneficiaries. The presently proposed skill development trainings are aquarium fabrication, maintenance and propagation of ornamental fish, aquaponics/Hydroponics integration with kitchen gardening, production of value-added fish products, advanced technology of fish preservation, utilization of fish waste for manure, SCUBA diving and Snorkeling, modernization and safeguarding of fishing boats and manual fish net making and mending.

This **Skill Development Centre and Safety Training Centre** could be upgraded to “**Blue Economy Training Institute and Research Centre**” by infusion of adequate funds to take up various skilling, up-skilling and capacity building programs. This would result in maximizing job opportunities for local communities especially women and other marginalized/disadvantaged communities.

10.1 Institutional Capacity and Human Resource Development

Sl. No.	Recommendations	Benefits Envisaged	Priority	Responsible Institutions	Investment Potential (Govt/Pvt)
1	Establish Blue Economy Training Institute and Research Centre/s to facilitate the various capacity building recommendations that are entailed in the Summary Outline Blue Economy Development Plan by engaging the various responsible institutions	To promote and engage in various skilling, upskilling and capacity building programs recommended to enhance growth in every blue economy sector	High	College of Fisheries, Mangaluru (CoFM), Dept. of Skill Development, Entrepreneurship, and Livelihood (SDEL)	Govt.

Implementation Strategy for Summary Outline Blue Economy Development Plan

To ensure effective implementation of the recommendations that are prioritized under various phases for implementation (High, Medium, Low), it is suggested to form four-tier committees as follows:

1. The “**Blue Economy High Level Committee**” headed by the Chief Minister and the cabinet members to overview the progress on implementation of recommendations, decision making on key aspects and allocation of funds.
2. The “**Blue Economy Secretary Level Committee**” headed by the various Chief Secretaries and Principal Secretaries of the key stakeholder departments. Their role would be to facilitate and augment the resources required by the various districts on blue economy aspects.
3. The “**Blue Economy District Level Committee**” headed by the Deputy Commissioners for each of the districts, which would form relevant sector-wise **Blue Economy (Sector) Task Force Committees** as applicable. The sector-wise task force committee could be composed of key resource persons, stakeholders, industry experts, national/international technical experts with adequate skill and experience in the sector, entrepreneurs etc.

These sector wise task force committees would be responsible to chalk out the grass root level information/hurdles and convert the recommendations herein into action plans along with an institutional mechanism, clearly defined roles & responsibilities and an appropriate monitoring mechanism to monitor and evaluate the implementation progress of the various recommendations. Moreover, it is also essential to track the output and outcome of the plan at the local level (number of beneficiaries, tangible and intangible benefits etc.) to quantify the progress in the blue economy at the state/national level.

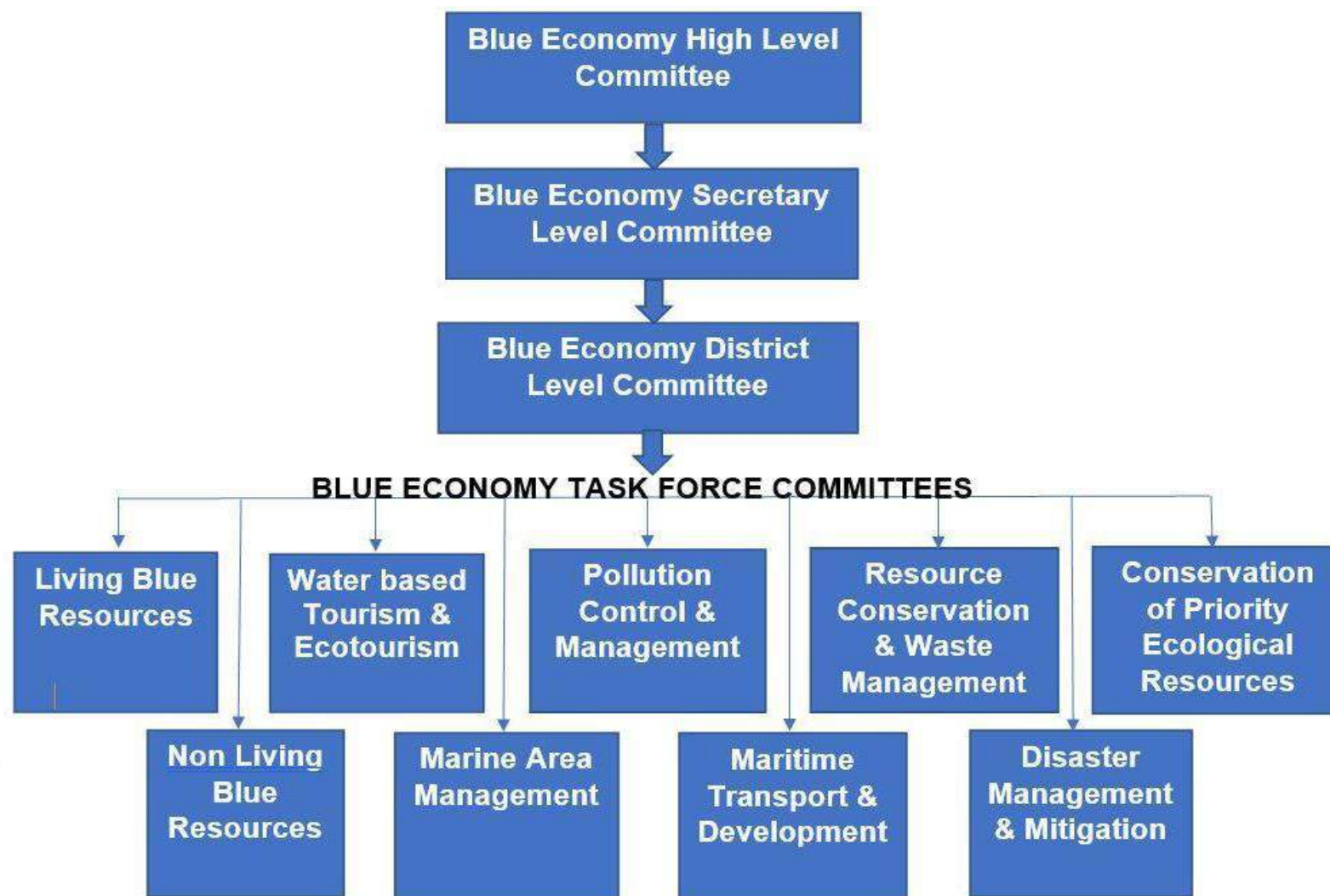


Chart 1: Organization Chart for Implementation of Blue Economy Development Plan

The below Table A1 provides the tentative responsible institutions that could form part of the Task force committees:

Sl. No.	Blue Economy Task Force Committees	Responsible Institutions
1	Blue Economy (Living Blue Resources) Task Force Committee	State Government Departments • Department of Fisheries, GoK • Department of Forest, Ecology & Environment, GoK • Department of Agriculture, GoK • Department of Food, Civil Supplies and Consumer Affairs, GoK • Karnataka State Police Department (Coastal Security Police Force (CSP)), GoK • Department of Infrastructure Development, Ports and Inland water Transport (ID, P&IWT), GoK • Rural Development and Panchayat Raj Department (RDPR), GoK • Karnataka State Pollution Control Board (KSPCB), Water Resource Department (WRD), GoK • Department of Skill Development and Entrepreneurship and Livelihood (SDEL), GoK • Department of Electronics, Information Technology, Biotechnology, Science & Technology, GoK • Public Works Department, GoK • Department of Personnel and Administrative Reforms (DPAR (e-Governance))- Karnataka State Remote Sensing Applications Centre (KSRSAC) • Karnataka Fisheries Development Corporation (KFDC) Other Institutions • College of Fisheries, Mangaluru • Coastal Aquaculture Authority (CAA) • Central Institute of Brackishwater Aquaculture (CIBA) • Central Institute of Coastal Engineering for Fishery (CICEF) • Central Institute of Freshwater Aquaculture (CIFA) • Central Institute of Fisheries Education (CIFE) • Central Inland Fisheries Research Institute (CIFRI) • Central Institute of Fisheries Technology (CIFT) • Central Marine Fisheries Research Institute (CMFRI) • Centre for Research in Alternative Farming Technologies (CRAFT) • Fisheries Research & Information Centre (FRIC) • International Collective in Support of Fish workers (ICSF) • Marine Products Export Development Authority (MPEDA) • National Bank for Agriculture and Rural Development (NABARD) • National Centre for Sustainable Aquaculture (NaCSA) • National Institute of Fisheries Post Harvest Technology and Training (NIFPHATT) • National Fisheries Development Board (NFDB)

		• Network for Fish Quality Management and Sustainable Fishing (NETFISH) • National Remote Sensing Centre (NRSC) • Ornamental Fisheries Training and Research Institute (OFTRI) • Rajiv Gandhi Centre for Aquaculture (RGCA) • Space Applications Centre (SAC)-ISRO • NGOs
2	Blue Economy (Tourism) Task Force Committee	State Government Departments • Department of Tourism, GoK • Karnataka State Tourism Development Corporation (KSTDC), GoK • Forest Department, GoK • Department of Fisheries, GoK • Department of Transport, GoK • Karnataka State Pollution Control Board (KSPCB), GoK • Karnataka Ecotourism Board, GoK • Directorate of Employment & Training, GoK • Water Resource Department (WRD), GoK • Department of Horticulture, GoK • Department of Skill development, entrepreneurship and Livelihood Other Institutions • NGOs
3	Blue Economy (Pollution Control and Management) Task Force Committee	State Government Departments • Karnataka State Pollution Control Board (KSPCB), GoK • Department of Collegiate Education, GoK • Primary and Secondary Education Department, GoK • Department of Forest, Ecology and Environment, GoK • Urban Development Department (UDD), GoK • Rural Development and Panchayat Raj Department (RDPR), GoK • Department of Personnel and Administrative Reforms (DPAR (e-Governance))- Karnataka State Remote Sensing Applications Centre (KSRSAC), GoK • Department of Fisheries Other Institutions • Space Applications Centre (SAC)-ISRO • IFMFOEA • Indian Coast Guard
4	Blue Economy (Resource conservation and Waste Management) Task Force Committee	State Government Departments • Urban Development Department (UDD), GoK • Rural Development & Panchayat Raj Department (RDPR), GoK • Department of Personnel and Administrative Reforms (DPAR (e-Governance))- Karnataka State Remote Sensing Applications Centre (KSRSAC) • Karnataka State Pollution Control Board (KSPCB)
5	Blue Economy	State Government Departments

	(Conservation of priority ecological resources) Task Force Committee	• Department of Fisheries, GoK • Dept. of Mines and Geology, GoK • Karnataka State Police Department (Coastal Security Police Force (CSP)), GoK • Department of Ecology and Environment, GoK • Karnataka State Pollution Control Board (KSPCB) • Karnataka Biodiversity Board (KBB) • Department of Forests, GoK • Karnataka Power Corporation Ltd. (KPCL) • Water Resources Department (WRD) Other Institutions • Central Marine Fisheries Research Institute (CMFRI) • Zoological Survey of India (ZSI) • Wildlife Institute of India (WII) • Western Ghats Ecology Expert Panel (WGEEP) • College of Fisheries, Mangaluru (CoFM) • NGOs involved in Conservation of priority ecological resources
6	Blue Economy (Non-living blue resources) Task Force Committee	State Government Departments • Department of Energy, GoK • Department of Mines and Geology, GoK • Department of Electronics, IT BT and Science & Technology, GoK • Karnataka Renewable Energy Development Ltd. (KREL), GoK, Other Institutions • National Institute of Ocean Technology (NIOT) Salt Commissioner
7	Blue Economy (Marine Area Management) Task Force Committee	State Government Departments • Department of Ecology & Environment, GoK • Department of Infrastructure Development, Ports and Inland water Transport (ID, P&IWT), GoK • Department of Fisheries, GoK • Karnataka State Pollution Control Board (KSPCB), GoK • Public Works Department (PWD), GoK • Department of Tourism, GoK • Revenue Department (Disaster Management), GoK (DDMA- Dakshina Kannada, Udupi & Uttara Kannada) • Urban Development Department (UDD), GoK • Rural Development & Panchayat Raj Department (RDPR), GoK • Department of Personnel and Administrative Reforms (DPAR (e-Governance))- Karnataka State Remote Sensing Applications Centre (KSRSAC), GoK • Department of Fisheries, GoK Other Institutions • Ministry of Environment, Forest and Climate Change (MoEF&CC) • National Centre for Sustainable Coastal Management (NCSCM)

		• Space Applications Centre (SAC)-ISRO • National Institute of Advanced Studies (NIAS) • Local Fisheries Societies/Fisheries Unions • NGOs involved in conservation efforts and welfare of coastal communities • National Remote Sensing Centre (NRSC)
8	Blue Economy (Maritime Transport and Development) Task Force Committee	State Government Departments • Department of Infrastructure Development, Ports and Inland water transport (ID, P&IWT), GoK • Public Works Department (PWD), GoK • Department of Commerce and Industry, GoK Other Institutions • New Mangalore Port Trust (NMPT) South Western Railway (SWR)
9	Blue Economy (Disaster Management) Task Force Committee	State Government Departments • Karnataka State Disaster Management Authority (KSDMA) • District Disaster Management Authority (DDMA)

Table A 1: List of tentative responsible institutions for Task force committees

The **Blue Economy High Level Committee and the sub-committees** could meet six-monthly to review the implementation status of high priority recommendations, achievements, learnings, key outcomes to facilitate cross-learnings and initiate common programs. In addition, for each blue economy sector, a public grievance redressal mechanism (online/offline) needs to be set-up as it provides important feedback on the efficiency and effectiveness of a recommendation/scheme.

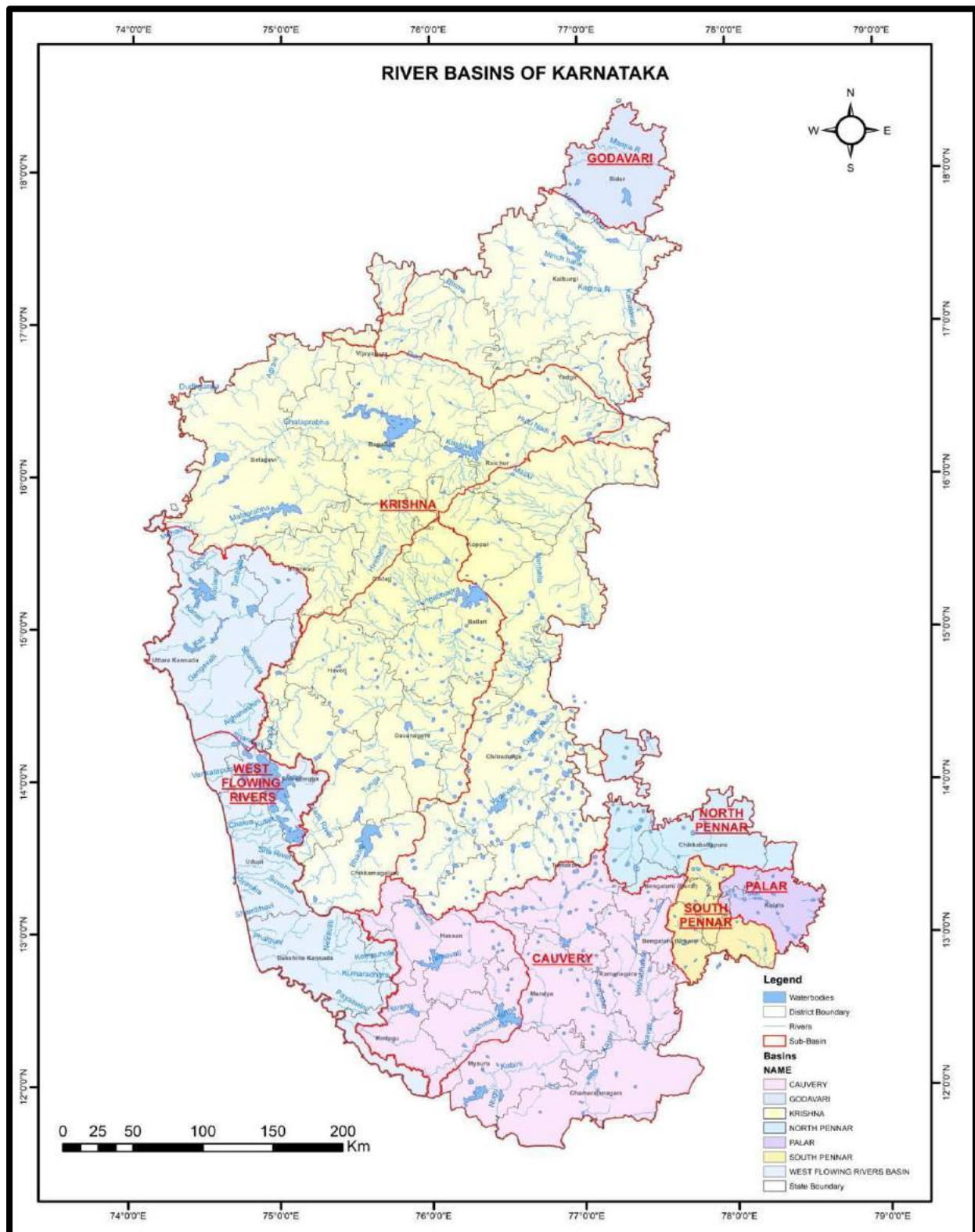
This will ensure a smooth streamlined approach for furthering blue economy growth in the state and maximizing the benefits from our blue economy resources effectively and efficiently with due cognizance to sustainability, inclusiveness and social equity.

ANNEXURES

DISTRICT WISE WATER RESOURCES OF KARNATAKA**River Basins of Karnataka**

Sl. No	River Basins	Drainage Area (sq.km)
1	Godavari	4,410
2	Krishna	1,13,290
3	Cauvery	34,270
4	North Pennar	6,940
5	South Pennar	4,370
6	Palar	2,970
7	West Flowing Rivers	24,250
	Total	1,90,500

KARNATAKA RIVER SYSTEM

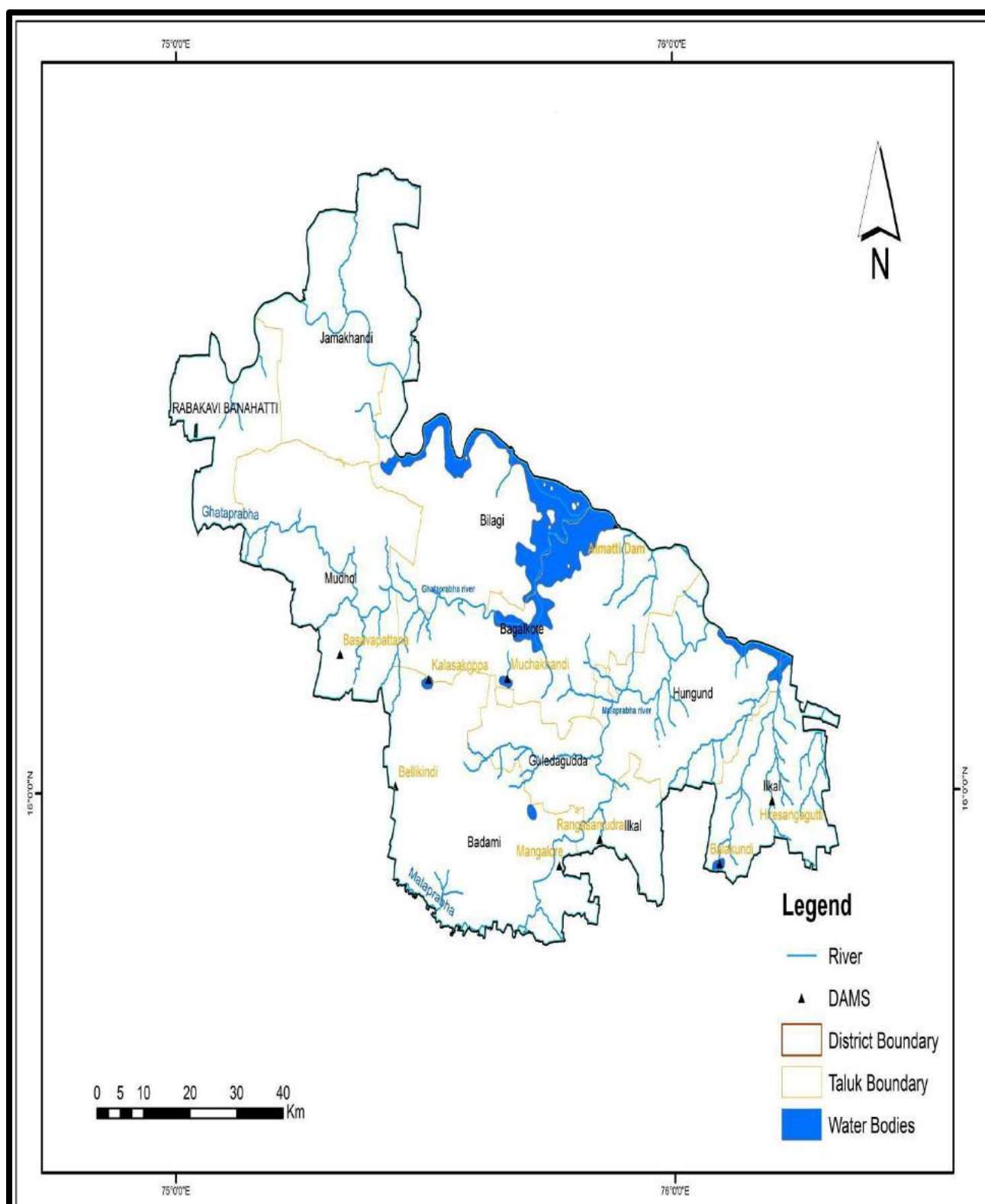


BAGALKOTE DISTRICT DETAILS

Sr No	Name	Description
1	District	Bagalkot
2	State	KA
3	Area in SqKms	6583
4	Population	1889752
5	Growth Rate	14.4
6	Sex Ratio	989
7	Literacy	68.82
8	Density	288
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	8
10.2	Barrage (in Nos)	1
10.3	Lift (in Nos)	5
10.4	Power House (in Nos)	1
10.5	Water Bodies (in Nos)	541
10.6	Water Bodies Area(in ha)	42207.45082
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	46231
1	Dugwells (in Nos)	3350
2	Shallow Tubewells (in Nos)	39077
3	Deep Tubewells (in Nos)	3804
11.2	Surface Water Schemes	16193
1	Surface Flow (in Nos)	4245
2	Surface Lift (in Nos)	11948
11.3	Water Distribution Devices	62411
1	Open Water Channel (in Nos)	13803
2	Underground Pipe (in Nos)	45006
3	Surface Pipe (in Nos)	1298
4	Drip (in Nos)	597
5	Sprinkler (in Nos)	1677
6	Others (in Nos)	30
11.4	Culturable Command Area(in ha)	143139.8
11.5	Irrigation Potential Created(in ha)	170483.04
11.6	Irrigation Potential Utilized(in ha)	163009.72

Source of Data COI, CGWB, CWC, Data State Agency

BAGALKOTE DISTRICT WATER BODIES

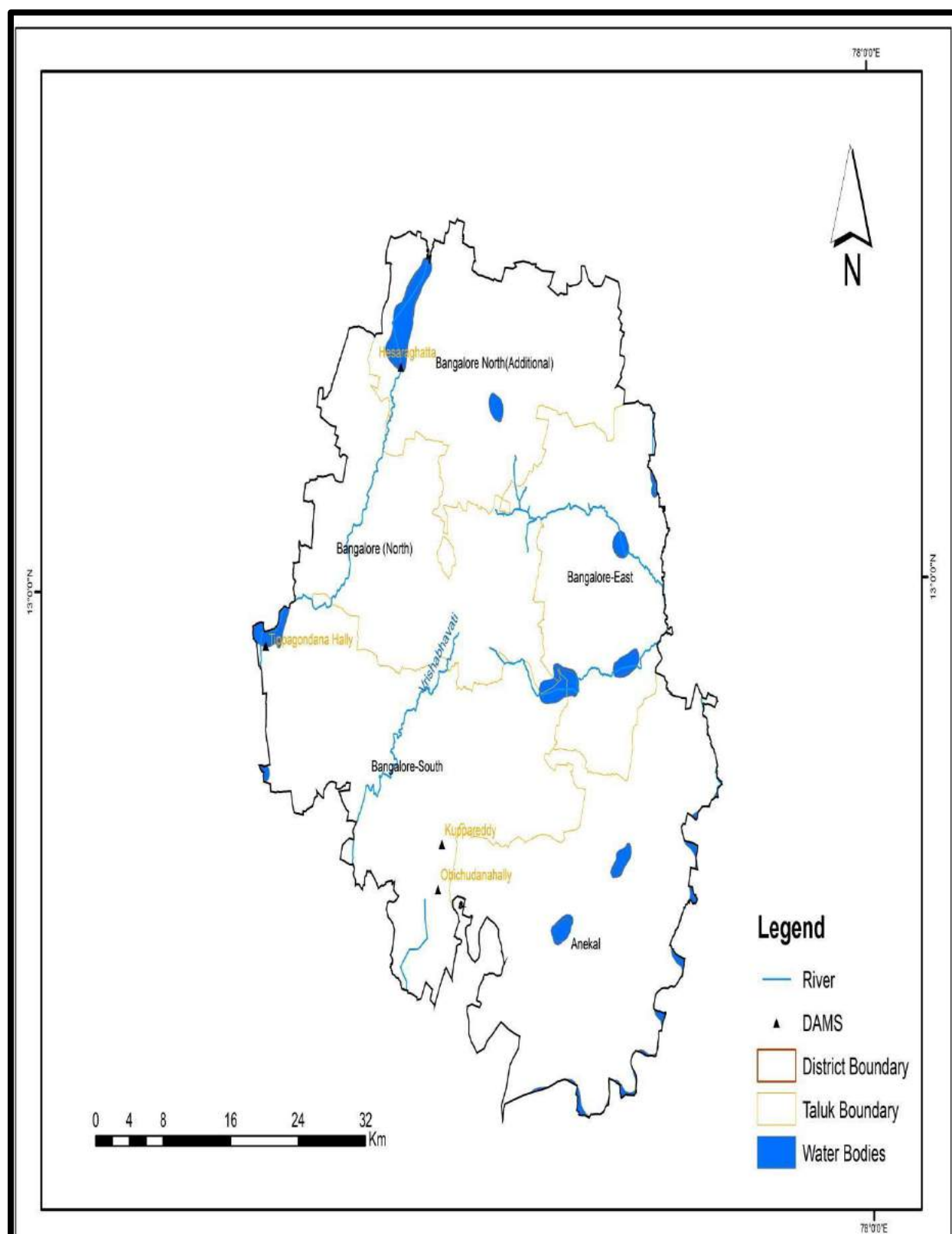


BENGALURU DISTRICT DETAILS

Sr No	Name	Description
1	District	Bangalore
2	State	KA
3	Area in SqKms	2190
4	Population	9621551
5	Growth Rate	47.18
6	Sex Ratio	916
7	Literacy	87.67
8	Density	4378
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	4
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	null
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	1052
10.6	Water Bodies Area(in ha)	9534.844023
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	11323
1	Dugwells (in Nos)	2574
2	Shallow Tubewells (in Nos)	8749
3	Deep Tubewells (in Nos)	0
11.2	Surface Water Schemes	825
1	Surface Flow (in Nos)	821
2	Surface Lift (in Nos)	4
11.3	Water Distribution Devices	12061
1	Open Water Channel (in Nos)	3167
2	Underground Pipe (in Nos)	7873
3	Surface Pipe (in Nos)	72
4	Drip (in Nos)	920
5	Sprinkler (in Nos)	19
6	Others (in Nos)	10
11.4	Culturable Command Area(in ha)	13818.35
11.5	Irrigation Potential Created(in ha)	15612.25
11.6	Irrigation Potential Utilized(in ha)	15385.98

Source of Data COI, CGWB, CWC, Data State Agency

BENGALURU DISTRICT WATER BODIES

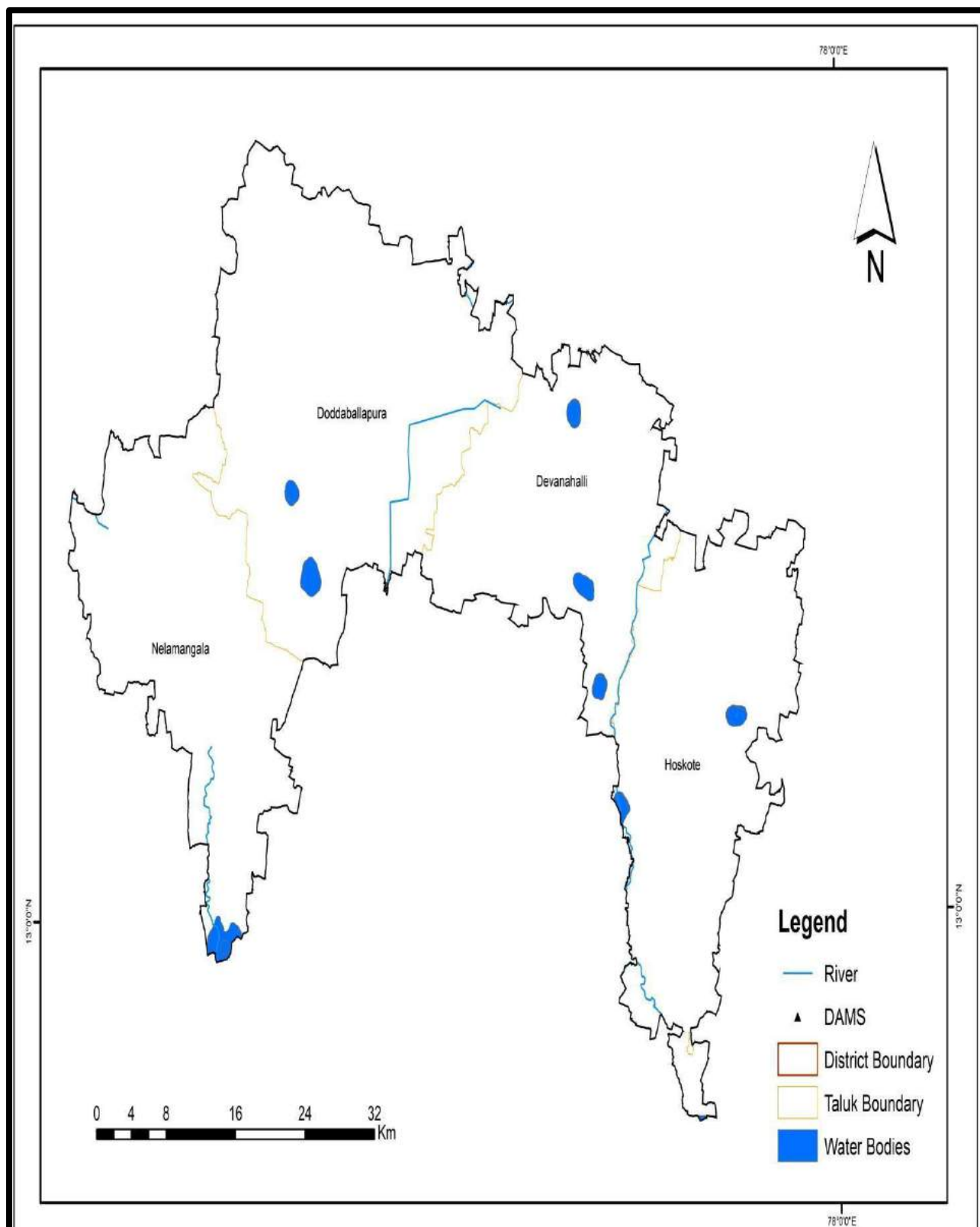


BENGALURU RURAL DISTRICT DETAILS

Sr No	Name	Description
1	District	Bangalore Rural
2	State	KA
3	Area in SqKms	2239
4	Population	990923
5	Growth Rate	16.45
6	Sex Ratio	946
7	Literacy	77.93
8	Density	441
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	null
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	null
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	762
10.6	Water Bodies Area(in ha)	8866.141627
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	19181
1	Dugwells (in Nos)	691
2	Shallow Tubewells (in Nos)	13791
3	Deep Tubewells (in Nos)	4699
11.2	Surface Water Schemes	936
1	Surface Flow (in Nos)	912
2	Surface Lift (in Nos)	24
11.3	Water Distribution Devices	19326
1	Open Water Channel (in Nos)	3388
2	Underground Pipe (in Nos)	6095
3	Surface Pipe (in Nos)	1452
4	Drip (in Nos)	5771
5	Sprinkler (in Nos)	355
6	Others (in Nos)	2265
11.4	Culturable Command Area(in ha)	22440.9
11.5	Irrigation Potential Created(in ha)	25515.16
11.6	Irrigation Potential Utilized(in ha)	24570.45

Source of Data COI, CGWB, CWC, Data State Agency

BENGALURU RURAL WATER BODIES



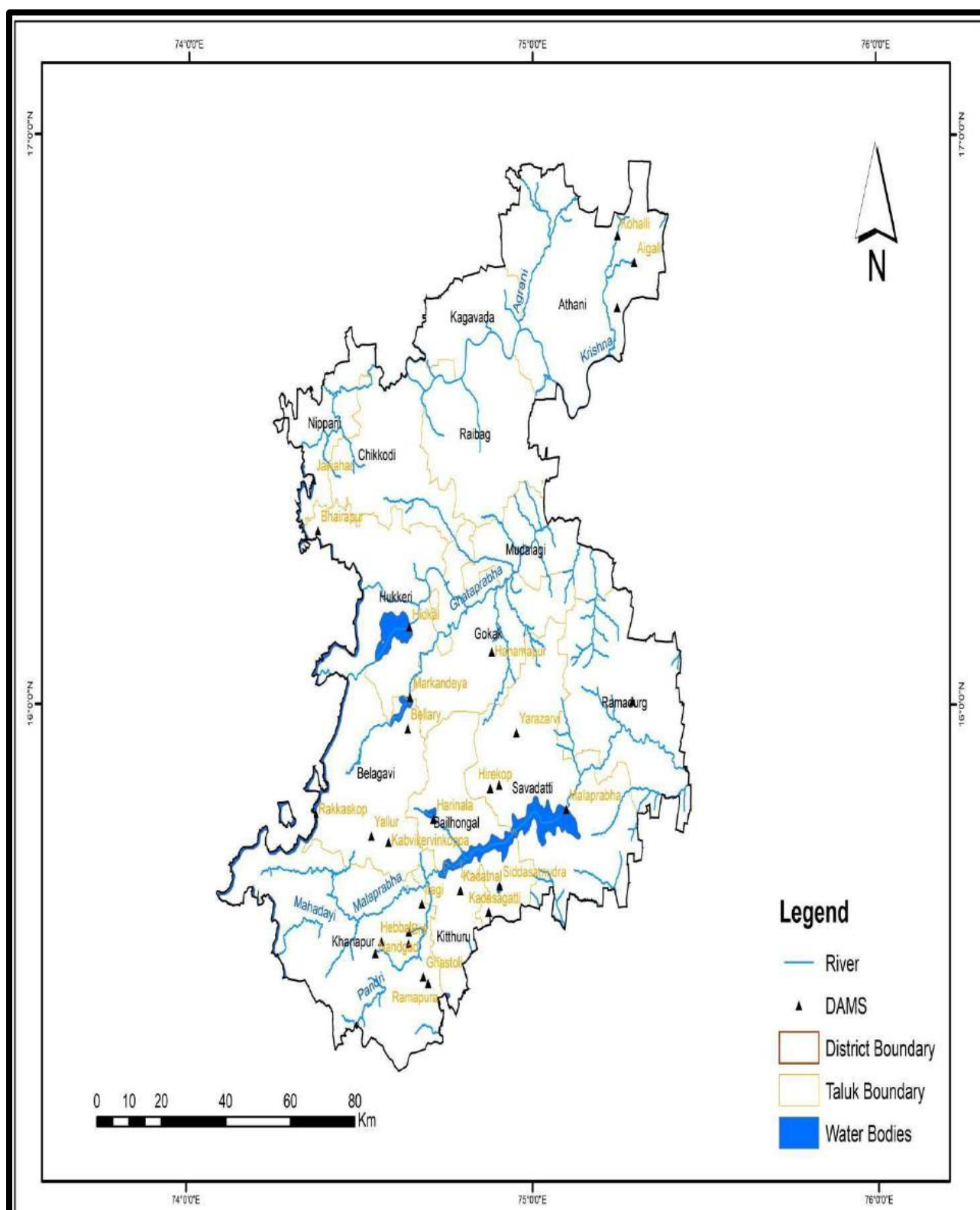
BELAGAVI DISTRICT DETAILS

Sr No	Name	Description
1	District	Belgaum
2	State	KA
3	Area in SqKms	13415
4	Population	4779661
5	Growth Rate	13.41
6	Sex Ratio	973
7	Literacy	73.48
8	Density	356
9	Seismic Zone	Seismic Zone-II & III
10	Water Resources	
10.1	Dams (in Nos)	28
10.2	Barrage (in Nos)	2
10.3	Lift (in Nos)	24
10.4	Power House (in Nos)	1
10.5	Water Bodies (in Nos)	1505
10.6	Water Bodies Area(in ha)	22011.63035
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	126862
1	Dugwells (in Nos)	49178
2	Shallow Tubewells (in Nos)	70028
3	Deep Tubewells (in Nos)	7656
11.2	Surface Water Schemes	19505
1	Surface Flow (in Nos)	6794
2	Surface Lift (in Nos)	12711
11.3	Water Distribution Devices	145021
1	Open Water Channel (in Nos)	29990
2	Underground Pipe (in Nos)	100099
3	Surface Pipe (in Nos)	9965
4	Drip (in Nos)	1620
5	Sprinkler (in Nos)	923
6	Others (in Nos)	2424
11.4	Culturable Command Area(in ha)	321132.47
11.5	Irrigation Potential Created(in ha)	352886.38
11.6	Irrigation Potential Utilized(in ha)	338773.98

Source of Data COI, CGWB, CWC, Data State Agency

Note: On 1 November 2014, the district Belgaum was renamed as Belagavi by the Karnataka Government.

BELAGAVI DISTRICT WATER BODIES

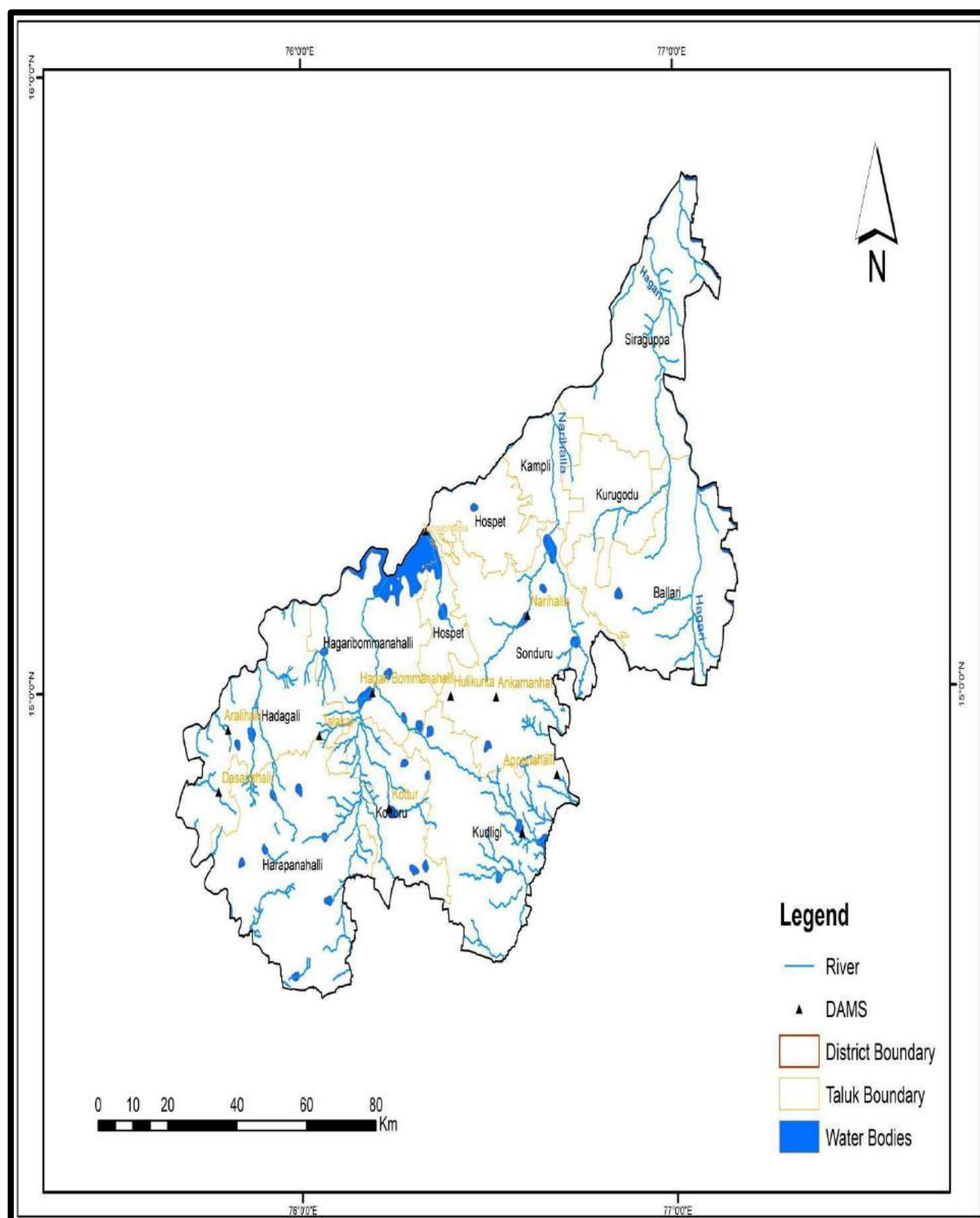


BALLARI DISTRICT DETAILS

Sr No	Name	Description
1	District	Bellary
2	State	KA
3	Area in SqKms	8439
4	Population	2452595
5	Growth Rate	20.99
6	Sex Ratio	983
7	Literacy	67.43
8	Density	300
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	10
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	3
10.4	Power House (in Nos)	2
10.5	Water Bodies (in Nos)	1189
10.6	Water Bodies Area(in ha)	12126.49697
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	27894
1	Dugwells (in Nos)	1256
2	Shallow Tubewells (in Nos)	22560
3	Deep Tubewells (in Nos)	4078
11.2	Surface Water Schemes	6099
1	Surface Flow (in Nos)	2102
2	Surface Lift (in Nos)	3997
11.3	Water Distribution Devices	33111
1	Open Water Channel (in Nos)	5944
2	Underground Pipe (in Nos)	24774
3	Surface Pipe (in Nos)	1796
4	Drip (in Nos)	224
5	Sprinkler (in Nos)	8
6	Others (in Nos)	365
11.4	Culturable Command Area(in ha)	134783.3
11.5	Irrigation Potential Created(in ha)	166390.31
11.6	Irrigation Potential Utilized(in ha)	143277.27

Source of Data COI, CGWB, CWC, Data State Agency

BALLARI DISTRICT WATER BODIES

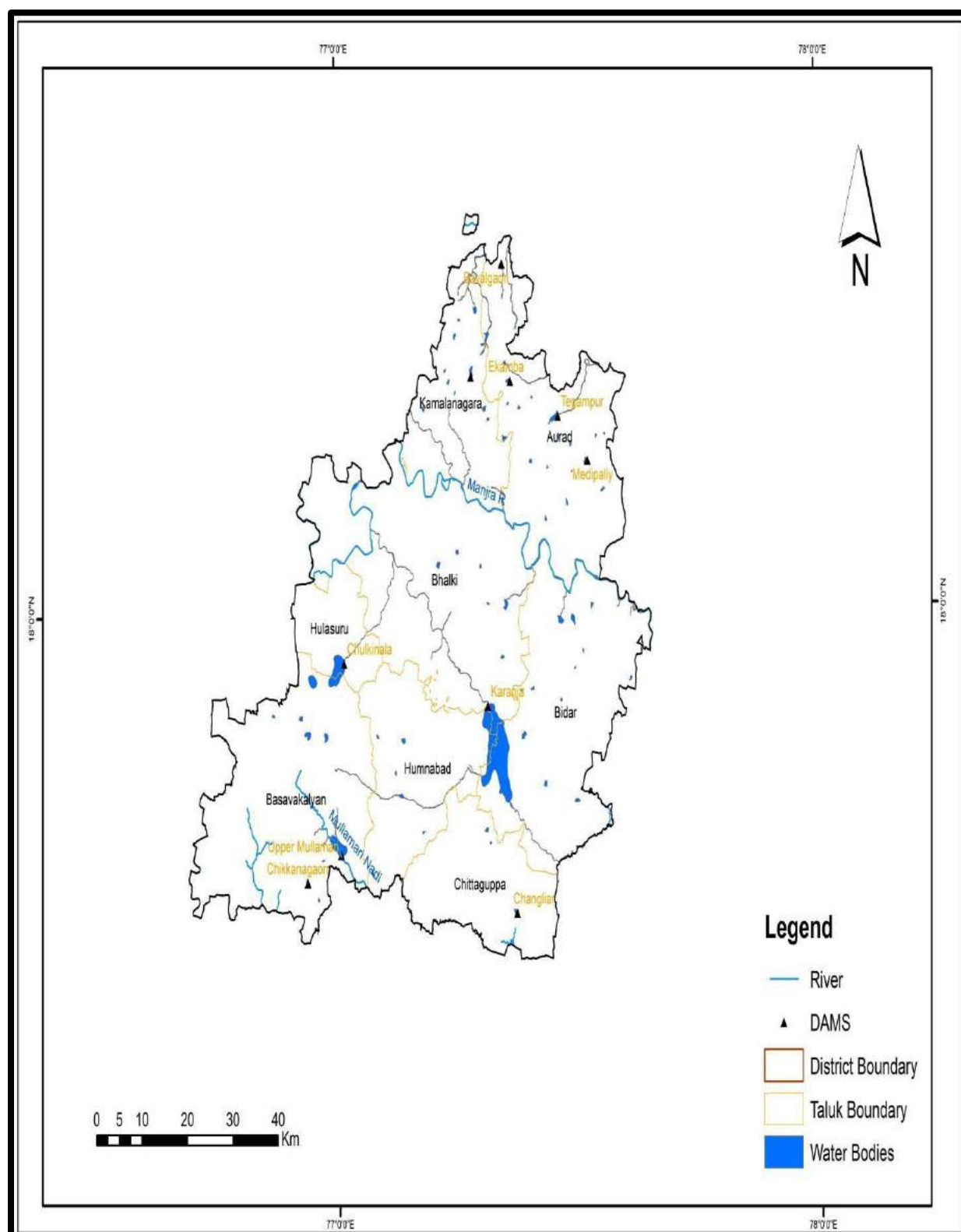


BIDAR DISTRICT DETAILS

Sr No	Name	Description
1	District	Bidar
2	State	KA
3	Area in SqKms	5448
4	Population	1703300
5	Growth Rate	13.37
6	Sex Ratio	956
7	Literacy	70.51
8	Density	312
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	10
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	1
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	288
10.6	Water Bodies Area(in ha)	6590.525308
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	37469
1	Dugwells (in Nos)	17504
2	Shallow Tubewells (in Nos)	19965
3	Deep Tubewells (in Nos)	0
11.2	Surface Water Schemes	2455
1	Surface Flow (in Nos)	798
2	Surface Lift (in Nos)	1657
11.3	Water Distribution Devices	39012
1	Open Water Channel (in Nos)	10330
2	Underground Pipe (in Nos)	22498
3	Surface Pipe (in Nos)	5005
4	Drip (in Nos)	219
5	Sprinkler (in Nos)	128
6	Others (in Nos)	832
11.4	Culturable Command Area(in ha)	73815.54
11.5	Irrigation Potential Created(in ha)	54969.21
11.6	Irrigation Potential Utilized(in ha)	51553.44

Source of Data COI, CGWB, CWC, Data State Agency

BIDAR DISTRICT WATER BODIES



CHAMARAJANAGAR DISTRICT DETAILS

Sr No	Name	Description
1	District	Chamarajanagar
2	State	KA
3	Area in SqKms	5102
4	Population	1020791
5	Growth Rate	5.73
6	Sex Ratio	993
7	Literacy	61.43
8	Density	200
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	13
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	null
10.4	Power House (in Nos)	1
10.5	Water Bodies (in Nos)	858
10.6	Water Bodies Area(in ha)	6616.420378
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	35067
1	Dugwells (in Nos)	1429
2	Shallow Tubewells (in Nos)	26823
3	Deep Tubewells (in Nos)	6815
11.2	Surface Water Schemes	162
1	Surface Flow (in Nos)	160
2	Surface Lift (in Nos)	2
11.3	Water Distribution Devices	34348
1	Open Water Channel (in Nos)	10944
2	Underground Pipe (in Nos)	12437
3	Surface Pipe (in Nos)	3471
4	Drip (in Nos)	5065
5	Sprinkler (in Nos)	204
6	Others (in Nos)	2227
11.4	Culturable Command Area(in ha)	63287.13
11.5	Irrigation Potential Created(in ha)	65348.04
11.6	Irrigation Potential Utilized(in ha)	65001.61

Source of Data COI, CGWB, CWC, Data State Agency

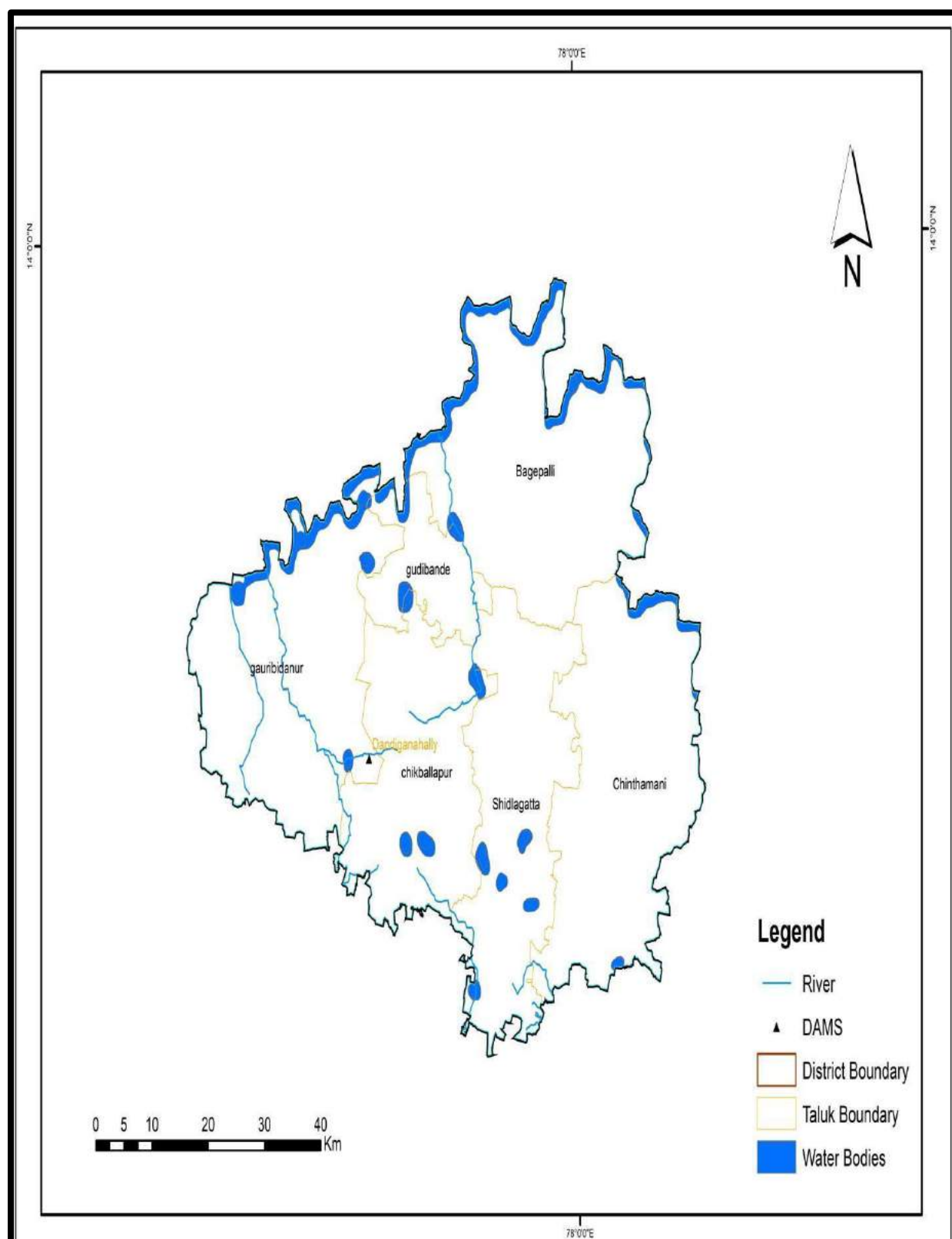


CHIKKABALLAPUR DISTRICT DETAILS

Sr No	Name	Description
1	District	Chikkaballapura
2	State	KA
3	Area in SqKms	4208
4	Population	1255104
5	Growth Rate	9.23
6	Sex Ratio	972
7	Literacy	69.76
8	Density	298
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	1
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	null
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	2280
10.6	Water Bodies Area(in ha)	18134.46292
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	41115
1	Dugwells (in Nos)	3403
2	Shallow Tubewells (in Nos)	33307
3	Deep Tubewells (in Nos)	4405
11.2	Surface Water Schemes	2017
1	Surface Flow (in Nos)	1520
2	Surface Lift (in Nos)	497
11.3	Water Distribution Devices	34996
1	Open Water Channel (in Nos)	6467
2	Underground Pipe (in Nos)	15555
3	Surface Pipe (in Nos)	823
4	Drip (in Nos)	10317
5	Sprinkler (in Nos)	173
6	Others (in Nos)	1661
11.4	Culturable Command Area(in ha)	96129.64
11.5	Irrigation Potential Created(in ha)	78599.34
11.6	Irrigation Potential Utilized(in ha)	77052.5

Source of Data COI, CGWB, CWC, Data State Agency

CHIKKABALLAPUR DISTRICT WATER BODIES

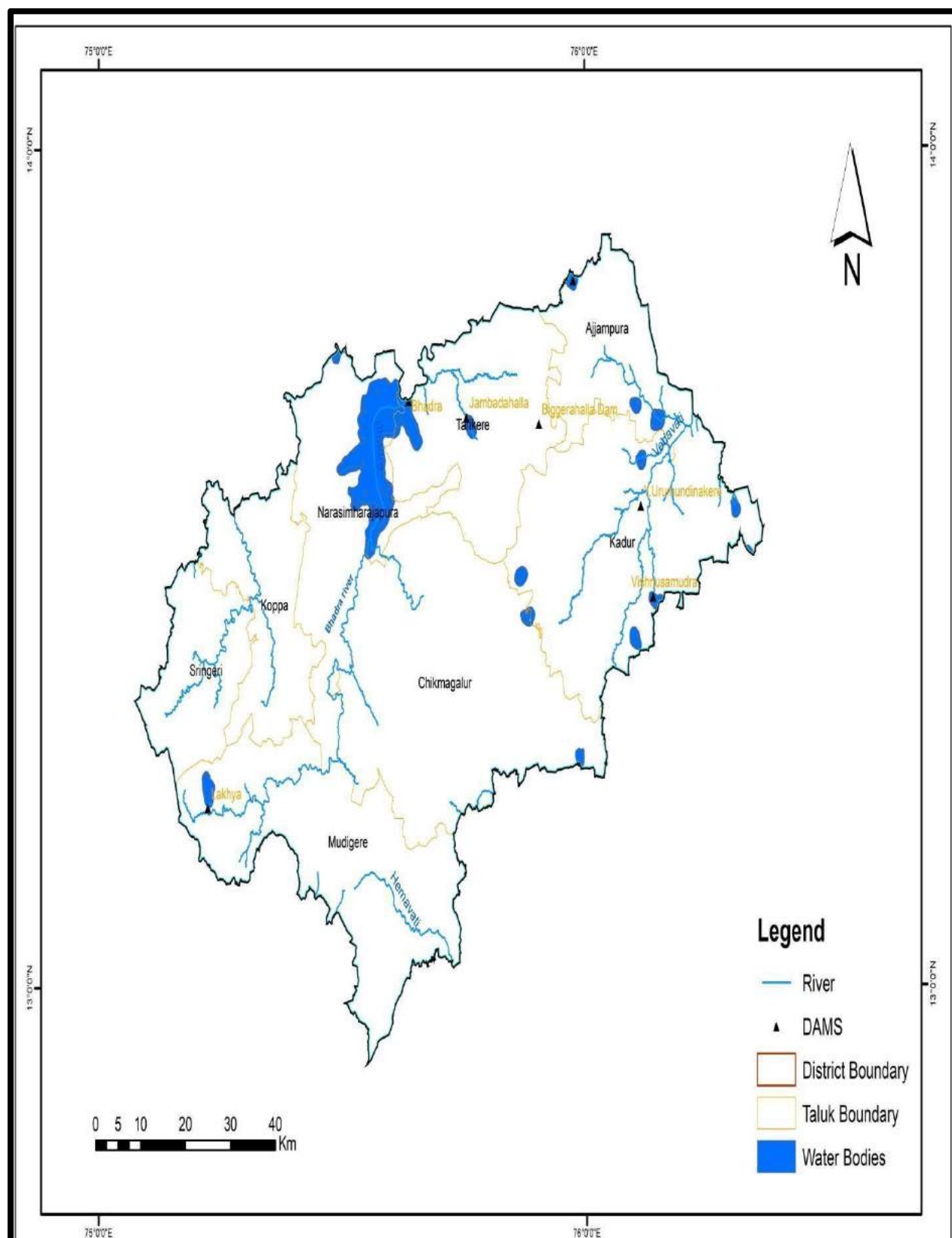


CHIKKAMAGALURU DISTRICT DETAILS

Sr No	Name	Description
1	District	Chikmagalur
2	State	KA
3	Area in SqKms	7201
4	Population	1137961
5	Growth Rate	-0.26
6	Sex Ratio	1008
7	Literacy	79.25
8	Density	158
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	7
10.2	Barrage (in Nos)	1
10.3	Lift (in Nos)	null
10.4	Power House (in Nos)	1
10.5	Water Bodies (in Nos)	1608
10.6	Water Bodies Area(in ha)	19463.48177
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	32300
1	Dugwells (in Nos)	880
2	Shallow Tubewells (in Nos)	27113
3	Deep Tubewells (in Nos)	4307
11.2	Surface Water Schemes	6914
1	Surface Flow (in Nos)	3518
2	Surface Lift (in Nos)	3396
11.3	Water Distribution Devices	38715
1	Open Water Channel (in Nos)	5149
2	Underground Pipe (in Nos)	16154
3	Surface Pipe (in Nos)	6559
4	Drip (in Nos)	4941
5	Sprinkler (in Nos)	2956
6	Others (in Nos)	2956
11.4	Culturable Command Area(in ha)	120226.84
11.5	Irrigation Potential Created(in ha)	118070.88
11.6	Irrigation Potential Utilized(in ha)	117714.6

Source of Data COI, CGWB, CWC, Data State Agency

CHIKKAMAGALURU DISTRICT WATER BODIES

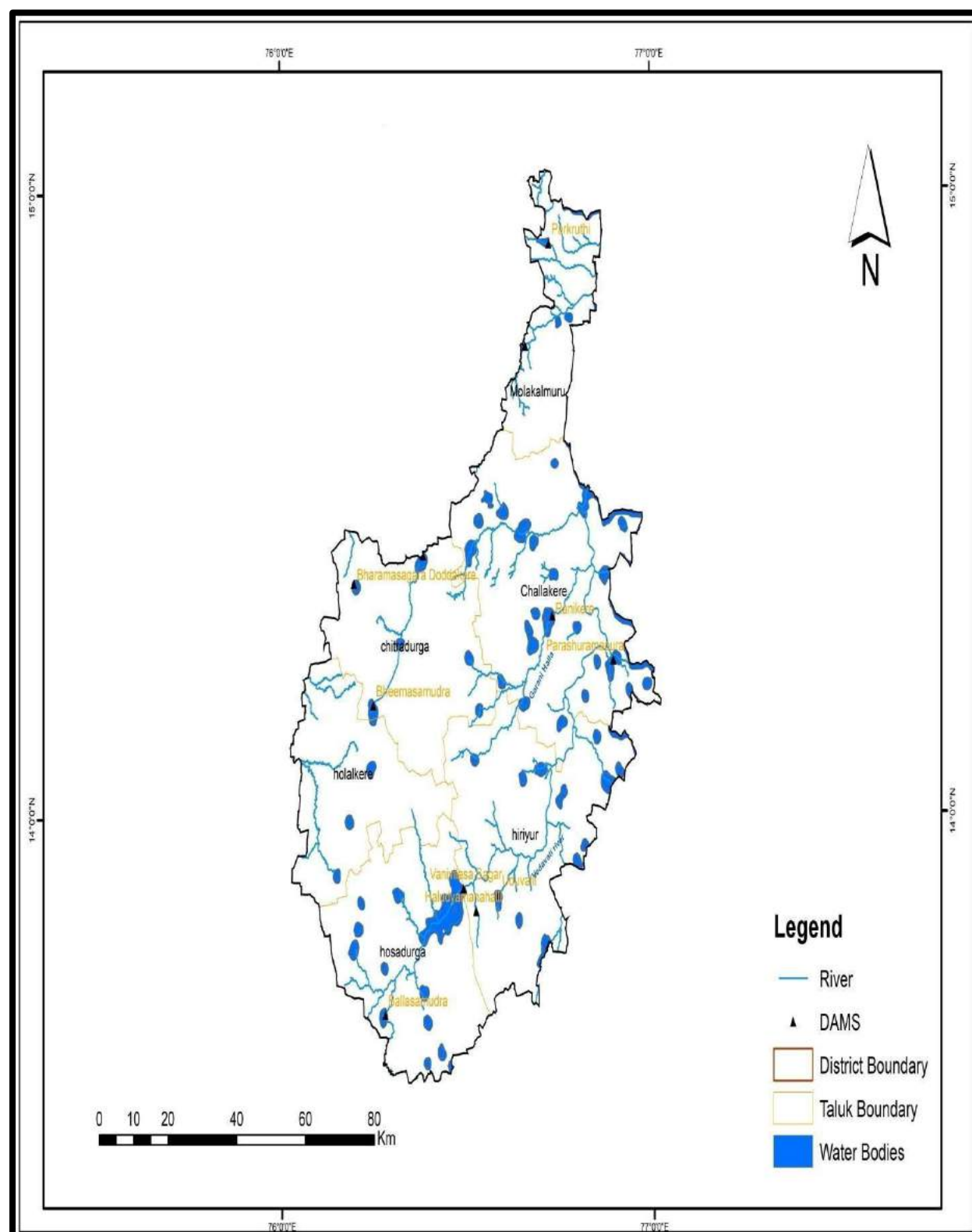


CHITRADURGA DISTRICT DETAILS

Sr No	Name	Description
1	District	Chitradurga
2	State	KA
3	Area in SqKms	8437
4	Population	1659456
5	Growth Rate	9.33
6	Sex Ratio	974
7	Literacy	73.71
8	Density	197
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	11
10.2	Barrage (in Nos)	1
10.3	Lift (in Nos)	null
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	1392
10.6	Water Bodies Area(in ha)	29829.01228
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	71856
1	Dugwells (in Nos)	10912
2	Shallow Tubewells (in Nos)	25099
3	Deep Tubewells (in Nos)	35845
11.2	Surface Water Schemes	398
1	Surface Flow (in Nos)	374
2	Surface Lift (in Nos)	24
11.3	Water Distribution Devices	71847
1	Open Water Channel (in Nos)	10935
2	Underground Pipe (in Nos)	39084
3	Surface Pipe (in Nos)	4457
4	Drip (in Nos)	15450
5	Sprinkler (in Nos)	320
6	Others (in Nos)	1601
11.4	Culturable Command Area(in ha)	126492.36
11.5	Irrigation Potential Created(in ha)	116103.16
11.6	Irrigation Potential Utilized(in ha)	112543.79

Source of Data COI, CGWB, CWC, Data State Agency

CHITRADURGA DISTRICT WATER BODIES

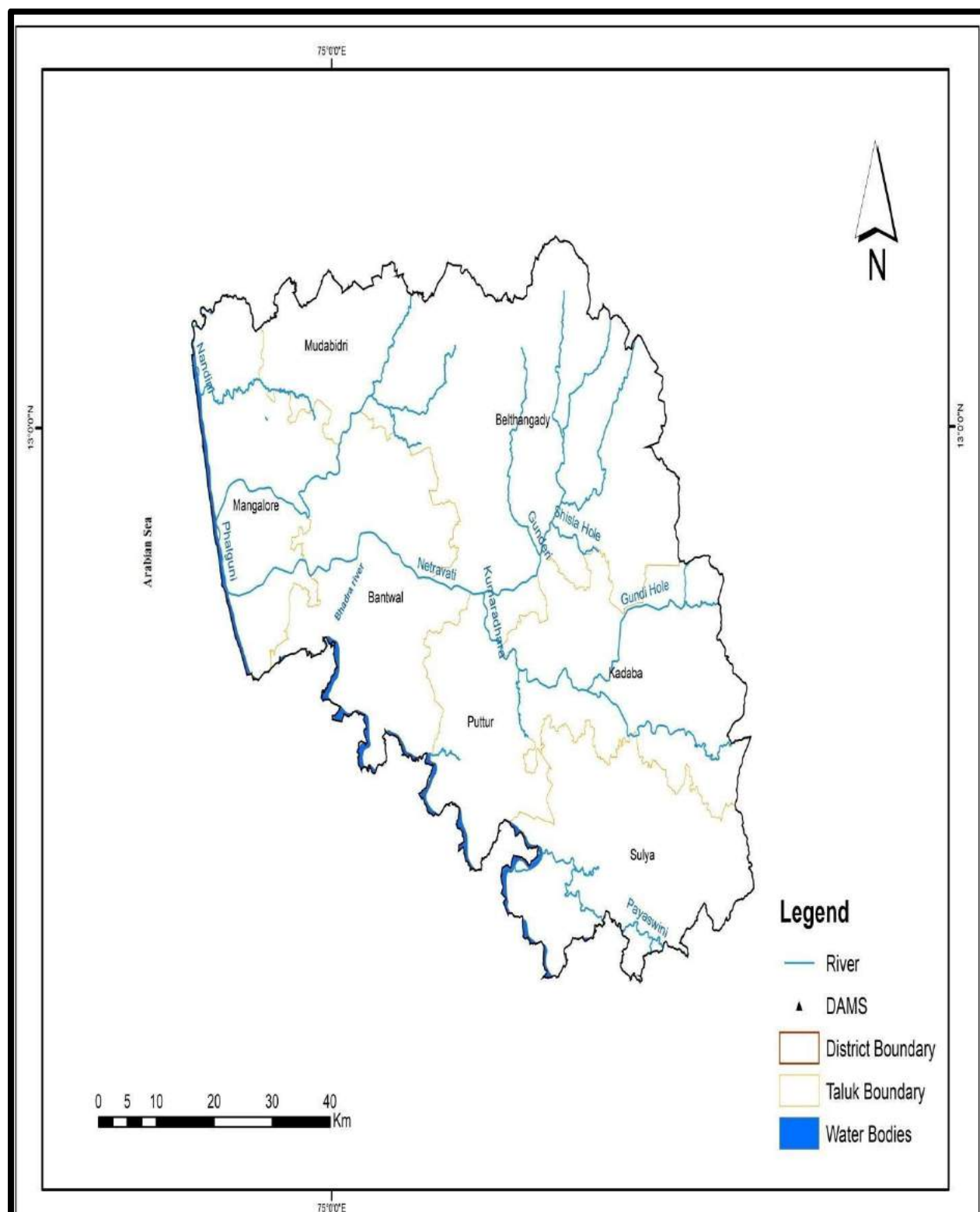


DAKSHINA KANNADA DISTRICT DETAILS

Sr No	Name	Description
1	District	Dakshina Kannada
2	State	KA
3	Area in SqKms	4559
4	Population	2089649
5	Growth Rate	10.11
6	Sex Ratio	1020
7	Literacy	88.57
8	Density	457
9	Seismic Zone	Seismic Zone-II & III
10	Water Resources	
10.1	Dams (in Nos)	null
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	null
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	88
10.6	Water Bodies Area(in ha)	118.2905811
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	32327
1	Dugwells (in Nos)	17991
2	Shallow Tubewells (in Nos)	14336
3	Deep Tubewells (in Nos)	0
11.2	Surface Water Schemes	1814
1	Surface Flow (in Nos)	1517
2	Surface Lift (in Nos)	297
11.3	Water Distribution Devices	33977
1	Open Water Channel (in Nos)	6744
2	Underground Pipe (in Nos)	6191
3	Surface Pipe (in Nos)	5122
4	Drip (in Nos)	8416
5	Sprinkler (in Nos)	7293
6	Others (in Nos)	211
11.4	Culturable Command Area(in ha)	98158.94
11.5	Irrigation Potential Created(in ha)	216151.76
11.6	Irrigation Potential Utilized(in ha)	214731.99

Source of Data COI, CGWB, CWC, Data State Agency

DAKSHINA KANNADA DISTRICT WATER BODIES



DAVANAGERE DISTRICT DETAILS

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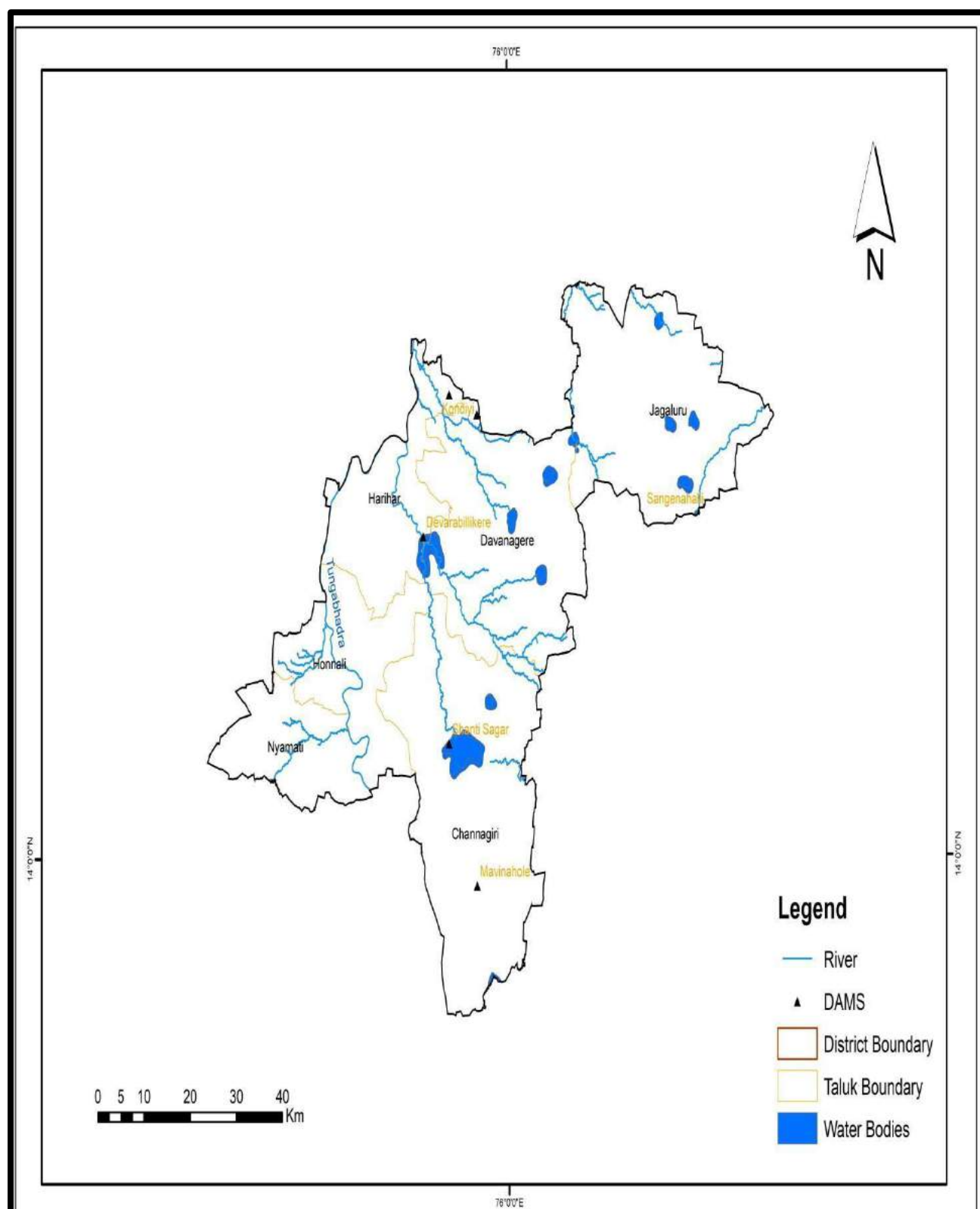
Davanagere

Sr No	Name	Description
1	District	Davanagere
2	State	KA
3	Area in SqKms	5926
4	Population	1945497
5	Growth Rate	8.63
6	Sex Ratio	972
7	Literacy	75.74
8	Density	329
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	7
10.2	Barrage (in Nos)	4
10.3	Lift (in Nos)	null
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	1043
10.6	Water Bodies Area(in ha)	12978.79794
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	59174
1	Dugwells (in Nos)	648
2	Shallow Tubewells (in Nos)	47110
3	Deep Tubewells (in Nos)	11416
11.2	Surface Water Schemes	7646
1	Surface Flow (in Nos)	3759
2	Surface Lift (in Nos)	3887
11.3	Water Distribution Devices	65464
1	Open Water Channel (in Nos)	11486
2	Underground Pipe (in Nos)	34759
3	Surface Pipe (in Nos)	4767
4	Drip (in Nos)	13653
5	Sprinkler (in Nos)	114
6	Others (in Nos)	685
11.4	Culturable Command Area(in ha)	143513.58
11.5	Irrigation Potential Created(in ha)	133301.67
11.6	Irrigation Potential Utilized(in ha)	122692.96

Source of Data COI, CGWB, CWC, Data State Agency

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DAVANAGERE DISTRICT WATER BODIES

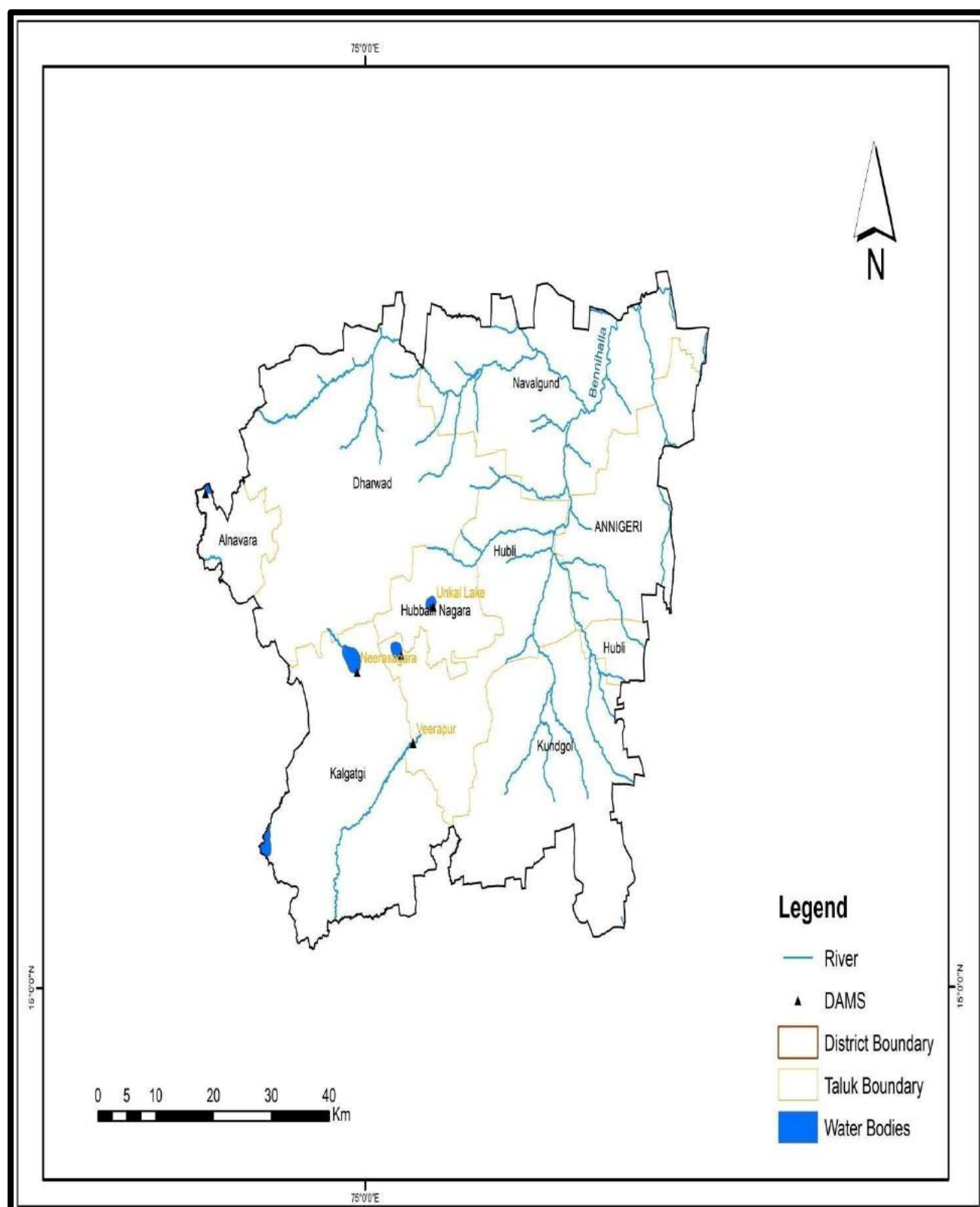


DHARWAD DISTRICT DETAILS

Sr No	Name	Description
1	District	Dharwad
2	State	KA
3	Area in SqKms	4265
4	Population	1847023
5	Growth Rate	15.13
6	Sex Ratio	971
7	Literacy	80
8	Density	434
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	6
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	null
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	1085
10.6	Water Bodies Area(in ha)	3399.374265
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	14165
1	Dugwells (in Nos)	127
2	Shallow Tubewells (in Nos)	14038
3	Deep Tubewells (in Nos)	0
11.2	Surface Water Schemes	2037
1	Surface Flow (in Nos)	1163
2	Surface Lift (in Nos)	874
11.3	Water Distribution Devices	16195
1	Open Water Channel (in Nos)	3977
2	Underground Pipe (in Nos)	10838
3	Surface Pipe (in Nos)	755
4	Drip (in Nos)	4
5	Sprinkler (in Nos)	620
6	Others (in Nos)	1
11.4	Culturable Command Area(in ha)	63125.49
11.5	Irrigation Potential Created(in ha)	63711.12
11.6	Irrigation Potential Utilized(in ha)	63431.15

Source of Data COI, CGWB, CWC, Data State Agency

DHARWAD DISTRICT WATER BODIES

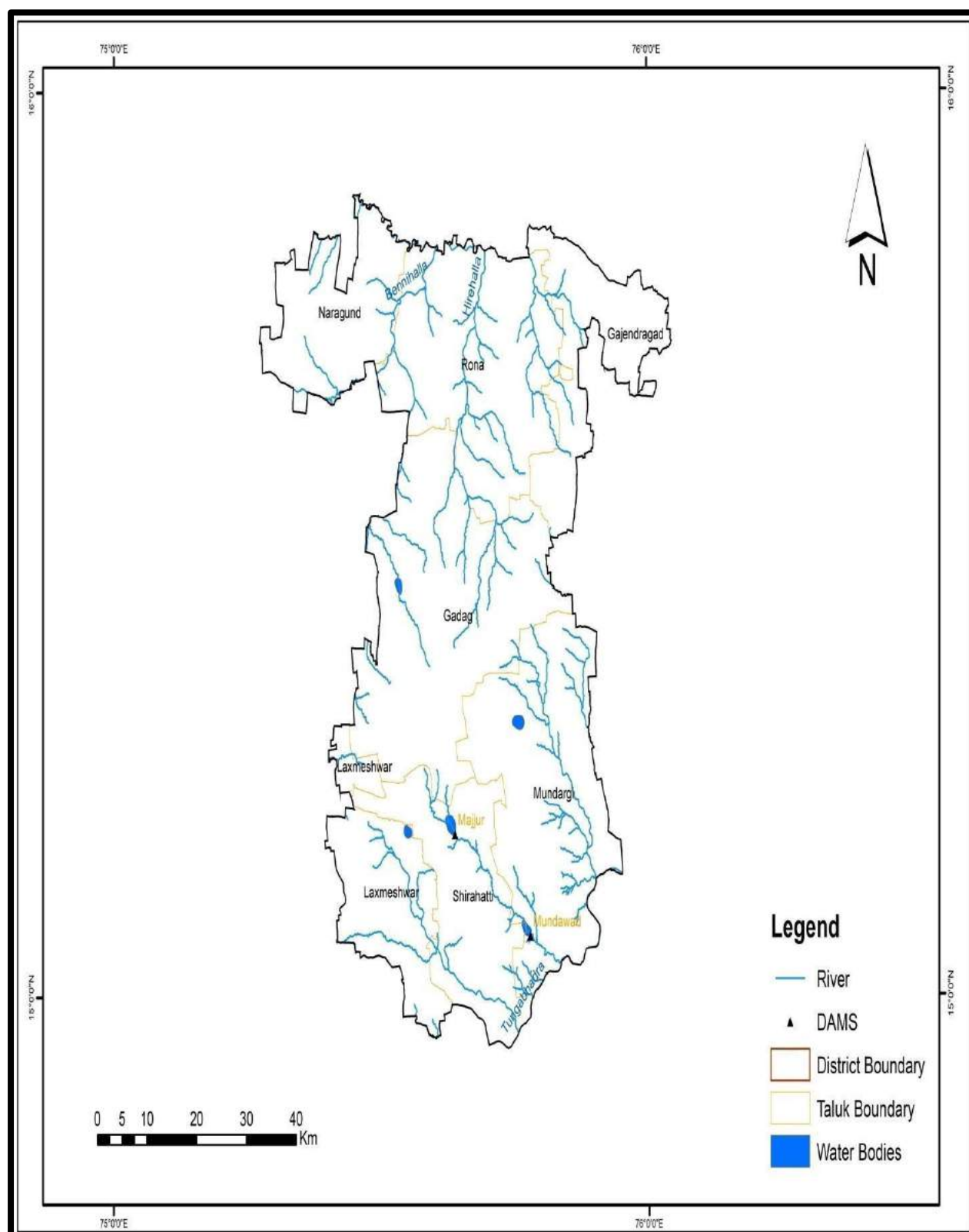


GADAG DISTRICT DETAILS

Sr No	Name	Description
1	District	Gadag
2	State	KA
3	Area in SqKms	4651
4	Population	1064570
5	Growth Rate	9.54
6	Sex Ratio	982
7	Literacy	75.12
8	Density	229
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	2
10.2	Barrage (in Nos)	1
10.3	Lift (in Nos)	13
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	657
10.6	Water Bodies Area(in ha)	1852.704782
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	14696
1	Dugwells (in Nos)	1111
2	Shallow Tubewells (in Nos)	9341
3	Deep Tubewells (in Nos)	4244
11.2	Surface Water Schemes	2756
1	Surface Flow (in Nos)	1809
2	Surface Lift (in Nos)	947
11.3	Water Distribution Devices	17272
1	Open Water Channel (in Nos)	3458
2	Underground Pipe (in Nos)	11362
3	Surface Pipe (in Nos)	1695
4	Drip (in Nos)	166
5	Sprinkler (in Nos)	568
6	Others (in Nos)	23
11.4	Culturable Command Area(in ha)	45083.98
11.5	Irrigation Potential Created(in ha)	63201.53
11.6	Irrigation Potential Utilized(in ha)	61303.98

Source of Data COI, CGWB, CWC, Data State Agency

GADAG DISTRICT WATER BODIES

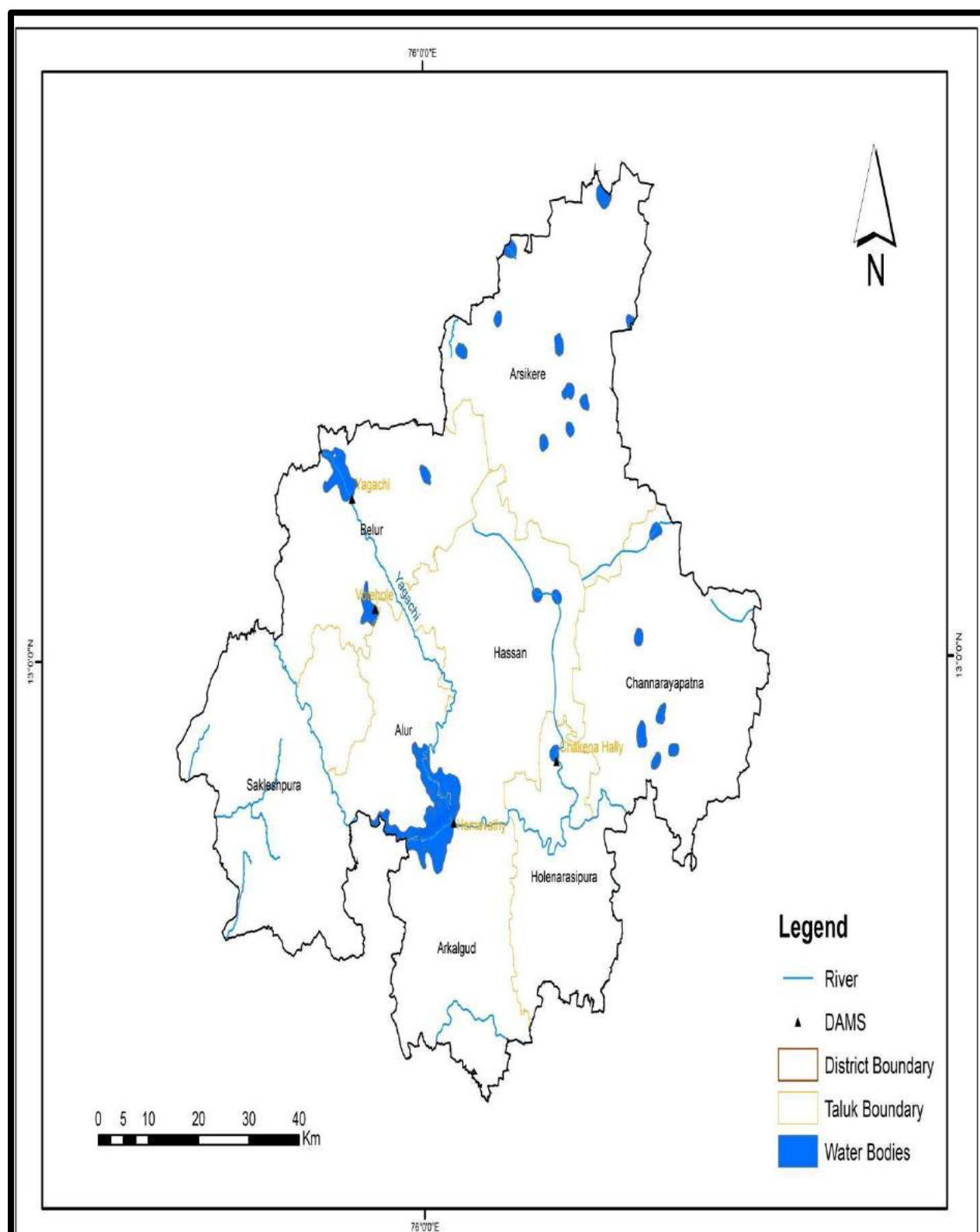


HASSAN DISTRICT DETAILS

Sr No	Name	Description
1	District	Hassan
2	State	KA
3	Area in SqKms	6814
4	Population	1776421
5	Growth Rate	3.18
6	Sex Ratio	1010
7	Literacy	76.07
8	Density	261
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	4
10.2	Barrage (in Nos)	3
10.3	Lift (in Nos)	8
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	6502
10.6	Water Bodies Area(in ha)	28863.23604
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	66494
1	Dugwells (in Nos)	2465
2	Shallow Tubewells (in Nos)	60895
3	Deep Tubewells (in Nos)	3134
11.2	Surface Water Schemes	7913
1	Surface Flow (in Nos)	5677
2	Surface Lift (in Nos)	2236
11.3	Water Distribution Devices	73660
1	Open Water Channel (in Nos)	15501
2	Underground Pipe (in Nos)	52710
3	Surface Pipe (in Nos)	2489
4	Drip (in Nos)	967
5	Sprinkler (in Nos)	1101
6	Others (in Nos)	892
11.4	Culturable Command Area(in ha)	119633.84
11.5	Irrigation Potential Created(in ha)	109626.02
11.6	Irrigation Potential Utilized(in ha)	100073.64

Source of Data COI, CGWB, CWC, Data State Agency

HASSAN DISTRICT WATER BODIES

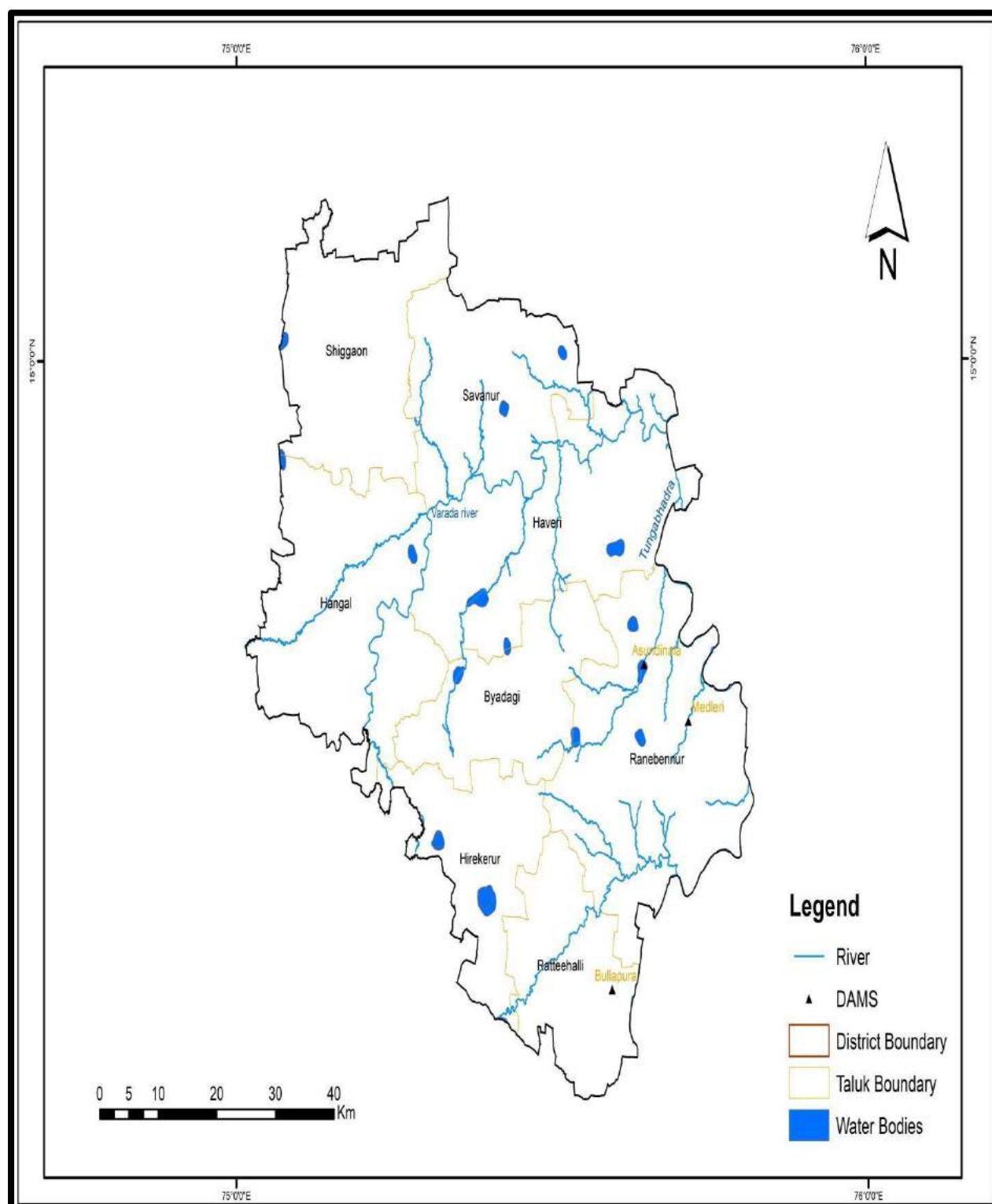


HAVERI DISTRICT DETAILS

Sr No	Name	Description
1	District	Haveri
2	State	KA
3	Area in SqKms	4825
4	Population	1597668
5	Growth Rate	11.02
6	Sex Ratio	950
7	Literacy	77.4
8	Density	331
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	4
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	4
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	2301
10.6	Water Bodies Area(in ha)	10703.08
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	34348
1	Dugwells (in Nos)	946
2	Shallow Tubewells (in Nos)	33402
3	Deep Tubewells (in Nos)	0
11.2	Surface Water Schemes	5826
1	Surface Flow (in Nos)	3217
2	Surface Lift (in Nos)	2609
11.3	Water Distribution Devices	40109
1	Open Water Channel (in Nos)	18723
2	Underground Pipe (in Nos)	19856
3	Surface Pipe (in Nos)	1236
4	Drip (in Nos)	29
5	Sprinkler (in Nos)	105
6	Others (in Nos)	160
11.4	Culturable Command Area(in ha)	89960.95
11.5	Irrigation Potential Created(in ha)	84932.33
11.6	Irrigation Potential Utilized(in ha)	84640.34

Source of Data COI, CGWB, CWC, Data State Agency

HAVERI DISTRICT WATER BODIES

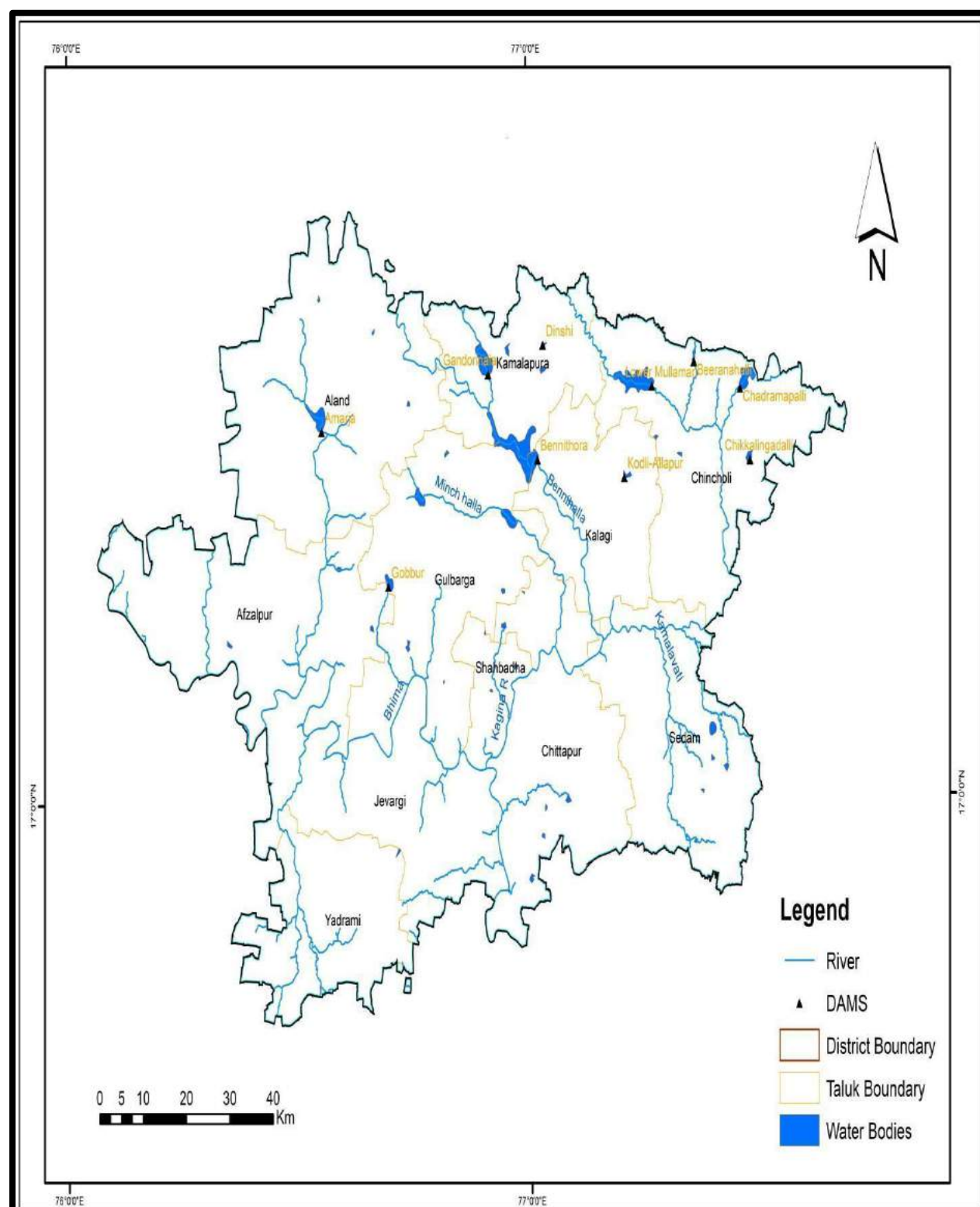


KALABURAGI (GULBARGA) DISTRICT DETAILS

Sr No	Name	Description
1	District	Gulbarga
2	State	KA
3	Area in SqKms	10990
4	Population	2566326
5	Growth Rate	18.01
6	Sex Ratio	971
7	Literacy	64.85
8	Density	233
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	10
10.2	Barrage (in Nos)	3
10.3	Lift (in Nos)	2
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	476
10.6	Water Bodies Area(in ha)	8718.910754
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	28069
1	Dugwells (in Nos)	13902
2	Shallow Tubewells (in Nos)	14167
3	Deep Tubewells (in Nos)	0
11.2	Surface Water Schemes	6305
1	Surface Flow (in Nos)	2727
2	Surface Lift (in Nos)	3578
11.3	Water Distribution Devices	33831
1	Open Water Channel (in Nos)	11259
2	Underground Pipe (in Nos)	19593
3	Surface Pipe (in Nos)	2147
4	Drip (in Nos)	593
5	Sprinkler (in Nos)	36
6	Others (in Nos)	203
11.4	Culturable Command Area(in ha)	69612.08
11.5	Irrigation Potential Created(in ha)	65908.29
11.6	Irrigation Potential Utilized(in ha)	64467.28

Source of Data COI, CGWB, CWC, Data State Agency

KALABURAGI (GULBARGA) DISTRICT WATER BODIES

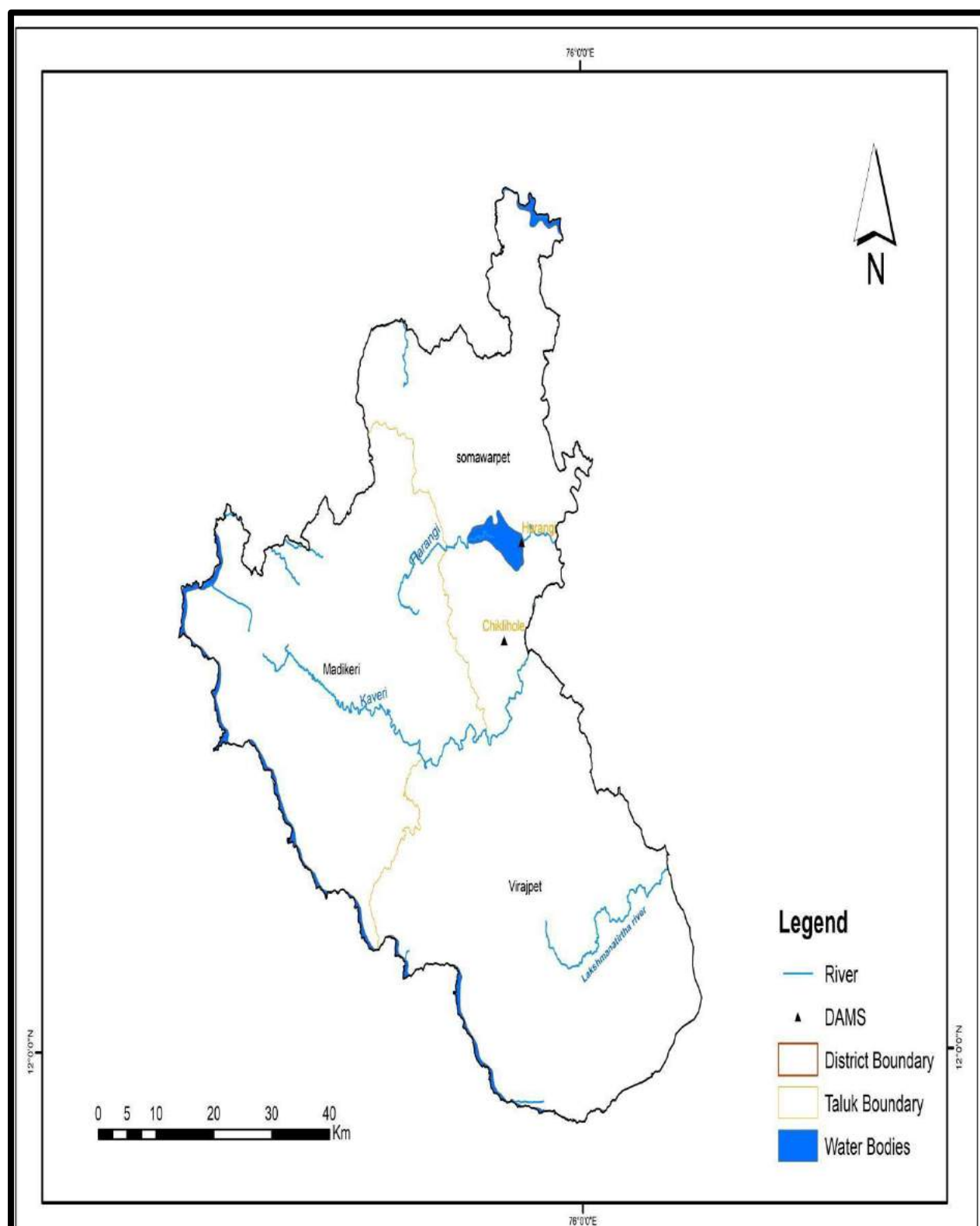


KODAGU DISTRICT DETAILS

Sr No	Name	Description
1	District	Kodagu
2	State	KA
3	Area in SqKms	4102
4	Population	554519
5	Growth Rate	1.09
6	Sex Ratio	1019
7	Literacy	82.61
8	Density	135
9	Seismic Zone	Seismic Zone-II & III
10	Water Resources	
10.1	Dams (in Nos)	2
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	1
10.4	Power House (in Nos)	1
10.5	Water Bodies (in Nos)	7028
10.6	Water Bodies Area(in ha)	2825.174251
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	3449
1	Dugwells (in Nos)	165
2	Shallow Tubewells (in Nos)	3284
3	Deep Tubewells (in Nos)	0
11.2	Surface Water Schemes	1213
1	Surface Flow (in Nos)	425
2	Surface Lift (in Nos)	788
11.3	Water Distribution Devices	4333
1	Open Water Channel (in Nos)	245
2	Underground Pipe (in Nos)	1164
3	Surface Pipe (in Nos)	1570
4	Drip (in Nos)	156
5	Sprinkler (in Nos)	1059
6	Others (in Nos)	139
11.4	Culturable Command Area(in ha)	10854.38
11.5	Irrigation Potential Created(in ha)	6868.8
11.6	Irrigation Potential Utilized(in ha)	6867.6

Source of Data COI, CGWB, CWC, Data State Agency

KODAGU DISTRICT WATER BODIES

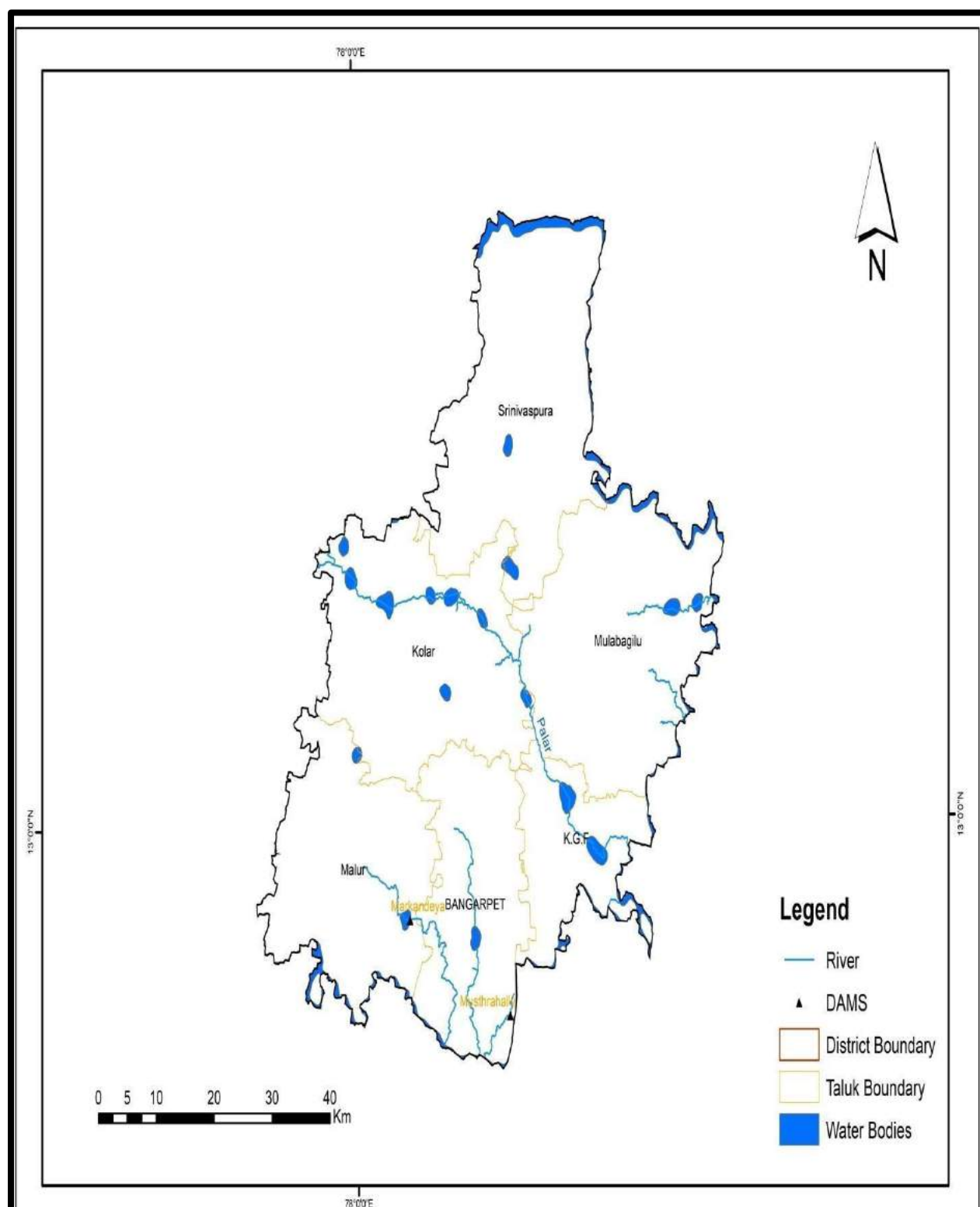


KOLAR DISTRICT DETAILS

Sr No	Name	Description
1	District	Kolar
2	State	KA
3	Area in SqKms	4012
4	Population	1536401
5	Growth Rate	10.77
6	Sex Ratio	979
7	Literacy	74.39
8	Density	384
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	2
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	null
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	1995
10.6	Water Bodies Area(in ha)	17382.42824
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	34721
1	Dugwells (in Nos)	549
2	Shallow Tubewells (in Nos)	30037
3	Deep Tubewells (in Nos)	4135
11.2	Surface Water Schemes	2584
1	Surface Flow (in Nos)	2423
2	Surface Lift (in Nos)	161
11.3	Water Distribution Devices	35394
1	Open Water Channel (in Nos)	4031
2	Underground Pipe (in Nos)	20240
3	Surface Pipe (in Nos)	1716
4	Drip (in Nos)	8293
5	Sprinkler (in Nos)	86
6	Others (in Nos)	1028
11.4	Culturable Command Area(in ha)	77729.2
11.5	Irrigation Potential Created(in ha)	65540.96
11.6	Irrigation Potential Utilized(in ha)	56952.69

Source of Data COI, CGWB, CWC, Data State Agency

KOLAR DISTRICT WATER BODIES

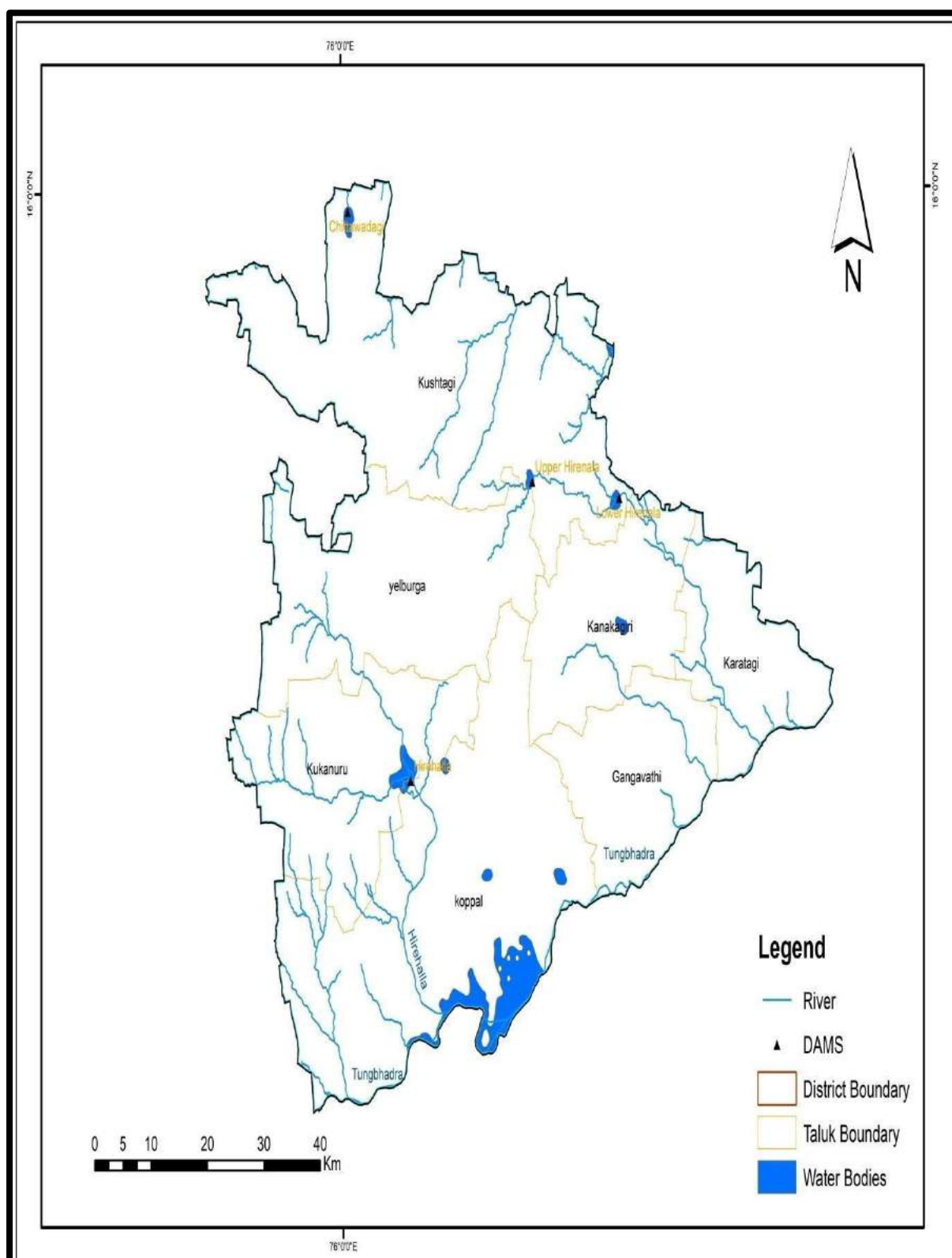


KOPPAL DISTRICT DETAILS

Sr No	Name	Description
1	District	Koppal
2	State	KA
3	Area in SqKms	5565
4	Population	1389920
5	Growth Rate	16.21
6	Sex Ratio	986
7	Literacy	68.09
8	Density	250
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	5
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	null
10.4	Power House (in Nos)	3
10.5	Water Bodies (in Nos)	786
10.6	Water Bodies Area(in ha)	19294.15108
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	32807
1	Dugwells (in Nos)	502
2	Shallow Tubewells (in Nos)	29804
3	Deep Tubewells (in Nos)	2501
11.2	Surface Water Schemes	2333
1	Surface Flow (in Nos)	602
2	Surface Lift (in Nos)	1731
11.3	Water Distribution Devices	35066
1	Open Water Channel (in Nos)	7044
2	Underground Pipe (in Nos)	26495
3	Surface Pipe (in Nos)	1007
4	Drip (in Nos)	153
5	Sprinkler (in Nos)	195
6	Others (in Nos)	172
11.4	Culturable Command Area(in ha)	81772.1
11.5	Irrigation Potential Created(in ha)	85765.6
11.6	Irrigation Potential Utilized(in ha)	83784.47

Source of Data COI, CGWB, CWC, Data State Agency

KOPPAL DISTRICT WATER BODIES

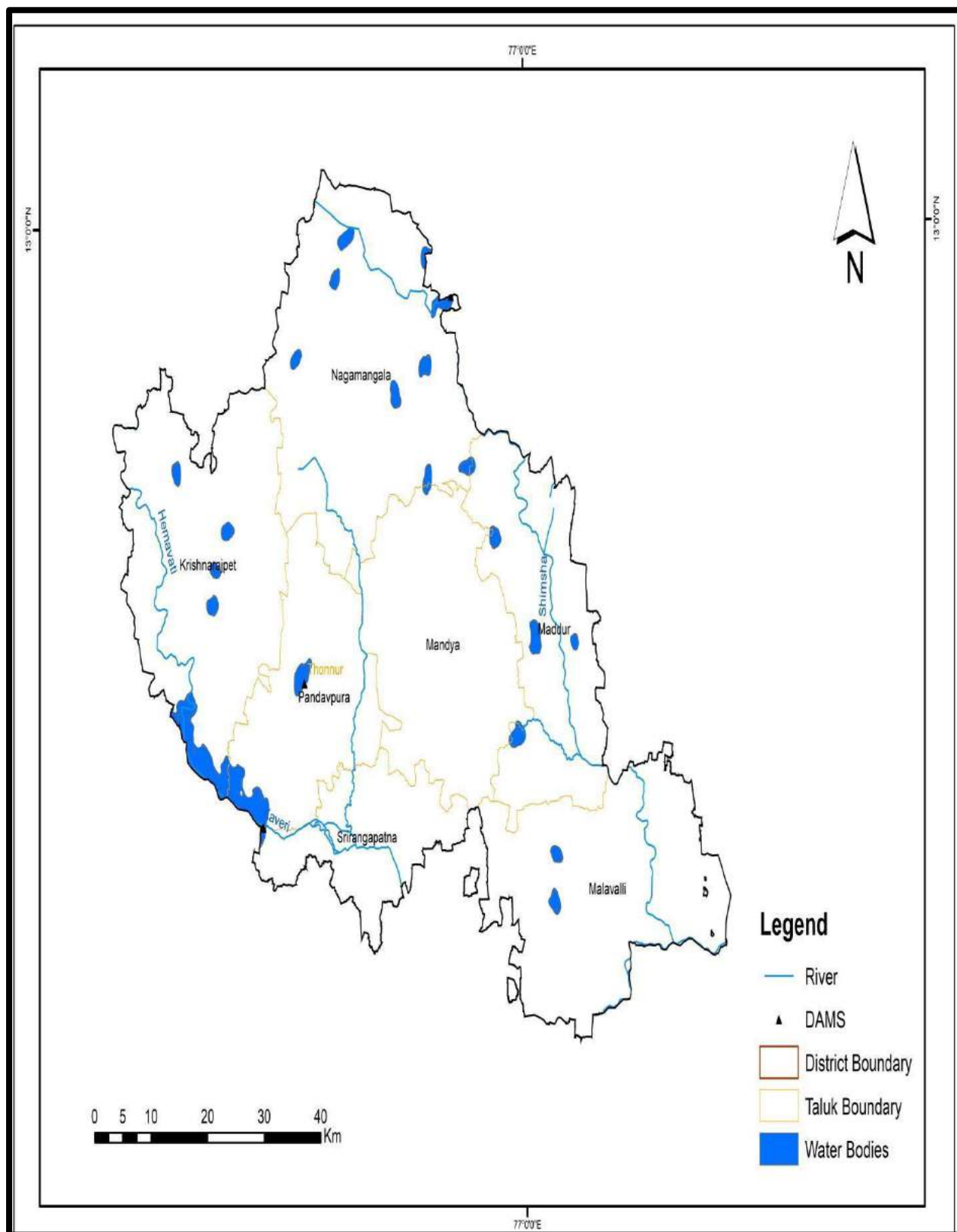


MANDYA DISTRICT DETAILS

Sr No	Name	Description
1	District	Mandya
2	State	KA
3	Area in SqKms	4961
4	Population	1805769
5	Growth Rate	2.38
6	Sex Ratio	995
7	Literacy	70.4
8	Density	365
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	2
10.2	Barrage (in Nos)	14
10.3	Lift (in Nos)	3
10.4	Power House (in Nos)	2
10.5	Water Bodies (in Nos)	2117
10.6	Water Bodies Area(in ha)	13248.24562
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	57872
1	Dugwells (in Nos)	4333
2	Shallow Tubewells (in Nos)	48450
3	Deep Tubewells (in Nos)	5089
11.2	Surface Water Schemes	1275
1	Surface Flow (in Nos)	706
2	Surface Lift (in Nos)	569
11.3	Water Distribution Devices	58807
1	Open Water Channel (in Nos)	18599
2	Underground Pipe (in Nos)	37033
3	Surface Pipe (in Nos)	954
4	Drip (in Nos)	2134
5	Sprinkler (in Nos)	35
6	Others (in Nos)	52
11.4	Culturable Command Area(in ha)	195437.17
11.5	Irrigation Potential Created(in ha)	207676.49
11.6	Irrigation Potential Utilized(in ha)	177539.75

Source of Data COI, CGWB, CWC, Data State Agency

MANDYA DISTRICT WATER BODIES

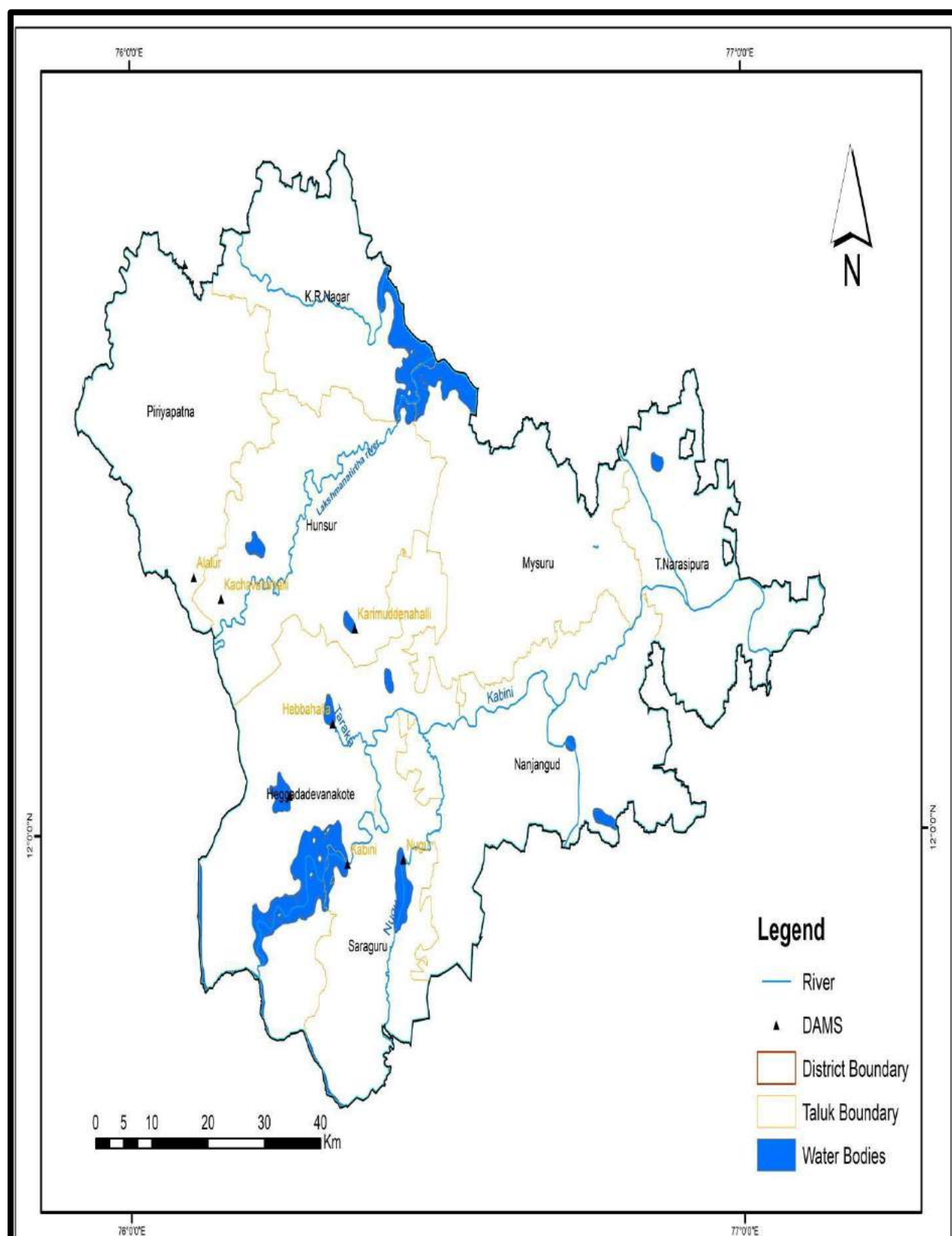


MYSURU DISTRICT DETAILS

Sr No	Name	Description
1	District	Mysore
2	State	KA
3	Area in SqKms	6854
4	Population	3001127
5	Growth Rate	13.63
6	Sex Ratio	985
7	Literacy	72.79
8	Density	437
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	7
10.2	Barrage (in Nos)	8
10.3	Lift (in Nos)	4
10.4	Power House (in Nos)	1
10.5	Water Bodies (in Nos)	2269
10.6	Water Bodies Area(in ha)	26540.48389
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	49362
1	Dugwells (in Nos)	736
2	Shallow Tubewells (in Nos)	42288
3	Deep Tubewells (in Nos)	6338
11.2	Surface Water Schemes	1794
1	Surface Flow (in Nos)	1495
2	Surface Lift (in Nos)	299
11.3	Water Distribution Devices	50904
1	Open Water Channel (in Nos)	2372
2	Underground Pipe (in Nos)	45494
3	Surface Pipe (in Nos)	1964
4	Drip (in Nos)	111
5	Sprinkler (in Nos)	105
6	Others (in Nos)	858
11.4	Culturable Command Area(in ha)	87540.21
11.5	Irrigation Potential Created(in ha)	105277.47
11.6	Irrigation Potential Utilized(in ha)	91481.02

Source of Data COI, CGWB, CWC, Data State Agency

MYSURU DISTRICT WATER BODIES

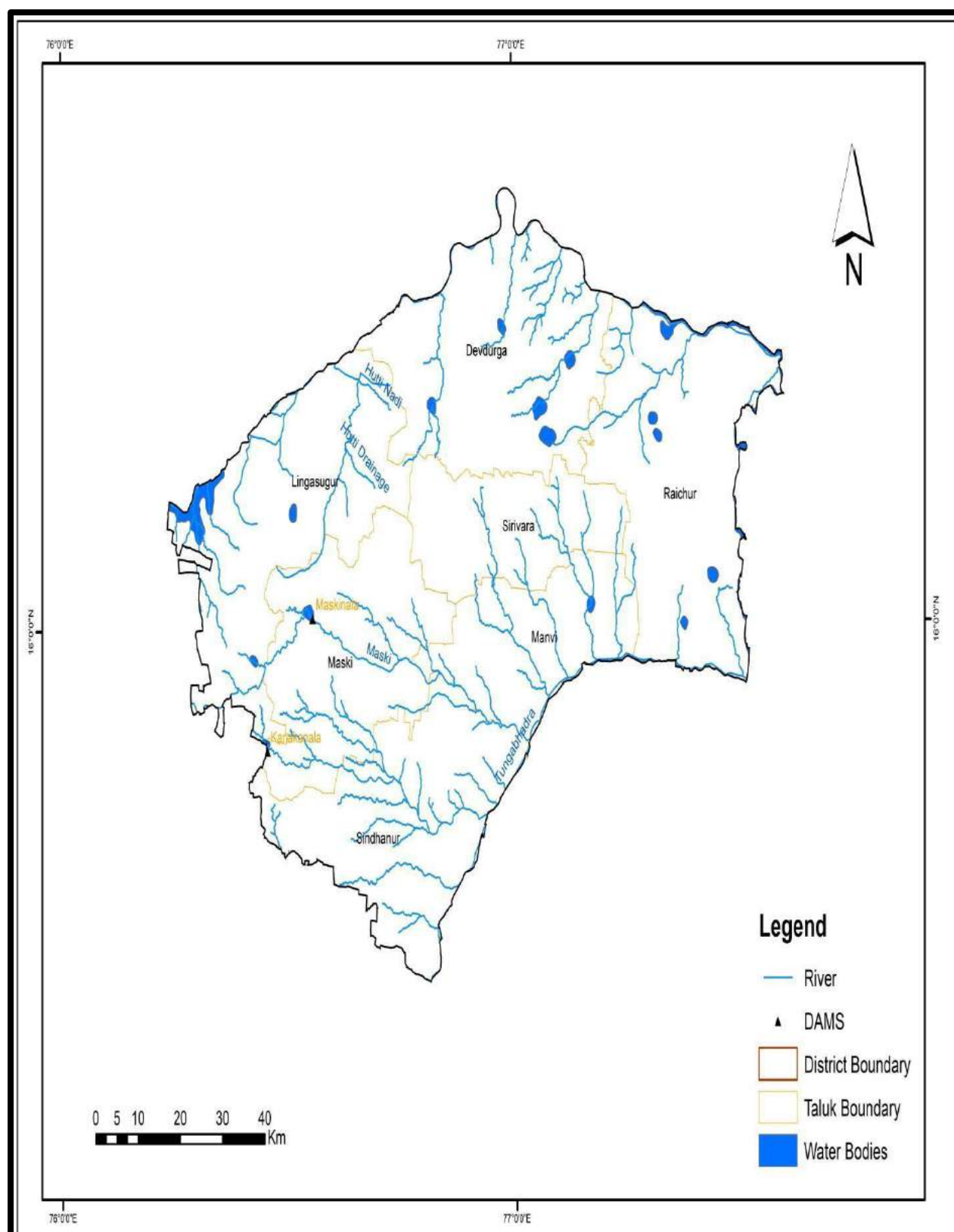


RAICHUR DISTRICT DETAILS

Sr No	Name	Description
1	District	Raichur
2	State	KA
3	Area in SqKms	6839
4	Population	1928812
5	Growth Rate	15.51
6	Sex Ratio	1000
7	Literacy	59.56
8	Density	228
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	2
10.2	Barrage (in Nos)	1
10.3	Lift (in Nos)	3
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	4295
10.6	Water Bodies Area(in ha)	8724.940321
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	19481
1	Dugwells (in Nos)	3913
2	Shallow Tubewells (in Nos)	12281
3	Deep Tubewells (in Nos)	3287
11.2	Surface Water Schemes	11530
1	Surface Flow (in Nos)	5528
2	Surface Lift (in Nos)	6002
11.3	Water Distribution Devices	30791
1	Open Water Channel (in Nos)	10488
2	Underground Pipe (in Nos)	15232
3	Surface Pipe (in Nos)	3068
4	Drip (in Nos)	1232
5	Sprinkler (in Nos)	46
6	Others (in Nos)	725
11.4	Culturable Command Area(in ha)	149853.75
11.5	Irrigation Potential Created(in ha)	155739.99
11.6	Irrigation Potential Utilized(in ha)	155620.08

Source of Data COI, CGWB, CWC, Data State Agency

RAICHUR DISTRICT WATER BODIES

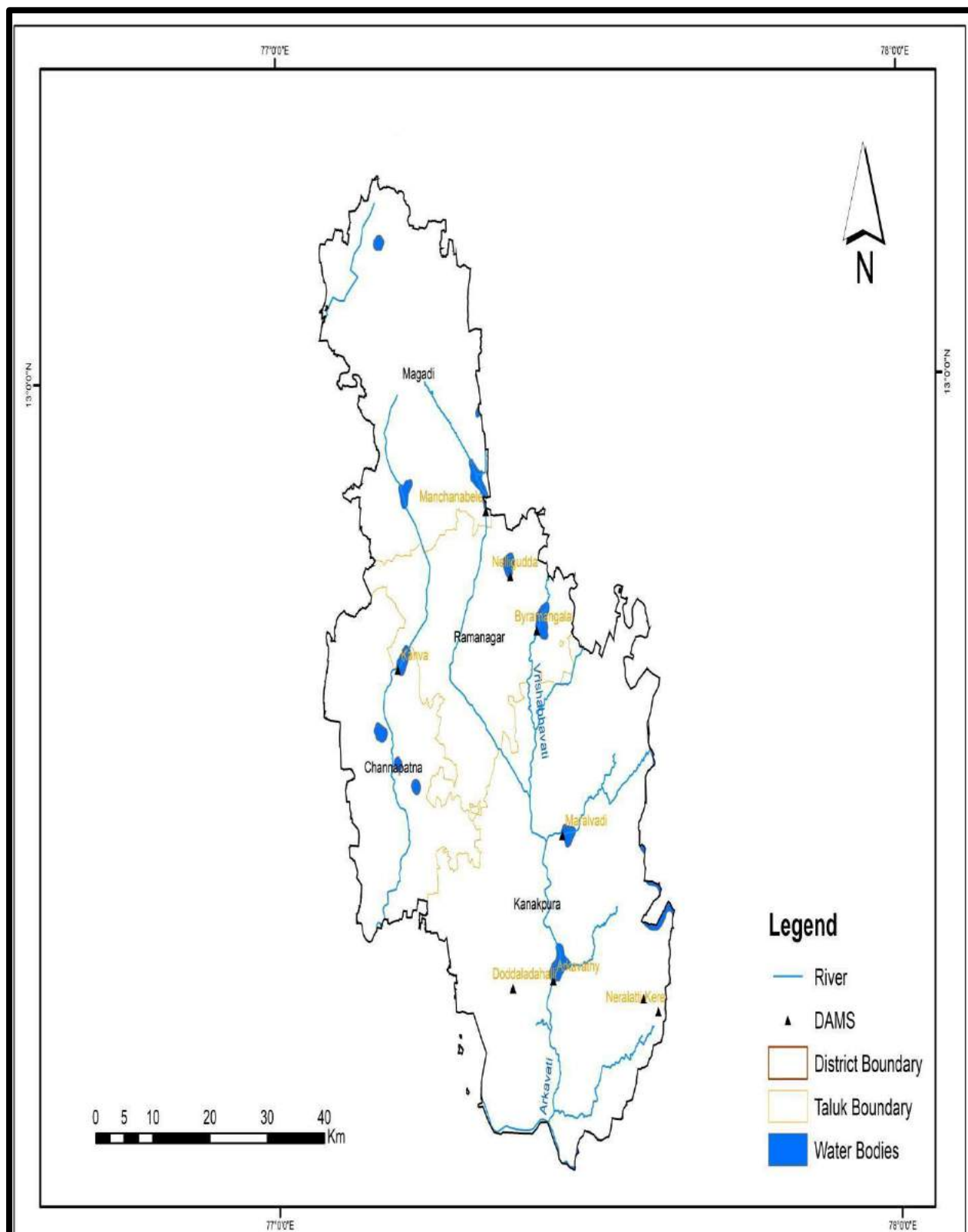


RAMANAGAR DISTRICT DETAILS

Sr No	Name	Description
1	District	Ramanagara
2	State	KA
3	Area in SqKms	3573
4	Population	1082636
5	Growth Rate	5.05
6	Sex Ratio	976
7	Literacy	69.22
8	Density	303
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	9
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	4
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	1429
10.6	Water Bodies Area(in ha)	7634.543705
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	24513
1	Dugwells (in Nos)	487
2	Shallow Tubewells (in Nos)	24026
3	Deep Tubewells (in Nos)	0
11.2	Surface Water Schemes	1715
1	Surface Flow (in Nos)	1359
2	Surface Lift (in Nos)	356
11.3	Water Distribution Devices	25280
1	Open Water Channel (in Nos)	4449
2	Underground Pipe (in Nos)	19378
3	Surface Pipe (in Nos)	717
4	Drip (in Nos)	97
5	Sprinkler (in Nos)	42
6	Others (in Nos)	597
11.4	Culturable Command Area(in ha)	55830.54
11.5	Irrigation Potential Created(in ha)	34993.82
11.6	Irrigation Potential Utilized(in ha)	34339.65

Source of Data COI, CGWB, CWC, Data State Agency

RAMANAGAR DISTRICT WATER BODIES

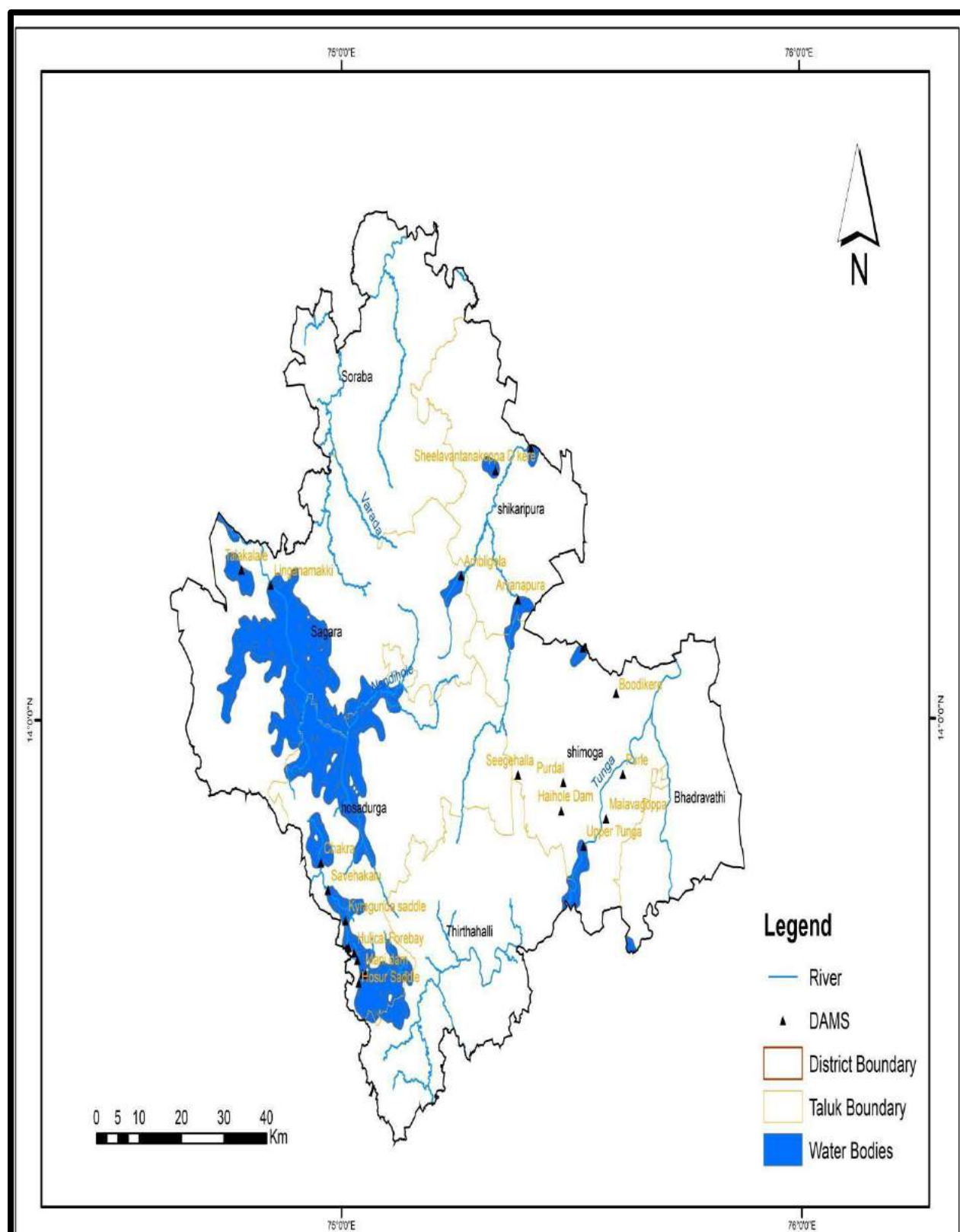


SHIVAMOGGA DISTRICT DETAILS

Sr No	Name	Description
1	District	Shimoga
2	State	KA
3	Area in SqKms	8495
4	Population	1752753
5	Growth Rate	6.71
6	Sex Ratio	998
7	Literacy	80.45
8	Density	207
9	Seismic Zone	Seismic Zone-II & III
10	Water Resources	
10.1	Dams (in Nos)	22
10.2	Barrage (in Nos)	4
10.3	Lift (in Nos)	1
10.4	Power House (in Nos)	6
10.5	Water Bodies (in Nos)	3311
10.6	Water Bodies Area(in ha)	48368.93288
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	40655
1	Dugwells (in Nos)	5767
2	Shallow Tubewells (in Nos)	32966
3	Deep Tubewells (in Nos)	1922
11.2	Surface Water Schemes	10534
1	Surface Flow (in Nos)	5895
2	Surface Lift (in Nos)	4639
11.3	Water Distribution Devices	51123
1	Open Water Channel (in Nos)	12466
2	Underground Pipe (in Nos)	29089
3	Surface Pipe (in Nos)	4314
4	Drip (in Nos)	1337
5	Sprinkler (in Nos)	3767
6	Others (in Nos)	150
11.4	Culturable Command Area(in ha)	98766.98
11.5	Irrigation Potential Created(in ha)	101253.09
11.6	Irrigation Potential Utilized(in ha)	100028.21

Source of Data COI, CGWB, CWC, Data State Agency

SHIVAMOGGA DISTRICT WATER BODIES

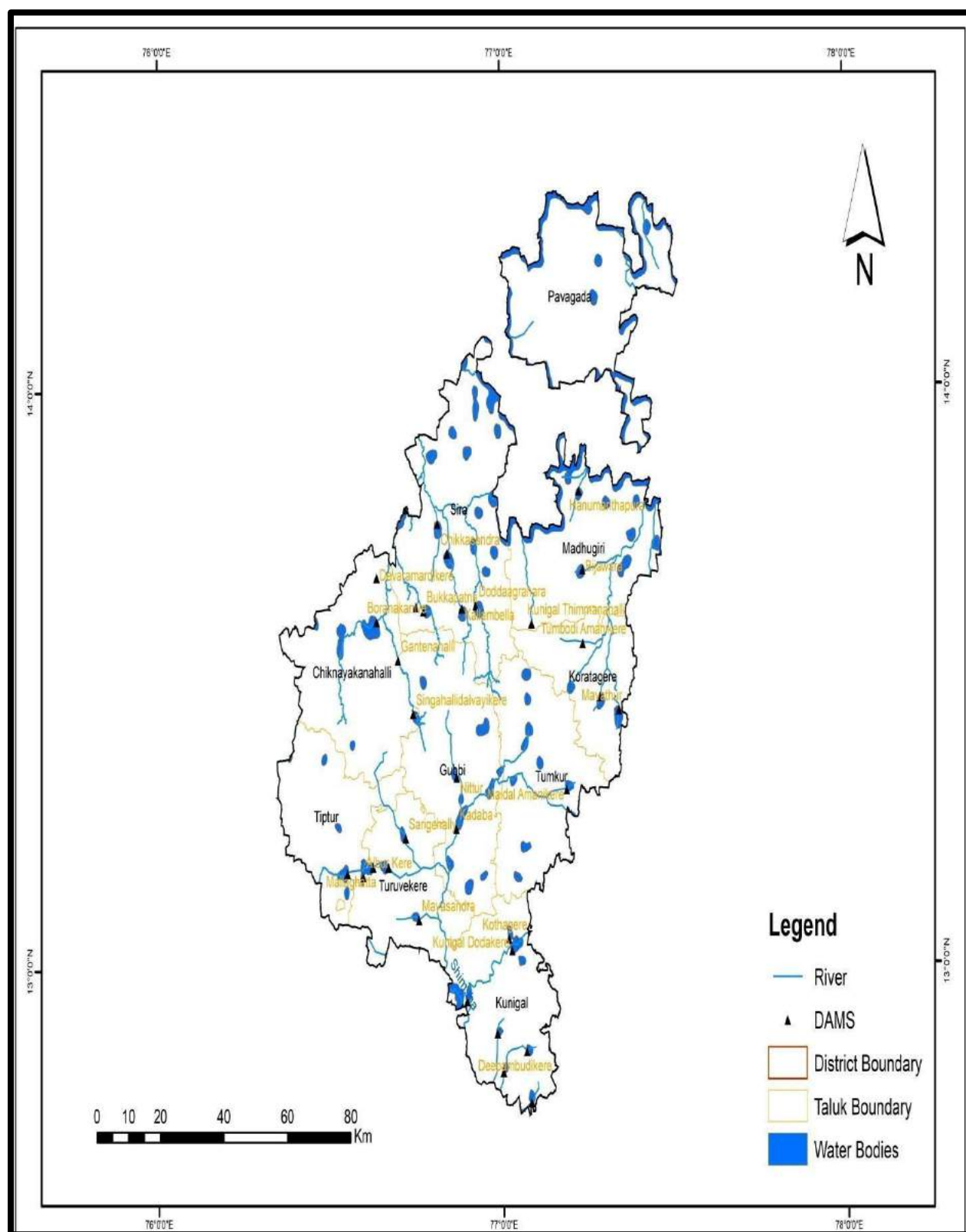


TUMKUR DISTRICT DETAILS

Sr No	Name	Description
1	District	Tumkur
2	State	KA
3	Area in SqKms	10598
4	Population	2678980
5	Growth Rate	3.65
6	Sex Ratio	984
7	Literacy	75.14
8	Density	253
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	33
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	null
10.4	Power House (in Nos)	null
10.5	Water Bodies (in Nos)	4180
10.6	Water Bodies Area(in ha)	46520.71421
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	143990
1	Dugwells (in Nos)	11272
2	Shallow Tubewells (in Nos)	127630
3	Deep Tubewells (in Nos)	5088
11.2	Surface Water Schemes	2915
1	Surface Flow (in Nos)	1727
2	Surface Lift (in Nos)	1188
11.3	Water Distribution Devices	142599
1	Open Water Channel (in Nos)	26956
2	Underground Pipe (in Nos)	100716
3	Surface Pipe (in Nos)	3485
4	Drip (in Nos)	7516
5	Sprinkler (in Nos)	437
6	Others (in Nos)	3489
11.4	Culturable Command Area(in ha)	221326.67
11.5	Irrigation Potential Created(in ha)	200480.72
11.6	Irrigation Potential Utilized(in ha)	193710.83

Source of Data COI, CGWB, CWC, Data State Agency

TUMKUR DISTRICT WATER BODIES

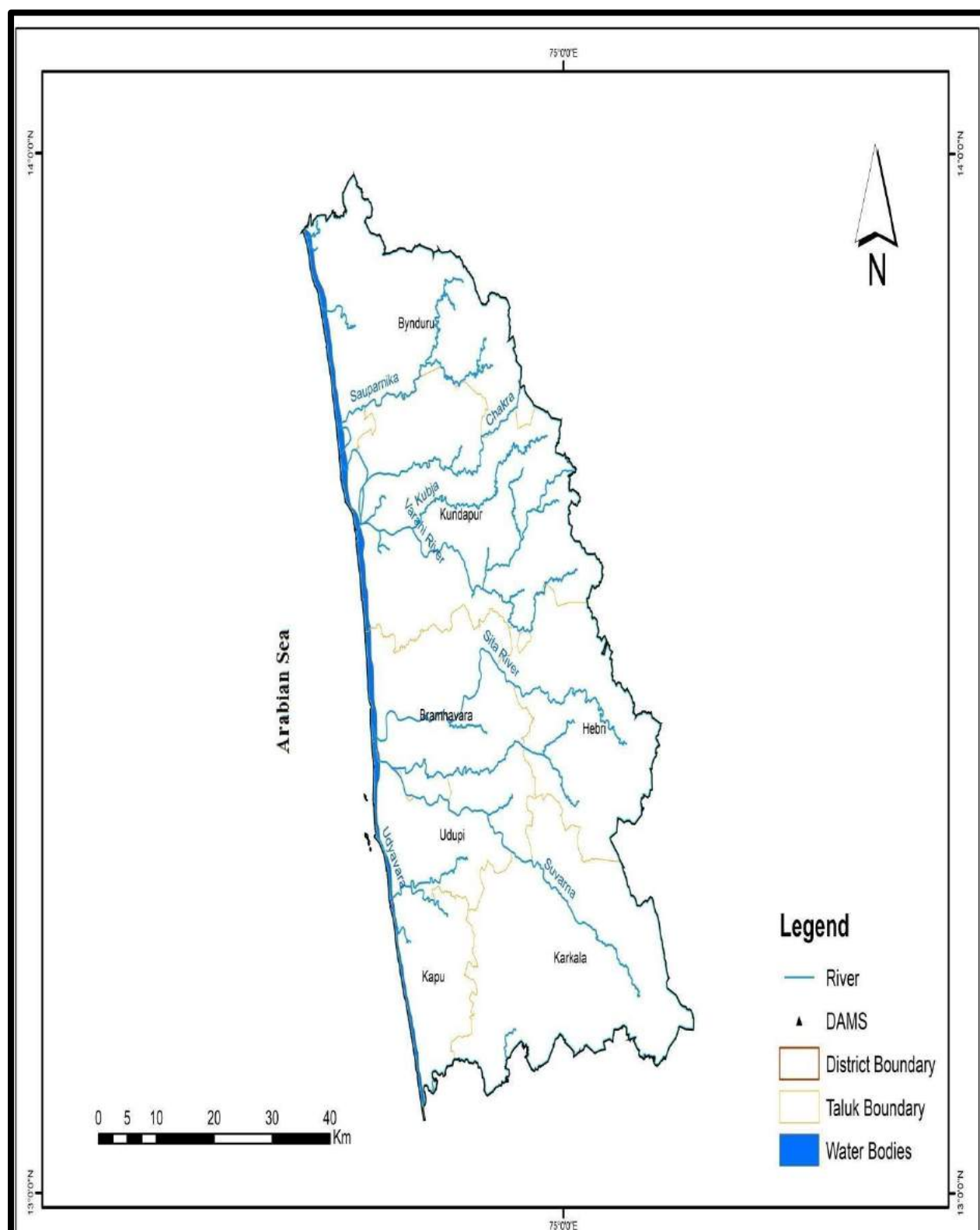


UDUPI DISTRICT DETAILS

Sr No	Name	Description
1	District	Udupi
2	State	KA
3	Area in SqKms	3879
4	Population	1177361
5	Growth Rate	5.85
6	Sex Ratio	1094
7	Literacy	86.24
8	Density	304
9	Seismic Zone	Seismic Zone-III
10	Water Resources	
10.1	Dams (in Nos)	null
10.2	Barrage (in Nos)	2
10.3	Lift (in Nos)	null
10.4	Power House (in Nos)	2
10.5	Water Bodies (in Nos)	210
10.6	Water Bodies Area(in ha)	391.3392718
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	15859
1	Dugwells (in Nos)	15348
2	Shallow Tubewells (in Nos)	511
3	Deep Tubewells (in Nos)	0
11.2	Surface Water Schemes	1740
1	Surface Flow (in Nos)	897
2	Surface Lift (in Nos)	843
11.3	Water Distribution Devices	17467
1	Open Water Channel (in Nos)	4426
2	Underground Pipe (in Nos)	5553
3	Surface Pipe (in Nos)	3967
4	Drip (in Nos)	1003
5	Sprinkler (in Nos)	2295
6	Others (in Nos)	223
11.4	Culturable Command Area(in ha)	24655.43
11.5	Irrigation Potential Created(in ha)	24819.02
11.6	Irrigation Potential Utilized(in ha)	23930.39

Source of Data COI, CGWB, CWC, Data State Agency

UDUPI DISTRICT WATER BODIES

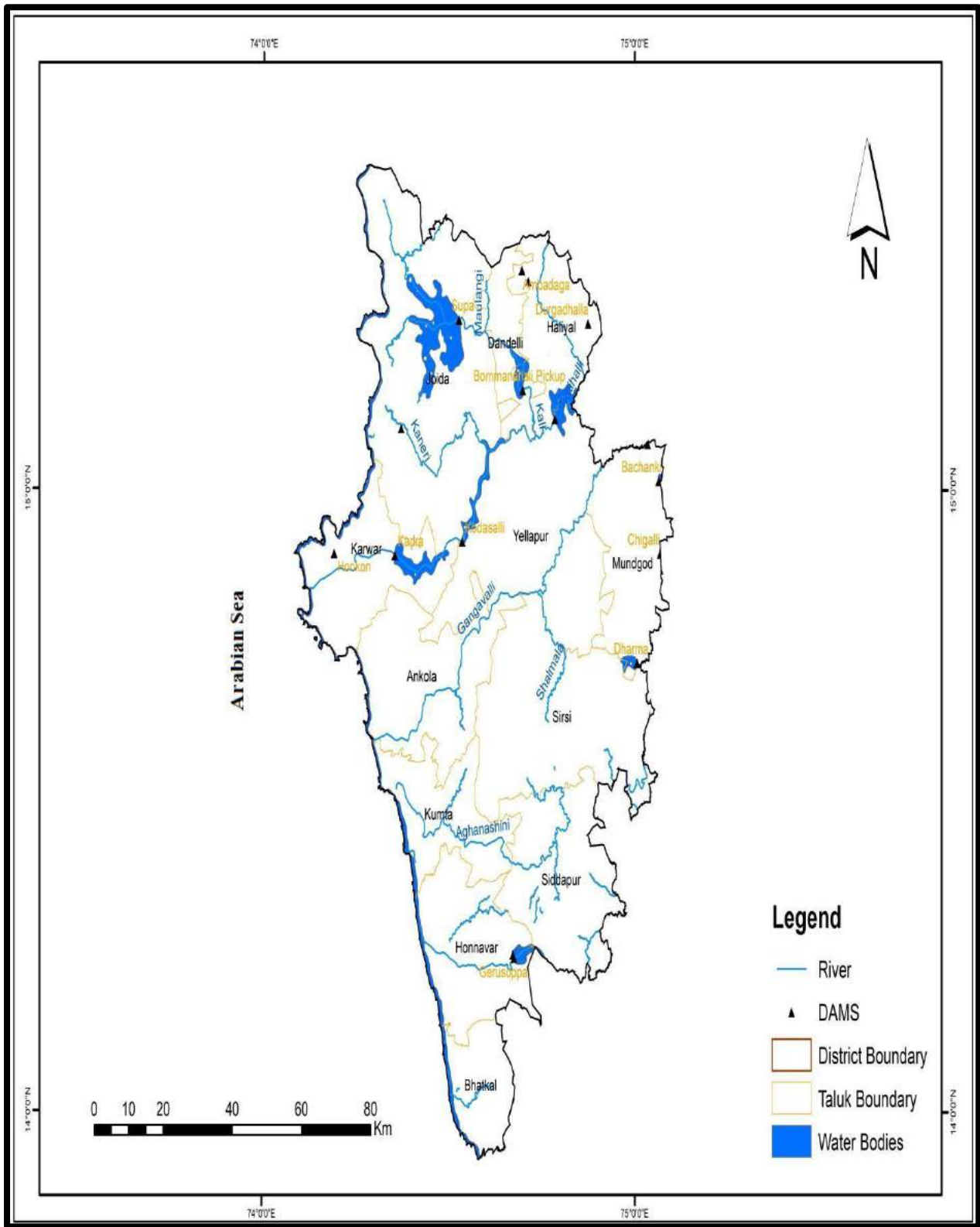


UTTARA KANNADA DISTRICT DETAILS

Sr No	Name	Description
1	District	Uttara Kannada
2	State	KA
3	Area in SqKms	10291
4	Population	1437169
5	Growth Rate	6.17
6	Sex Ratio	979
7	Literacy	84.06
8	Density	132
9	Seismic Zone	Seismic Zone-II & III
10	Water Resources	
10.1	Dams (in Nos)	15
10.2	Barrage (in Nos)	null
10.3	Lift (in Nos)	null
10.4	Power House (in Nos)	5
10.5	Water Bodies (in Nos)	887
10.6	Water Bodies Area(in ha)	22436.85101
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	31833
1	Dugwells (in Nos)	24543
2	Shallow Tubewells (in Nos)	7290
3	Deep Tubewells (in Nos)	0
11.2	Surface Water Schemes	3366
1	Surface Flow (in Nos)	2472
2	Surface Lift (in Nos)	894
11.3	Water Distribution Devices	34982
1	Open Water Channel (in Nos)	5142
2	Underground Pipe (in Nos)	8990
3	Surface Pipe (in Nos)	13233
4	Drip (in Nos)	2805
5	Sprinkler (in Nos)	3315
6	Others (in Nos)	1497
11.4	Culturable Command Area(in ha)	39616.52
11.5	Irrigation Potential Created(in ha)	36533.67
11.6	Irrigation Potential Utilized(in ha)	35097.52

Source of Data COI, CGWB, CWC, Data State Agency

UTTARA KANNADA

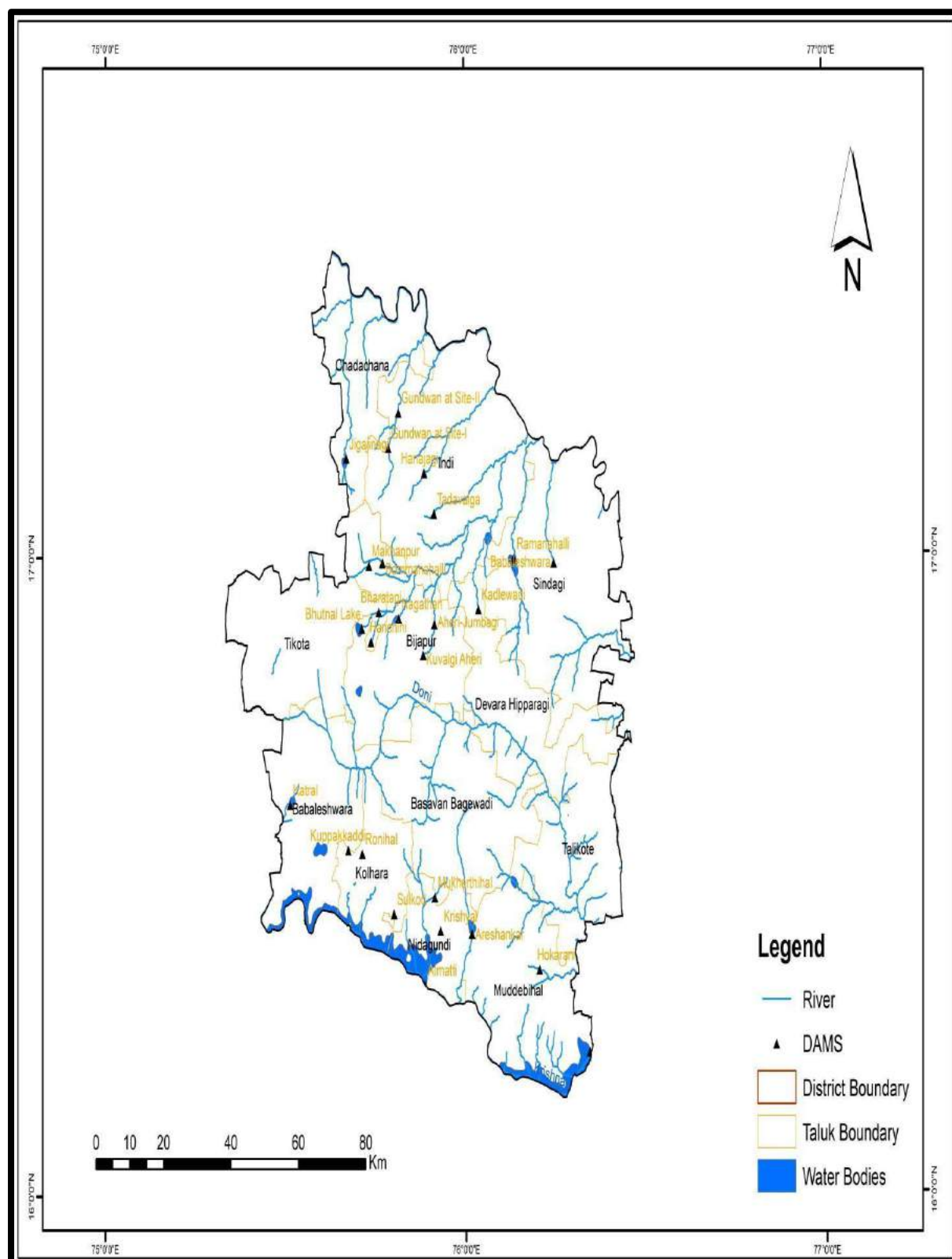


VIJAYAPURA (BIJAPUR) DISTRICT DETAILS

Sr No	Name	Description
1	District	Bijapur
2	State	KA
3	Area in SqKms	10517
4	Population	2177331
5	Growth Rate	20.5
6	Sex Ratio	960
7	Literacy	67.15
8	Density	207
9	Seismic Zone	Seismic Zone-II & III
10	Water Resources	
10.1	Dams (in Nos)	26
10.2	Barrage (in Nos)	2
10.3	Lift (in Nos)	3
10.4	Power House (in Nos)	2
10.5	Water Bodies (in Nos)	545
10.6	Water Bodies Area(in ha)	5420.601867
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	48218
1	Dugwells (in Nos)	20001
2	Shallow Tubewells (in Nos)	28217
3	Deep Tubewells (in Nos)	0
11.2	Surface Water Schemes	1235
1	Surface Flow (in Nos)	491
2	Surface Lift (in Nos)	744
11.3	Water Distribution Devices	49414
1	Open Water Channel (in Nos)	7702
2	Underground Pipe (in Nos)	33253
3	Surface Pipe (in Nos)	7100
4	Drip (in Nos)	977
5	Sprinkler (in Nos)	120
6	Others (in Nos)	262
11.4	Culturable Command Area(in ha)	119370.63
11.5	Irrigation Potential Created(in ha)	132378.35
11.6	Irrigation Potential Utilized(in ha)	129016.26

Source of Data COI, CGWB, CWC, Data State Agency

VIJAYAPURA (BIJAPUR) DISTRICT WATER BODIES

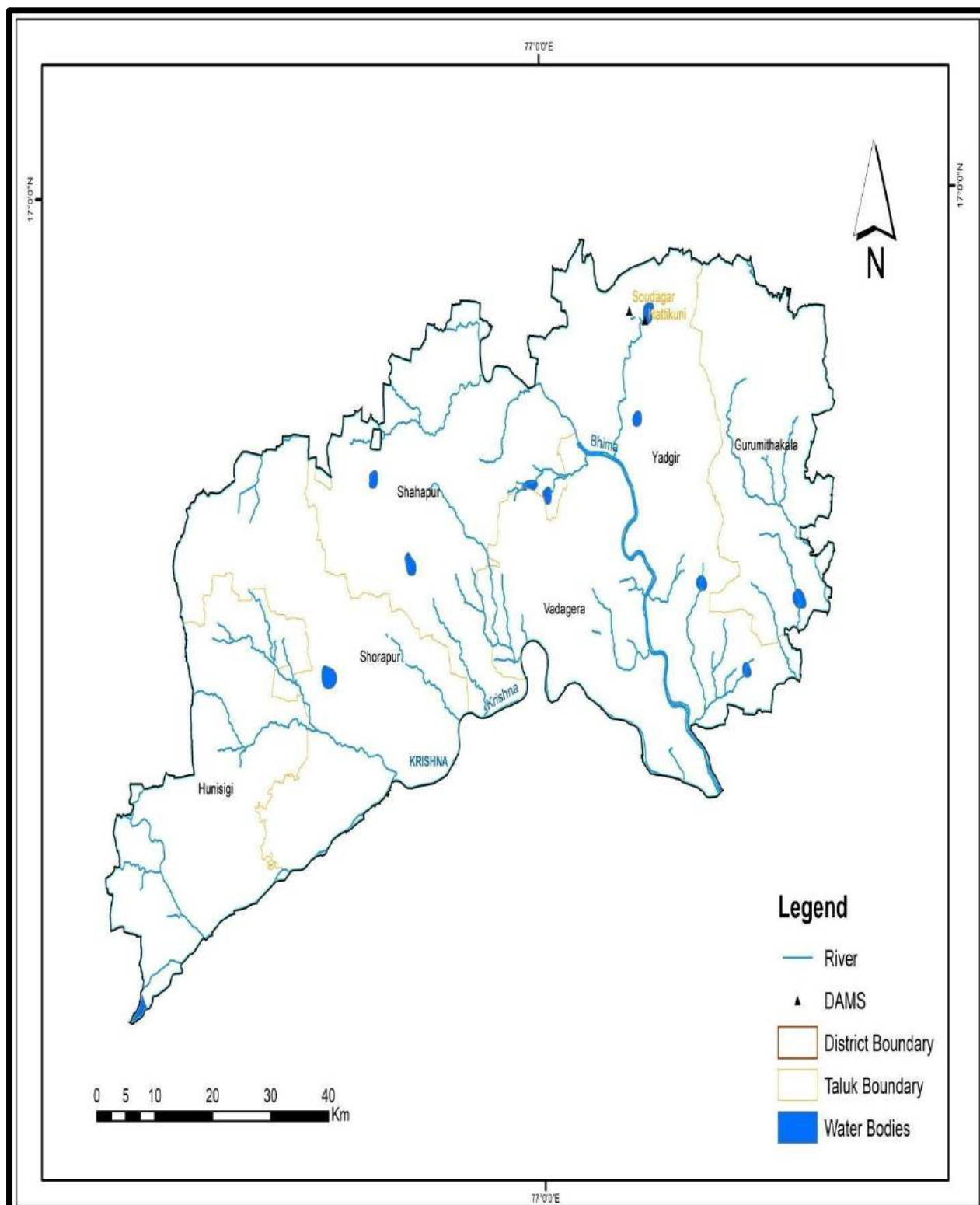


YADGIRI DISTRICT DETAILS

Sr No	Name	Description
1	District	Yadgir
2	State	KA
3	Area in SqKms	5225
4	Population	1174271
5	Growth Rate	22.81
6	Sex Ratio	989
7	Literacy	51.83
8	Density	224
9	Seismic Zone	Seismic Zone-II
10	Water Resources	
10.1	Dams (in Nos)	2
10.2	Barrage (in Nos)	2
10.3	Lift (in Nos)	2
10.4	Power House (in Nos)	2
10.5	Water Bodies (in Nos)	534
10.6	Water Bodies Area(in ha)	7737.786976
11	Minor Irrigation(5th Census)	
11.1	Ground Water Schemes	14669
1	Dugwells (in Nos)	1988
2	Shallow Tubewells (in Nos)	12681
3	Deep Tubewells (in Nos)	0
11.2	Surface Water Schemes	5854
1	Surface Flow (in Nos)	1393
2	Surface Lift (in Nos)	4461
11.3	Water Distribution Devices	19889
1	Open Water Channel (in Nos)	3549
2	Underground Pipe (in Nos)	8186
3	Surface Pipe (in Nos)	4952
4	Drip (in Nos)	67
5	Sprinkler (in Nos)	2138
6	Others (in Nos)	997
11.4	Culturable Command Area(in ha)	40211.75
11.5	Irrigation Potential Created(in ha)	55032.55
11.6	Irrigation Potential Utilized(in ha)	52899.65

Source of Data COI, CGWB, CWC, Data State Agency

YADGIRI DISTRICT WATER BODIES





PROCEEDINGS OF THE GOVERNMENT OF KARNATAKA

Sub: Constitution of Vision group for the “Coastal Development Vision Report 2030” - reg.

Read: Letter from Shri Ullas Kamath, Chairman, FICCI, Karnataka State Council to Hon’ble Shri Jagadish Shettar, Minister of Medium & Large-Scale Industries, dated 24.03.2021.

PREAMBLE:

In the Coastline Business Conclave organised by FICCI on 21st March 2021 in Mangalore Hon’ble Minister for Medium & Large-Scale Industries, Government of Karnataka suggested creating a vision group to prepare a Coastline Development Vision Report 2030 to laydown specific areas of interventions needed to achieve the greater growth of the region.

Karnataka has 320 K.M coastline between Mangalore in Dakshina Kannada District and Karwar in Uttara Kannada District. Bhatkal is the main centre with around 8 beaches. The coastline of Karnataka is along the eastern shore of Arabian sea. This region is also known for major port at Mangalore and the 9 minor ports. The coastline is flanked by the Arabian sea in the west and a vast picturesque Western Ghats in the east. There are 3 distinct climatic zones. It has difficult terrains full of rivers, creeks, water falls, peaks and hill ranges providing immense opportunities for tourism.

The coastline is also blessed with ancient temples with loads of mythology. The region is also known for its knowledge and banking base. Mangluru being the prominent city in the coast line hosts many higher educational institutions including more than 10 medical colleges, University and others.

The region has tremendous potential for Development of Maritime Industries, Fisheries and Marine Assets Creation, Tourism with more focus on wellness/Dharmik/Cruise/Aqua, Banking and Education, knowledge based service and industry viz., IT/BT.

NITI Aayog had suggested setting up coastal economic zones — one on the west coast of India and the Coastline of Karnataka has a huge potential to fully realise the strategic advantage India has due to its coastline, especially in the context of the proposed Sagarmala project.

The potential of coastal line in terms of port development/industrial development is not completely tapped and hence there is a need to study and provide inputs / suggestions and guidance for the development of these sectors.

The proposal has been examined in the Government in all the aspects and hence the following order.

GOVERNMENT ORDER NO. CI 172 SPI 2021, BENGALURU,
DATED 03.05.2021

In the circumstances explained in the preamble, Government is pleased to constitute a Coastal Development Vision Group for attracting investments and holistic development of the coastal region comprising of the following stakeholder members:

Sl. No.	Name/ Designation	
1.	Shri Ullas Kamath, Chairman, FICCI Karnataka State Council	Chairperson
2.	Shri Isaac Vas, President, KCCI	Member
3.	Shri Vishal Hegde, Medical Education	Member
4.	Shri Manjunath Bhandary, Technical Education	Member
5.	Shri Prakash Kalbavi, Cashew Industry	Member
6.	Shri Gaurav Hegde, MSME	Member
7.	Shri Pranjal Ghate, Asst Director (Research), NMPT	Member
8.	Shri Yogish Nayak, CGM Finance, MRPL	Member
9.	Dr. Senthil Vel A, Dean, Fisheries College	Member
10.	Shri Abhay Hanjura, Licious, Fresh Meat & Seafood	Member
11.	Shri Capt. John Prasad Menezes, Maritime	Member
12.	Smt. Vathika Pai, Tourism & Hospitality	Member
13.	Shri Jitendra S Kottary, Real Estate	Member
14.	Shri G Nandagopal Shenoy, Consultant	Member

15.	Shri Pradeep Pai, FMCG	Member
16.	Shri Giridhar Kamath, CA	Member
17.	Managing Director, Karnataka Udyog Mitra	Member Secretary

Terms of Reference:

The role of the Vision Group would be primarily to provide the following for Development of Maritime, Fisheries, and marine asset creation, Tourism with a more specific focus on wellness, Dharmic, Cruise, and aqua tourism, Banking and Education:

- i. Providing inputs/suggestions/guidance pertaining to establishment of aforesaid sectors.
- ii. Proposing fiscal and non-fiscal interventions required for Coastal development plan.
- iii. Preparation of investment plan
- iv. Preparation of infrastructure plan
- v. Any other interventions required for development of the cluster
- vi. The Committee may invite others as special invitees if required.

By Order and in the name of the
Governor of Karnataka,

U. Nagarathnamma.
(NAGARATHNAMMA .G)
Desk Officer (Technical Cell), 3/5/22,
Commerce & Industries Department.

To,

The Compiler, Karnataka Gazette, Bengaluru for publication in the next issue of the Gazette and supply 10 copies to this office.

Copy:

1. Principal Accountant General (G&SSA), Karnataka, New Building, 'Audit Bhawan', Post Box No. 5398, Bengaluru-01.
2. Principal Accountant General (E&RSA), Karnataka, New Building, 'Audit Bhawan', Post Box No. 5398, Bengaluru-01.
3. Principal Accountant General (A&E), Karnataka, Park House Road, Post Box No. 5329, Bengaluru-01.

4. Commissioner for Industrial Development and Director of Industries and Commerce, Industries and Commerce Department, Khanija Bhavan, Race Course Road, Bengaluru-01 CEO, IKF, Khanija Bhavan, Race Course Road, Bengaluru-01.
5. Managing Director, Karnataka Udyog Mitra, Khanija Bhavan, Race Course Road, Bengaluru-01. (**with a request to send this G.O. to the concerned members through your office**)
6. PS to the Hon'ble Minister for Large and Medium Scale Industries, Vidhana Soudha, Bengaluru-01.
7. PS to Additional Chief Secretary to Government, Commerce & Industries Department, Vikasa Soudha, Bengaluru.
8. Guard File / Spare Copies.

Chapter 1 Annexure 1**YEAR-WISE FISH PRODUCTION OF KARNATAKA**

Year	Marine		Inland		Total	
	Quantity (MT)	Value (INR in Lakhs)	Quantity (MT)	Value (INR in Lakhs)	Quantity (MT)	Value (INR in Lakhs)
1997-98	189859	23643	120542	28394	310401	52037
1998-99	160627	21009	118419	27995	279046	49004
1999-00	165653	23684	126646	29706	292299	53390
2000-01	177907	24829	127468	29911	305375	54740
2001-02	128416	19942	121196	28343	249612	48285
2002-03	180161	33653	86262	9805	266423	43458
2003-04	187003	40498	70036	18783	257039	59281
2004-05	171227	45873	80470	21582	251698	67455
2005-06	176974	46598	120599	32321	297573	78918
2006-07	168545	55143	123919	37176	292464	92318
2007-08	175566	51787	122124	42744	297690	94531
2008-09	218137	82024	143717	57487	361854	139511
2009-10	248729	90198	159324	63730	408053	153928
2010-11	340571	133565	186009	77348	526579	210913
2011-12	347383	150630	199053	80016	546437	230645
2012-13	357325	201668	168241	84605	525566	286273
2013-14	357358	204101	203914	159621	561272	363722
2014-15	389822	265093	223419	193205	613241	458298
2015-16	411762	342433	168828	148217	580590	490650
2016-17	398928	347270	158566	143779	557494	491049
2017-18	414348	393300	188174	169356	602522	562656
2018-19	389491	373362	197921	178129	587412	551491

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

Chapter 1 Annexure 2

YEAR-WISE MARINE FISH CATCH, VALUE AND GROWTH RATE

Year	Quantity (MT)	Value (INR in Lakhs)	% Growth Quantity	% Growth Value	Unit Value INR /Kg
1997-98	189859	23643			12.45
1998-99	160627	21009	-15.40%	-11.14%	13.08
1999-00	165653	23684	3.13%	12.73%	14.3
2000-01	177907	24829	7.40%	4.83%	13.96
2001-02	128416	19942	-27.82%	-19.68%	15.53
2002-03	180161	33653	40.29%	68.75%	18.68
2003-04	187003	40498	3.80%	20.34%	21.66
2004-05	171227	45873	-8.44%	13.27%	26.79
2005-06	176974	46598	3.36%	1.58%	26.33
2006-07	168545	55143	-4.76%	18.34%	32.72
2007-08	175566	51787	4.17%	-6.09%	29.5
2008-09	218137	82024	24.25%	58.39%	37.6
2009-10	248729	90198	14.02%	9.97%	36.26
2010-11	340571	133565	36.92%	48.08%	39.22
2011-12	347383	150630	2.00%	12.78%	43.36
2012-13	357325	201668	2.86%	33.88%	56.44
2013-14	357358	204101	0.01%	1.21%	57.11
2014-15	389822	265093	9.08%	29.88%	68
2015-16	411762	342433	5.63%	29.17%	83.16
2016-17	398928	347270	-3.12%	1.41%	87.05
2017-18	414348	393300	3.87%	13.25%	94.92
2018-19	389491	373362	-6.00%	-5.07%	95.86

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

DISTRICT AND SPECIES-WISE MARINE FISH LANDINGS AND ITS VALUE FOR 2016-17

Quantity: in metric tonnes Value : Rs. in Lakh

Sl. No.	Species	Dakshina Kannada		Udupi		Uttara Kannada		TOTAL		Contribution %	
		Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1	Anchovies	1564.00	1326.56	805.00	812.00	887.19	532.24	3256.19	2670.80	0.82%	0.77%
2	Barracudas	2036.00	1897.36	570.00	592.00	199.82	104.73	2805.82	2594.09	0.70%	0.75%
3	Big jawed jumper	1404.00	1205.63	3301.00	3440.00	1709.73	609.25	6414.73	5254.88	1.61%	1.51%
4	Black pomfret	771.00	1056.48	2570.00	2685.00	114.18	298.66	3455.18	4040.14	0.87%	1.16%
5	Bull's eye	9433.00	8956.36	2880.00	2972.00	58.18	8.81	12371.18	11937.17	3.10%	3.44%
6	Catfishes	679.00	879.25	3160.00	3300.00	162.89	55.56	4001.89	4234.81	1.00%	1.22%
7	Carangids	84.00	75.50	920.00	945.00	0.00	0.00	1004.00	1020.50	0.25%	0.29%
8	Coilia	5.00	4.32	1150.00	1179.00	2448.91	645.03	3603.91	1828.35	0.90%	0.53%
9	Crabs-Charybdis spp.	245.00	495.63	2350.00	2592.00	1506.67	2410.00	4101.67	5497.63	1.03%	1.58%
10	Croakers	1891.00	1215.63	3132.00	3362.00	1403.88	423.08	6426.88	5000.71	1.61%	1.44%
11	Cuttle fish	5345.00	12547.25	1556.00	1682.00	733.61	321.90	7634.61	14551.15	1.91%	4.19%
12	Eels	251.00	211.45	242.00	305.00	3.09	0.65	496.09	517.10	0.12%	0.15%
13	Flat fishes & Soles	1245.00	1156.36	2147.00	2203.00	343.96	80.78	3735.96	3440.14	0.94%	0.99%
14	Flat heads	152.00	145.78	0.00	0.00	0.00	0.00	152.00	145.78	0.04%	0.04%
15	Halibut	453.00	502.36	2950.00	3410.00	235.09	134.55	3638.09	4046.91	0.91%	1.17%
16	Horse Mackerel	1054.00	949.80	887.00	952.00	447.46	433.67	2388.46	2335.47	0.60%	0.67%
17	Lactarius	0.00	0.00	2043.00	2104.00	0.00	0.00	2043.00	2104.00	0.51%	0.61%
18	Lady fish	217.00	256.12	1356.25	1412.00	0.00	0.00	1574.00	1868.12	0.39%	0.48%
19	Little tuna (kawa kawa)	925.00	915.45	7950.00	8025.00	416.87	432.24	9291.87	9372.69	2.33%	2.70%
20	Lizard fishes	5432.00	4925.63	120.00	130.00	0.19	0.06	5552.19	5055.69	1.39%	1.46%
21	Mackerel	14435.00	15465.15	890.54	910.00	16139.16	7906.55	32453.16	26281.80	7.89%	6.99%
22	Octopus	863.50	1256.49	1022.00	1095.00	0.00	0.00	1885.50	2351.49	0.47%	0.68%
23	Oil sardine	27169.00	24789.14	9960.00	10040.00	40267.46	5683.80	77396.46	42412.94	19.40%	11.67%
24	Other carangids	1456.00	923.50	4539.00	4638.00	4.29	2.43	5999.29	5563.93	1.50%	1.60%

Sl. No.	Species	Dakshina Kannada		Udupi		Uttara Kannada		TOTAL		Contribution %	
		Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
25	Other clupeids	1624.00	845.75	2604.00	2757.00	2727.25	1369.16	6955.25	4971.91	1.76%	1.43%
26	Other sardines	1688.56	1918.15	10422.00	10153.10	1709.85	437.44	14155.85	13008.89	3.46%	3.60%
27	Pink Perch	45.00	42.53	1161.00	1206.00	0.00	0.00	1206.00	1248.53	0.30%	0.36%
28	Prawns	0.00	0.00	11.00	14.00	0.00	0.00	11.00	14.00	0.00%	0.00%
29	Metapenaeus spp.	1945.10	2545.15	9472.00	10543.03	2466.07	2243.44	16183.07	16565.59	3.48%	4.41%
30	Parapenaeopsis spp.	769.00	780.96	8446.00	8575.00	1388.27	1211.21	10603.27	10567.17	2.66%	3.04%
31	Penaeid-Penaeus spp.	92.00	145.89	8073.00	8167.00	128.02	198.04	8293.02	8510.93	2.08%	2.45%
32	Puffer fishes	15.00	8.96	0.00	0.00	0.00	0.00	15.00	8.96	0.00%	0.00%
33	Rays	204.00	345.63	300.00	310.00	4.74	3.13	508.74	658.76	0.13%	0.19%
34	Ribbon fishes	3255.13	4596.29	4480.00	4268.00	126.56	59.31	10862.56	12523.61	1.97%	2.57%
35	Seer fishes	376.00	412.21	63.00	75.00	36.23	97.56	475.23	584.77	0.12%	0.17%
36	Setipinna	756.00	654.21	15044.00	14160.00	2829.59	847.98	18629.59	16662.19	4.67%	4.51%
37	Sharks	315.00	396.23	5812.00	5888.00	827.31	1515.98	6954.31	8398.10	1.74%	2.25%
38	Shell fish	8.00	9.10	118.00	120.00	0.00	0.00	126.00	129.10	0.03%	0.04%
39	Silver Bar	0.00	0.00	48.00	54.00	0.00	0.00	48.00	54.00	0.01%	0.02%
40	Silver pomfret	919.00	1105.32	4085.00	4138.00	921.15	1438.15	5925.15	7781.45	1.49%	1.92%
41	Silverbellies	475.00	479.65	192.00	201.00	2931.34	844.14	3598.34	1524.79	0.90%	0.44%
42	Snappers	1590.00	1602.36	21.00	25.00	636.00	2.33	2247.00	1629.69	0.56%	0.47%
43	Soles	150.00	152.32	3843.00	3901.00	1970.90	750.80	5963.90	4804.12	1.49%	1.38%
44	Squids	8234.00	11564.86	4054.00	4130.00	334.45	555.45	12622.45	16250.31	3.16%	4.68%
45	Stomatopods-Oratosquilla	23567.00	21457.81	2513.00	1860.00	428.39	23.76	26508.39	24041.57	6.64%	6.72%
46	Threadfin breams	23507.00	21546.89	6889.00	6941.00	0.00	0.00	30396.00	28487.89	7.62%	8.20%
47	Thryssa	220.00	195.63	293.00	305.00	1516.65	466.81	2029.65	967.44	0.51%	0.28%
48	Tuna	0.00	0.00	5018.00	5861.00	1623.48	699.79	7648.49	6724.79	1.66%	1.89%
49	Wolf herring	212.00	209.63	0.00	0.00	1044.50	635.47	1256.50	845.10	0.31%	0.24%
50	Miscellaneous	1593.10	1519.43	854.10	700.00	9158.33	6956.78	15585.43	9973.67	2.91%	2.64%
Grand Total		148719.39	153692.16	150316.89	153137.13	99891.71	40440.72	398927.99	347270.01	100.00%	100.00%

DISTRICT AND SPECIES-WISE MARINE FISH LANDINGS AND ITS VALUE FOR 2017-18

Quantity: in metric tonnes Value : Rs. in Lakh

Sl. No.	Species	Dakshina Kannada		Udupi		Uttara Kannada		TOTAL		Contribution %	
		Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1	Anchovies	126.00	126.32	850.00	920.00	8.48	2.36	984.48	1048.68	0.24%	0.27%
2	Barracudas	1739.00	1023.63	520.00	622.00	206.48	87.83	2465.48	1733.46	0.60%	0.474%
3	Big jawed jumper	502.00	203.54	1872.00	2145.00	1553.85	818.42	3927.85	3166.96	0.95%	0.81%
4	Black pomfret	276.00	302.42	1070.00	1390.00	9.17	231.47	1355.17	1923.89	0.33%	0.49%
5	Bull's eye	1071.00	875.25	414.00	470.00	133.78	28.60	1618.78	1373.85	0.39%	0.35%
6	Catfishes	1571.00	892.36	870.00	1010.00	280.22	98.50	2721.22	2000.86	0.66%	0.51%
7	Carangids	92.00	89.00	1120.00	1371.00	0.00	0.00	1212.00	1460.00	0.29%	0.37%
8	Coilia	33.00	26.32	1150.00	1410.00	368.42	104.45	1551.42	1540.77	0.37%	0.39%
9	Crabs - Charybdis spp.	437.00	425.63	1285.00	1662.00	0.00	0.00	1722.00	2087.63	0.42%	0.53%
10	Croakers	1794.00	1235.00	2027.00	2272.00	2596.66	394.38	6417.66	3901.38	1.55%	0.99%
11	Cuttle fish	12500.00	24156.35	2826.00	3304.00	993.70	376.00	16319.70	27836.35	3.94%	7.08%
12	Eels	500.00	425.69	242.00	295.00	0.60	0.27	742.60	720.96	0.18%	0.18%
13	Flat fishes & Soles	1737.00	963.36	2843.00	2423.00	0.00	0.00	4584.00	3386.36	1.11%	0.86%
14	Flat heads	236.00	201.36	0.00	0.00	0.00	0.00	236.00	201.36	0.06%	0.05%
15	Halibut	660.00	785.65	620.00	862.00	371.06	245.63	1651.06	1893.28	0.40%	0.48%
16	Horse Mackerel	3004.00	3125.62	2940.00	2392.00	546.15	124.46	6490.15	5642.08	1.57%	1.43%
17	Lactarius	0.00	0.00	1620.00	1864.00	0.00	0.00	1620.00	1864.00	0.39%	0.47%
18	Lady fish	250.00	356.90	1356.00	1952.00	8.50	34.04	1614.50	2342.94	0.39%	0.60%
19	Little Tuna (kawa kawa)	100.00	140.36	1350.00	1636.00	0.00	0.00	1450.00	1776.36	0.35%	0.45%
20	Lizard fishes	4584.00	4023.65	120.00	141.00	0.00	0.00	4704.00	4164.65	1.14%	1.06%
21	Mackerel	7821.00	8635.36	14005.00	15078.00	15041.18	10760.50	36867.18	34473.86	8.90%	8.77%
22	Octopus	412.00	432.56	3122.00	3598.00	0.00	0.00	3534.00	4030.56	0.85%	1.02%
23	Oil sardine	45071.00	40526.37	3676.00	4046.00	26465.33	4408.45	75212.33	48980.82	18.15%	12.45%
24	Other carangids	773.00	789.60	20364.00	24361.00	0.00	0.00	21137.00	25150.60	5.10%	6.39%
25	Other clupeids	1663.00	1238.60	2604.00	3157.00	4158.62	1229.49	8425.62	5625.09	2.03%	1.43%
26	Other sardines	504.00	512.32	2531.00	3113.00	3463.00	156.84	6498.00	3782.16	1.57%	0.96%

Sl. No.	Species	Dakshina Kannada		Udupi		Uttara Kannada		TOTAL		Contribution %	
		Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
27	Pink Perch	79.00	80.50	3161.00	3806.00	0.00	0.00	3240.00	3886.50	0.78%	0.99%
28	Prawns	0.00	0.00	332.00	639.00	0.00	0.00	332.00	639.00	0.08%	0.16%
29	Metapenaeus spp.	2853.00	3965.36	3472.00	5197.00	2876.15	1456.03	9201.15	10618.39	2.22%	2.70%
30	Parapenaeopsis spp.	640.00	720.58	1265.00	2005.00	937.76	755.44	2842.76	3481.02	0.69%	0.89%
31	Penaeid-Penaeus spp.	118.00	125.36	4173.00	5890.00	444.49	314.30	4735.49	6329.66	1.14%	1.61%
32	Puffer fishes	25.00	20.30	0.00	0.00	0.00	0.00	25.00	20.30	0.01%	0.01%
33	Rays	215.00	326.25	650.00	860.00	10.52	6.39	875.52	1192.64	0.21%	0.30%
34	Ribbon fishes	6221.00	7212.02	662.00	1000.00	649.80	65.53	7532.80	8277.55	1.82%	2.10%
35	Seer fishes	412.00	485.60	149.00	378.00	181.22	35.90	742.22	899.50	0.18%	0.23%
36	Setipinna	598.00	425.63	9970.00	11731.00	1083.45	279.87	11651.45	12436.50	2.81%	3.16%
37	Sharks	409.00	421.30	2764.00	4030.00	933.83	2601.28	4106.83	7052.58	0.99%	1.79%
38	Shell fish	5.49	7.20	230.00	562.00	0.00	0.00	235.49	569.20	0.06%	0.14%
39	Silver Bar	0.00	0.00	75.00	285.00	0.00	0.00	75.00	285.00	0.02%	0.07%
40	Silver pomfret	251.00	325.63	866.00	1286.00	158.96	1712.09	1275.96	3323.72	0.31%	0.85%
41	Silverbellies	145.46	150.30	192.24	331.00	4160.54	1099.24	4498.24	1580.54	1.09%	0.40%
42	Snappers	2150.00	2250.36	39.00	148.00	4.47	158.43	2193.47	2556.79	0.53%	0.65%
43	Soles	89.00	90.40	3360.00	3952.00	317.00	765.35	3766.00	4807.75	0.91%	1.22%
44	Squids	7239.00	8231.52	4884.00	5723.00	216.56	579.48	12339.56	14534.00	2.98%	3.70%
45	Stomatopods-Oratosquilla	28258.00	23447.59	5179.26	6218.00	0.00	0.00	33437.26	29665.59	8.07%	7.54%
46	Threadfin breams	34456.00	29564.12	2365.20	2180.00	0.00	0.00	36821.20	31744.12	8.89%	8.07%
47	Thryssa	63.00	55.23	260.00	490.00	40.50	7.97	363.50	553.20	0.09%	0.14%
48	Tuna	0.00	0.00	15620.00	19795.00	1867.00	111.59	17487.00	19906.59	4.22%	5.06%
49	Wolf herring	98.00	82.66	0.00	0.00	8141.83	982.03	8239.83	1064.69	1.99%	0.27%
50	Miscellaneous	4531.00	3956.32	10076.25	7758.03	18660.81	24052.09	33268.06	35766.44	8.03%	9.09%
Grand Total		176311.95	173457.45	141145.95	165758.03	96890.09	54084.52	414347.99	393300.00	100.00%	100.00%

DISTRICT AND SPECIES-WISE MARINE FISH LANDINGS AND ITS VALUE FOR 2018-19

Quantity: in metric tonnes Value : Rs. in Lakh

Sl. No.	Species	Dakshina Kannada		Udupi		Uttara Kannada		TOTAL		Contribution%	
		Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1	Anchovies	118.00	145.25	932.00	897.12	1276.52	531.54	2326.52	1573.91	0.60%	0.42%
2	Barracudas	1754.00	1234.56	1941.00	1821.80	108.73	67.77	3803.73	3124.13	0.98%	0.84%
3	Big jawed jumper	612.00	215.65	2260.00	2155.70	1546.46	835.01	4414.46	3206.36	1.13%	0.86%
4	Black pomfret	315.00	312.56	350.00	734.00	273.80	619.70	938.8	1666.26	0.24%	0.45%
5	Bull's eye	1124.00	965.89	2135.00	2685.00	1972.57	431.79	5231.57	4082.68	1.34%	1.09%
6	Catfishes	1423.00	1012.25	3266.00	1631.75	157.45	96.48	4846.45	2740.48	1.24%	0.73%
7	Carangids	95.00	96.23	0.00	0.00	0.00	0.00	95.00	96.23	0.02%	0.03%
8	Coilia	25.00	28.26	0.00	0.00	418.11	247.76	443.11	276.02	0.11%	0.07%
9	Crabs- Charybdis spp.	450.00	542.13	854.00	997.10	2645.87	1612.02	3949.87	3151.25	1.01%	0.84%
10	Croakers	1894.00	1456.36	1874.00	1947.10	1804.28	1033.89	5572.28	4437.35	1.43%	1.19%
11	Cuttle fish	12542.00	26547.89	2064.00	2026.05	219.90	173.65	14825.90	28747.59	3.81%	7.70%
12	Eels	425.00	478.89	1662.00	636.20	0.00	0.00	2087.00	1115.09	0.54%	0.30%
13	Flat fishes & Soles	1875.00	1142.54	0.00	0.00	0.00	0.00	1875.00	1142.54	0.48%	0.31%
14	Flat heads	245.00	236.12	1214.00	1653.30	0.00	0.00	1459.00	1889.42	0.37%	0.51%
15	Halibut	650.00	845.01	0.00	0.00	356.70	254.03	1006.70	1099.04	0.26%	0.29%
16	Horse Mackerel	2985.00	3247.14	2481.00	2446.60	1431.26	507.30	6897.26	6201.04	1.77%	1.66%
17	Lactarius	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00%	0.00%
18	Lady fish	265.00	457.08	0.00	0.00	76.71	64.74	341.71	521.82	0.09%	0.14%
19	Little Tuna (kawa kawa)	66.00	128.45	3842.00	471.10	3503.47	2673.61	7411.47	3273.16	1.90%	0.88%
20	Lizard fishes	4213.00	4201.12	2999.00	3112.10	14.53	9.99	7226.53	7323.21	1.86%	1.96%
21	Mackerel	8452.00	8852.32	12423.00	13233.00	27720.22	25014.71	48595.22	47100.03	12.48%	12.62%
22	Octopus	411.00	439.63	756.00	722.50	0.00	0.00	1167.00	1162.13	0.30%	0.31%
23	Oil sardine	46023.00	41023.56	12542.00	2159.21	26653.80	19240.74	85218.80	62423.51	21.88%	16.72%
24	Other carangids	754.00	754.21	2120.00	1467.70	0.00	0.00	2874.00	2221.91	0.74%	0.60%
25	Other clupeids	1669.00	1342.56	2928.00	1529.50	4318.32	3156.28	8915.32	6028.34	2.29%	1.61%
26	Other sardines	615.00	509.56	3660.00	1230.27	7533.70	3322.88	11808.70	5062.71	3.03%	1.36%
27	Pink Perch	95.00	78.25	0.00	0.00	0.00	0.00	95.00	78.25	0.02%	0.02%
28	Prawns	0.00	0.00	0.00	0.00	329.11	250.14	329.11	250.14	0.08%	0.07%

Sl. No.	Species	Dakshina Kannada		Udupi		Uttara Kannada		Total		Contribution %	
		Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
29	Metapenaeus spp.	1678.00	3874.52	2843.00	3026.60	3026.40	3389.78	7547.40	10290.90	1.94%	2.76%
30	Parapenaeopsis spp.	545.00	745.23	2497.00	2824.10	1162.19	859.71	4204.19	4429.04	1.08%	1.19%
31	Penaeid-Penaeus spp.	95.00	115.06	2545.00	2627.20	806.60	2249.45	3446.60	4991.71	0.88%	1.34%
32	Puffer fishes	29.00	18.45	0.00	0.00	0.00	0.00	29.00	18.45	0.01%	0.00%
33	Rays	302.00	325.41	523.00	509.00	0.00	0.00	825.00	834.41	0.21%	0.22%
34	Ribbon fishes	6958.00	7320.22	4349.00	11903.10	148.69	110.17	11455.69	19333.49	2.94%	5.18%
35	Seer fishes	545.00	692.35	2150.00	6443.20	433.15	1258.67	3128.15	8394.22	0.80%	2.25%
36	Setipinna	615.00	418.56	499.00	927.07	5543.28	1175.73	6657.28	2521.36	1.71%	0.68%
37	Sharks	315.00	495.64	1756.00	1844.50	402.68	970.67	2473.68	3310.81	0.64%	0.89%
38	Shell fish	4.00	7.23	0.00	0.00	0.00	0.00	4.00	7.23	0.00%	0.00%
39	Silver Bar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00%	0.00%
40	Silver pomfret	245.00	369.32	285.00	603.40	788.34	2212.33	1318.34	3185.05	0.34%	0.85%
41	Silverbellies	135.00	145.26	3911.00	4150.00	1606.35	637.69	5652.35	4932.95	1.45%	1.32%
42	Snappers	2032.00	2256.47	1828.00	2055.30	0.00	0.00	3860.00	4311.77	0.99%	1.15%
43	Soles	86.00	89.69	492.00	402.00	3673.99	1641.71	4251.99	2133.40	1.09%	0.57%
44	Squids	7145.00	8315.46	4593.00	4596.10	1213.62	1050.32	12951.62	13961.88	3.33%	3.74%
45	Stomatopods-Oratosquilla	26548.00	24146.93	1707.00	1590.20	161.73	17.04	28416.73	25754.17	7.30%	6.90%
46	Threadfin breams	24023.00	22922.18	8822.00	10188.00	0.00	0.00	32845.00	33110.18	8.43%	8.87%
47	Thryssa	56.00	57.23	2336.00	577.40	0.00	0.00	2392.00	634.63	0.61%	0.17%
48	Tuna	18.00	32.62	5531.00	6141.10	3510.07	2677.57	9059.07	8851.29	2.33%	2.37%
49	Wolf herring	82.00	79.15	834.00	1698.25	1077.80	709.18	1993.80	2486.58	0.51%	0.67%
50	Miscellaneous	2545.00	1992.36	8091.00	8595.38	2583.90	9285.95	13219.9	19873.69	3.39%	5.32%
Grand Total		163096.00	170712.81	117895.00	114259.0	108500.30	88390.00	389491.30	373361.80	100%	100%

Chapter 1 Annexure 4**YEAR WISE MARINE FISH LANDINGS BY DIFFERENT CRAFTS (2008-2019)**

Sl. No.	Year	Purse-seiners (MT)	Trawlers (MT)	Other mechanized boats (Motorized) (MT)	Rampani (Shore seine) (MT)	Other Non-mechanized Boats (MT)	Total (MT)
1	2008-09	45254.5	130379.45	32559.1	4413.6	5529.95	218137
2	2009-10	55413.55	150364.7	34202.25	2333.2	6415.1	248729
3	2010-11	67702.95	184838.58	73994.05	1760.36	12274.74	340571
4	2011-12	83903.62	175881.9	71850.59	1827.08	13920.07	34738 3
5	2012-13	72958.59	200921	52926.27	320.16	30801.76	357 928
6	2013-14	97475.49	193008.1	42852.99	4246	19775.24	357358
7	2014-15	109096.2	191954.4	62128.24	4387.13	22255.93	389822
8	2015-16	112753.5	234490	45791.35	4360.13	14367.07	4117 62
9	2016-17	88353.1	220562.2	71997.93	4070.33	13944.49	398928
10	2017-18	98035.93	235243.1	57362.97	2309	21396.69	414348
11	2018-19	71872.07	268499.29	25682.76	1288.05	22149.04	389491

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

Chapter 1 Annexure 5

DISTRICT-WISE MARINE FISH LANDINGS BY DIFFERENT CRAFTS

	Purse-seiners	Trawlers	Other mechanized boats (Motorized)	Rampani (Shore seine)	Other Non-mechanized Boats	Total
Dakshina Kannada						
2016-17	19629	125536	3426	74.39	54	148719.39
2017-18	25042.25	147153.56	4026	0	90.14	176311.95
2018-19	20570	139286	3219	11	10	163096
Udupi						
2016-17	30956.2	72438.23	41508	1919.46	3495	150316.89
2017-18	31548	79724.15	25413	2307.8	2153	141145.95
2018-19	10270	93962	13153	510	0	117895
Uttara Kannada						
2016-17	29890.87	19642.48	39912.35	23.32	10422.69	99891.71
2017-18	36398.52	25998.03	21897.92	0	12595.62	96890.09
2018-19	34787.07	32423.24	18410.63	771.05	22108.04	108500.03

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

Chapter 1 Annexure 6

MARINE PRODUCTS EXPORTS FROM KARNATAKA: PORT WISE AND YEAR WISE DETAILS

Port		2014-15	2015-16	2016-17	2017-18	2018-19
<i>MANGALORE/ ICD</i>	Quantity in ton	115470	83954	126405	144235	141980
	Value in Crore	1363.38	1048.08	1584.08	1793.41	1886.43
	US\$ Million	223.2	160.63	278.45	281.54	269.26
<i>KARWAR</i>	Quantity in ton	42	0	0	8	0
	Value in Crore	1.47	0	0	0.88	0
	US\$ Million	0.24	0	0	0.14	0
<i>BANGALORE</i>	Quantity in ton	810	79	202	52	68
	Value in Crore	10.12	2.3	4.98	2.39	4.45
	US\$ Million	1.67	0.35	0.75	0.38	0.64
<i>Total Karnataka</i>	Quantity in ton	116322	84033	126607	144295	142048
	Value in Crore	1374.97	1050.38	1589.06	1796.68	1890.88
	US\$ Million	225.11	160.98	279.2	282.06	269.9
<i>Total India</i>	Quantity in ton	1051243	945892	1134948	1377244	1392559
	Value in Crore	33441.61	30420.83	37870.9	45106.89	46589.37
	US\$ Million	5511.12	4687.94	5777.61	7081.55	6728.5
<i>Contribution from Karnataka to the total exports from India</i>	Quantity in ton	11.07 %	8.88 %	11.16 %	10.48 %	10.20 %
	Value in crore	4.11 %	3.45 %	4.20 %	3.98 %	4.06 %

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

Chapter 1 Annexure 7

RESOURCE-WISE CONTRIBUTION TO INLAND FISH PRODUCTION IN 2018-19

Sl. No.	Resource	Extent	Natural (MT)	Culture (MT)	Total (MT)	Contribution (%)	Per ha production kg/ha (TWSA)
1	Gram Panchayat tanks	52432 ha	209.73	14747.40	14957.13	7.56%	285.27
2	Department tanks	239195 ha	4843.70	112160.99	117004.7	59.12%	489.16
3	Small Reservoirs (<500 ha)	7195 ha	161.89	0.00	161.89	0.08%	22.5
4	Large reservoirs (>500 ha)	265063 ha	7156.70	16812.43	23969.13	12.11%	90.43
5	Water logged area	63091 ha	63.09	0.00	63.09	0.03%	0.68
6	Rivers (Perennial)	5813 km	877.95	0.00	877.95	0.44%	150
7	Estuaries (25 Nos)	7202 ha	5410.50	0.00	5410.5	2.73%	750
8	Private ponds	8000 ha	0.00	10004.70	25472.00	12.87%	2830.22
9	Brackish Water	9000 ha	0.00	25472.00	10004.7	5.05%	1.25
TOTAL			18723.56	179197.52	197921.1		

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

Chapter 1 Annexure 8

DISTRICT WISE INLAND FISH PRODUCTION IN KARNATAKA (2013-2019)

(Quantity in Metric Tons)							
Sl. No.	District	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
1	Bagalkote	860	1958	2427	3349	1903	1736
2	Bengaluru (R)	1174	2788	2393	2110	2531	5798
3	Bengaluru (U)	2814	3938	3946	4423	4434	2618
4	Belagavi	4683	4896	4092	4760	6286	5547
5	Bellary	13698	15004	9124	10388	9094	6994
6	Bidar	2988	2334	1725	1877	3338	1030
7	Vijayapura	7446	9795	6881	4744	9811	8787
8	Chamarajanagar	2094	3883	4243	2017	3497	4995
9	Chikballapur	1766	1690	4177	4309	5682	3772
10	Chikkamagaluru	5341	7211	5814	5409	4132	5646
11	Chitradurga	3995	5875	4488	3768	4405	5116
12	Dakshina Kannada	1106	1112	1106	1203	7067	3353
13	Davanagere	13626	15718	9323	7532	1841	6861
14	Dharwad	2121	2856	2227	1943	446	2517
15	Gadag	835	1071	687	757	5605	594
16	Kalburgi	3813	3410	4079	5024	7620	5840
17	Hassan	10925	10296	9464	9578	3865	11614
18	Haveri	4084	6606	3901	2206	4328	1806
19	Kodagu	2960	3790	3084	3517	3881	3528
20	Kolar	2132	1523	1848	1608	3292	3937
21	Koppal	4212	4458	2749	2219	17418	3252
22	Mandya	35469	14673	17528	12924	7175	23019
23	Mysuru	6064	8517	7721	7332	16172	8902
24	Raichur	13599	18101	12707	10095	20721	11499
25	Ramanagara	3447	4575	4079	5019	7941	6222
26	Shivamogga	26834	43765	17302	17443	3227	23454
27	Tumakuru	9249	12803	11412	9971	11784	11899
28	Udupi	2161	2173	2182	3571	3983	3077
29	Uttara kannada	5749	6451	6441	7688	4931	12016
30	Yadgiri	2705	2150	1677	1782	1762	2490
Total		197950	223420	168827	158566	188174	197921

Chapter 1 Annexure 9

DISTRICT WISE INLAND FISHERIES RESOURCES OF KARNATAKA

SL No.	ZONE	DISTRICT	DEPT. TANKS (>40 Ha Acheut)		G P TANKS (<40 Ha Acheut)		RESERVOIRS		RIVERS Length (in km)
			No.	WSA (in ha)	No.	WSA (in ha)	No.	WSA (in ha)	
1	Bengaluru	Bangaluru (Rural)	102	6085.63	484	5545.64	0	0.00	62.00
2		Chikkaballapura	214	11413.03	1269	8117.52	0	0.00	160.00
3		Bangaluru (Urban)	178	5629.28	143	5819.82	2	2322.00	0.00
4		Kolar	135	11195.21	2328	19964.19	2	472.00	18.00
5		Ramanagara	107	4073.60	417	3098.40	4	1858.00	20.00
6		Tumakuru	400	31333.39	1232	17288.05	4	3078.00	290.00
7	Shivamogga	Shivamogga	448	5958.91	4921	4555.56	9	39542.00	348.00
8		Chikkamagaluru	128	4150.40	1766	4596.20	2	11415.00	158.00
9		Chitradurga	169	17990.64	122	3933.63	3	9753.00	109.00
10	Belagavi	Davanagere	122	7308.03	154	3394.94	2	3625.00	115.00
11		Belagavi	221	3410.92	626	1171.41	5	22914.00	271.00
12		Vijayapura	160	5998.71	89	19.40	2	61835.00	227.00
13		Dharwad	128	1738.78	439	1600.00	1	490.00	0.00
14		Gadag	32	1603.95	96	613.19	0	0.00	25.00
15		Haveri	194	5749.81	1153	4848.08	1	183.00	0.00
16	Mysuru	Bagalkote	42	1988.52	26	141.22	0	0.00	206.00
17		Mysuru	102	4179.31	873	4940.20	3	8585.00	509.00
18		Hasan	172	9517.01	3128	13201.14	3	11723.00	301.00
19		Kodagu	9	17.83	419	843.77	2	1991.00	211.00
20		Mandya	178	11489.96	688	3981.60	4	13419.00	299.00
21		Chamrajnagar	91	5633.60	221	1514.78	3	885.00	218.00
22	Bellary	Bellary	101	8373.31	137	2632.39	4	40143.00	161.00
23		Bidar	92	2295.62	115	498.55	3	6686.00	119.00
24		Raichur	80	3004.35	227	1627.93	3	665.00	275.00
25		Kalburgi	82	3069.03	41	4489.61	6	5803.80	405.00
26		Yadgiri	74	2674.35	270	3753.21	2	245.20	256.00
27	Karwar	Koppal	52	2265.56	40	410.62	5	1643.00	80.00
28		Uttarkannada	86	1133.39	694	2615.38	7	22982.00	335.00
29		Udupi	7	57.38	45	35.72	0	0.00	295.00
30	Mangalore	Dakshina Kannada	0	0.00	251	35.14	0	0.00	380.00
Total			3906	179339.51	22414	125287.29	82	272258.00	5853.00

Chapter 1 Annexure 10

DISTRICT-WISE RESERVOIRS AND WATER SPREAD AREA IN KARNATAKA

Sl. No.	DISTRICT	W.S.A. > 500 HA.		W.S.A. < 500 HA.		TOTAL	
		No.	Area(ha)	No.	Area(ha)	No.	Area(ha)
1	Bengaluru (U)	2	2322.00	0	0.00	2	2322.00
2	Bengaluru (R)	0	0.00	0	0.00	0	0.00
3	Ramanagara	1	1192.98	3	665.00	4	1857.98
4	Chikkaballapura	0	0.00	0	0.00	0	0.00
5	Bagalkote	0	0.00	0	0.00	0	0.00
6	Belagavi	3	22258.00	2	656.00	5	22914.00
7	Bellary	3	39863.00	1	280.00	4	40143.00
8	Bidar	2	6409.00	1	277.00	3	6686.00
9	Vijayapura	2	61835.00	0	0.00	2	61835.00
10	Chamarajanagar	0	0.00	3	885.00	3	885.00
11	Chikkamagalur	1	11250.00	1	165.00	2	11415.00
12	Chitradurga	2	9433.00	1	320.00	3	9753.00
13	D. Kannada	0	0.00	0	0.00	0	0.00
14	Davanagere	2	3624.50	0	0.00	2	3624.50
15	Dharwad	0	0.00	1	490.00	1	490.00
16	Gadag	0	0.00	0	0.00	0	0.00
17	Kalburgi	5	5448.30	1	356.00	6	5804.30
18	Hassan	3	11723.00	0	0.00	3	11723.00
19	Haveri	0	0.00	1	183.00	1	183.00
20	Kodagu	1	1886.00	1	105.00	2	1991.00
21	Kolar	0	0.00	2	472.00	2	472.00
22	Koppal	1	1247.00	4	396.00	5	1643.00
23	Mandya	1	12924.00	3	495.00	4	13419.00
24	Mysuru	3	8585.00	0	0.00	3	8585.00
25	Raichur	0	0.00	3	665.00	3	665.00
26	Shivamogga	8	39398.66	1	144.00	9	39542.66
27	Tumakuru	2	2682.00	2	396.00	4	3078.00
28	Udupi	0	0.00	0	0.00	0	0.00
29	Uttara Kannada	7	22982.00	0	0.00	7	22982.00
30	Yadgiri	0	0.00	2	245.20	2	245.20
TOTAL		49	265063.00	33	7195.00	82	272258.00

Chapter 1 Annexure 11

TALUK-WISE RESERVOIRS AND WATER SPREAD AREA IN KARNATAKA

Sl. No.	District / Taluk	Name of the Reservoir	Location of the Reservoir	W.S.A >500 ha	W.S.A. < 500 ha
BENGALURU					
1	Bengaluru North	Hessarghatta	Hessarghatta	1160.00	0.00
2	Bengaluru South	T.G.Halli	T.G.Halli	1162.00	0.00
RAMANAGARA					
3	Channarayana	Kanva	Kanva	0.00	447.00
4	Kanakapura	Arkavathi	Harobele	665.00	0.00
5	Ramanagar	Bhyramangala	Bhyramangala	0.00	411.98
6	Magadi	Manchanabele	Manchanabele	0.00	334.00
BELAGAVI					
7	Belagavi	Rakkasakoppa	Rakkasakoppa	0.00	360.00
8		Markandya	Basapura	890.00	0.00
9	Hukkeri	Ghataprabha	Hidkal	7800.00	0.00
10	Soundathi	Malaprabha	Naviluthirtha	13568.00	0.00
11	Bylahongala	Tigadiharinalla	Tigadi	0.00	296.00
BELLARY					
12	H.B.Halli	H.B.Halli	Malve	1209.00	0.00
13	Hospet	Thungabhadra	T.B.Dam	37814.00	0.00
14	Sandur	Narihalla	Narihalla		280.00
15		Dharoji	Dharoji	840.00	0.00
BIDAR					
16	Basavakalyana	Mullamari	Sharanagar	0.00	277.00
17		Chulkinala	Chulkinala	737.00	0.00
18	Bhalki	Karanja	Byalhalli	5672.00	0.00
VIJAYAPURA					
19	Muddebihal	Basavasagara	Narayanapura	13048.00	0.00
20	Basavanabagevadi	Lal Bahadur Shastri (Alamatti)	Alamatti	48787.00	0.00
CHAMARAJANAGAR					
21	Chamarajanagar	Suvarnavathi	Suvarnavathi	0.00	485.00
22		Chikkahole	Chikkahole	0.00	120.00
23	Kollegal	Gundal	Gundal	0.00	280.00
CHIKKAMAGALURU					
24	Narasimharajapur	Bhadra	B.R.Project	11250.00	0.00
25	Tarikere	Jambbadahalla	Tarikere	0.00	165.00
CHITRADURGA					
26	Hiriyur	V.V.Sagar	V.V.Sagar	8640.00	0.00
27		Gayathri	J.J. Halli	793.00	0.00
28	Molakalmuru	Rangaiahnadhurga	H.K.Road		320.00

Sl. No.	District / Taluk	Name of the Reservoir	Location of the Reservoir	W.S.A >500 ha	W.S.A. < 500 ha
DAVANAGERE					
29	Channagiri	Shanthisagara	Channagiri	2977.00	0.00
30	Harihara	Devara belekere	Devarabelekere	647.50	0.00
DHARWAD					
31	Kalghatki	Neersagara	Kalghatki	0.00	490.00
KALBURGI					
32	Afzalpur	Bhima lift	--	1098.30	0.00
33	Aland	Amarja	Koralli	640.00	
34	Chincholi	Chandrapalli	Chandrapalli	0.00	356.00
35		Lower Mullamari	nagonala	845.00	0.00
36	Chitapur	Bennithora	Bennithora	2201.00	0.00
37	Kalburgi	Gandori Nala	Mahagoan	664.00	0.00
YADGIR					
38	Yadgir	Hattikuni	Hattikuni	0.00	121.20
39		Soudagar	Soudagar	0.00	124.00
HASSAN					
40	Belur	Vatehole	Vatehole	600.00	0.00
41		Yagachi	Belur	1961.00	0.00
42	Hassan	Hemavathi	Gorur	9162.00	0.00
KODAGU					
43	Somawarpet	Harangi	Hulugunda	1886.00	0.00
44		Chikklihole	Nanjarayanapatn	0.00	105.00
KOLAR					
45	Bangarpet	Bethamangala	Bethamangala	0.00	317.00
46	Malur	Markandeya	Toralakki	0.00	155.00
KOPPAL					
47	Gangavathi	Sannapura	-	0.00	40.00
48		Mallapura	-	0.00	40.00
49	Koppal	Shivapura	Shivapura	0.00	125.00
50		Hirehalla	Mudlapura	1247.00	0.00
51	Kustagi	Kanakanala	Kilarahatti	0.00	191.00
MANDYA					
52	Malavalli	Netkal	Netkal	0.00	95.00
53		Shivasamudra	Shimsha	0.00	320.00
54		Bhima	D.K.Halli	0.00	80.00
55	Srirangapatna	K.R.Sagar	Kannambadi	12924.00	0.00
MYSURU					
56	H.D.Kote	Kabini	Beechanahalli	6092.00	0.00
57		Nugu	Bhirwala	1413.00	0.00
58		Taraka (Forest)	Taraka	1080.00	0.00

Sl. No.	District / Taluk	Name of the Reservoir	Location of the Reservoir	W.S.A >500 ha	W.S.A. < 500 ha
RAICHUR					
59	Devadurga	Gannekal	Gannekal	0.00	292.00
60	Manvi	Rajolibanda	Rajolibanda	0.00	200.00
61	Lingasagur	Maski	Maski	0.00	173.00
SHIVAMOGGA					
62	Hosanagar	Chakra	Pataguppa	1228.00	0.00
63		Savehaklu	Mastikatte	940.00	0.00
64	Sagar	Linganamakki	Kargal	32256.00	0.00
65		Talakale	Kargal	768.00	0.00
66		Sirur	Kargal		144.00
67	Shikaripura	Anjanapura	Anjanapura	1340.00	0.00
68		Ambligola	Ambligola	685.00	0.00
69	Shivamogga	Tunga	Gajanur	1631.66	0.00
70	Thirthahalli	Varahi	Karnapura	550.00	0.00
TUMAKURU					
71	C.N.Halli	Borakanive	Hoysalakatte	1346.00	
72	Koratagere	Theetha	Theetha	0.00	150.00
73	Kunigal	Markonahalli	Markonahalli	1336.00	0.00
74		Mangala	Mangala	0.00	246.00
UTTARA KANNADA					
75	Haliyal	Bommanahalli	Bommanahalli	1539.00	0.00
76	Haliyal	Tattihalla	Tattihalla	2537.00	0.00
77	Mundgod	Dhanna	Malagi	696.00	0.00
78	Supa (Joida)	Supa (KPC)	Supa	12100.00	0.00
79	Karwar	Kadra (KPC)	Mallapura	3775.00	0.00
80	Karwar	Kodasalli (KPC)	Kodasalli	1735.00	0.00
81	Honnavar	Gerusoppa (MPC)	Gerusoppa	600.00	0.00
HAVERI					
82	Hanagal	Chigalli	Mundagoda	0.00	183.00
Total Area ha				265063.00	7195.00

NUMBER OF FISHING FAMILIES AND FISH MARKETS IN KARNATAKA

AS ON 31-03-2019

Sl. No.	District	No. of Families involved in fishing		No. of Fish Markets
		Full Time	Part time	
1	Belagavi	4,067	2,088	3
2	Bagalkot	1,725	2,917	13
3	Vijayapura	1,820	949	162
4	Kalburgi	2,262	910	9
5	Bidar	20,000	10,000	12
6	Raichur	1,233	2,816	-
7	Koppal	3,456	185	12
8	Gadag	159	315	29
9	Dharwad	4,200	1,613	17
10	Uttara Kannada	41,746	35,003	45
11	Haveri	4,957	5,170	3
12	Ballari	8,820	10,510	2
13	Chitradurga	2,525	2,315	30
14	Davanagere	2,540	2,472	4
15	Shivamogga	5,735	3,501	25
16	Udupi	33,549	6,719	112
17	Chikkamagaluru	1,297	1,307	10
18	Tumakuru	11,250	16,200	-
19	Kolara	8,091	94,946	2
20	Bengaluru(U)	2,661	7,372	147
21	Bengaluru(R)	6,182	759	8
22	Mandya	12,870	2,390	20
23	Hassan	6,955	22,961	14
24	Dakshina Kannada	2,638	1,786	123
25	Kodagu	390	2,750	56
26	Mysuru	8,551	5,701	27
27	Chamarajanagara	2,125	8,200	-
28	Chikkaballapura	1,820	1,005	5
29	Ramanagara	1,852	3,087	-
30	Yadgir	2,725	2,398	-
	Total	2,08,201	2,58,345	890

Chapter 1 Annexure 13

DISTRICT-WISE FISHERMEN POPULATION DURING 2018-19

Sl. No.	District	Fishermen Population			Active Fishermen		
		Male	Female	Total	Male	Female	Total
1	Bangalore (U)	10468	2545	13013	2290	557	2846
2	Bangalore (R)	18650	14935	33585	4076	3267	7346
3	Bagalkote	10509	2989	13498	2299	654	2952
4	Belgaum	10806	3562	14368	2363	779	3143
5	Bellary	15245	6672	21917	3334	1459	4794
6	Bidar	25680	10200	35880	5617	2231	7848
7	Bijapur	13850	4560	18410	3029	997	4027
8	Chamarajanagar	9426	1850	11276	2062	405	2466
9	Chickmagalur	8450	4240	12690	1848	927	2776
10	Chitradurga	10814	5950	16764	2365	1301	3667
11	D. Kannada	34629	35282	69911	16186	16492	32678
12	Davanagere	15456	10564	26020	3380	2311	5691
13	Dharwad	10063	4200	14263	2201	919	3120
14	Gadag	6586	1050	7636	1440	230	1670
15	Gulbarga	3245	1055	4300	710	231	940
16	Hassan	13667	6150	19817	2989	1345	4334
17	Haveri	9899	1225	11124	2165	268	2433
18	Kodagu	486	95	581	106	21	127
19	Kolar	71527	33860	105387	15644	7406	23050
20	Koppal	18846	11800	30646	4122	2581	6703
21	Mandya	46800	30430	77230	10236	6656	16892
22	Mysore	12960	3300	16260	2835	722	3556
23	Raichur	12850	6565	19415	2811	1436	4246
24	Shimoga	18965	15296	34260	4148	3346	7493
25	Tumkur	17579	6820	24399	3845	1492	5336
26	Udupi	47877	63677	111554	22379	29764	52143
27	U. Kannada	81370	73975	155345	38034	34577	72611
28	Ramnagar	10635	7625	18260	2326	1668	3994
29	Chikkaballapur	8942	1010	9952	1956	221	2177
30	Yadagiri	17486	9028	26514	3824	1975	5799
Total		593766	380510	974276	170624	126233	296857

Chapter 1 Annexure 14**DISTRICT-WISE FISHERMEN CO-OPERATIVE SOCIETIES AS ON 31/03/2019**

Sl. No.	Name of the District	Total	No. of FCS Working	Defunct	No. of Members
1	Bangalore (U)	30	28	2	4910
2	Bangalore (R)	3	1	2	684
3	Tumkur	31	30	1	4966
4	Kolar	18	12	6	2090
5	Chikkaballapur	7	6	1	916
6	Ramnagar	22	19	3	3298
7	Mysore	49	40	9	5964
8	Chamarajanagar	24	18	6	4782
9	Mandya	44	43	1	11496
10	Hassan	16	16	0	3907
11	Kodagu	1	1	0	45
12	Dakshina Kannada	25	23	2	34180
13	Udupi	55	54	1	84525
14	Uttara Kannada	50	48	2	59401
15	Shimoga	11	10	1	3949
16	Chitradurga	11	6	5	1505
17	Davanagere	19	18	1	3728
18	Chickmagalur	7	7	0	3985
19	Bellary	21	19	2	3536
20	Gulbarga	24	20	4	1889
21	Raichur	25	23	2	3221
22	Bidar	24	16	3	1110
23	Koppal	13	13	0	2439
24	Belgaum	24	23	1	3401
25	Bijapur	24	22	2	5599
26	Bagalkote	21	20	1	5826
27	Dharwad	8	7	1	1047
28	Gadag	10	9	1	1283
29	Haveri	31	30	1	3496
30	Yadagiri	6	5	1	1143
Total		654	592	62	2,68,321

Chapter 1 Annexure 15

DETAILS OF FISH SEED STOCKED YEAR 2017-18

(Seed Stocked: in lakh fingerlings)

Sl. No.	District	Dept. Tanks		G.P Tanks		Private Ponds		Reservoirs		Total	
		No	Seed Stocked	No	Seed Stocked	HA	Seed Stocked	No	Seed Stocked	No	Seed Stocked
1	Bagalkote	26	11.96	32	1.40	8.95	0.65	0	0.00	58	14.01
2	Bengaluru (Rural)	79	43.70	187	17.51	3	0.32	0	0.00	266	61.53
3	Bengaluru (Urban)	155	69.90	125	29.58	24	2.48	2	3.75	282	105.71
4	Belagavi	131	57.71	45	8.96	51	5.33	4	27.01	180	99.01
5	Bellary	65	44.90	13	31.00	685	50.50	1	0.60	79	127.00
6	Bidar	73	12.98	0	0.00	0	0.00	1	5.00	74	17.98
7	Vijayapura	114	102.92	20	8.51	10	3.30	2	45.77	136	160.5
8	Chamarajna gar	85	89.13	1	2.00	6	1.10	0	0.00	86	92.23
9	Chikballapur	176	84.74	48	4.95	1.72	0.93	0	0.00	224	90.62
10	Chikkamagaluru	58	31.92	34	2.21	87	8.65	2	13.38	94	56.16
11	Chitradurga	116	79.18	26	8.98	65	1.49	2	5.92	144	95.57
12	Dakshina Kannada	0	0.00	5	0.49	3.95	0.98	0	0.00	5	1.47
13	Davangere	117	94.33	44	31.97	20.32	4.75	1	4.99	162	136.04
14	Dharwad	97	29.06	67	4.30	8	1.12	0	0.00	164	34.48
15	Gadag	11	2.00	5	1.00	0.2	0.20	0	0.00	16	3.20
16	Kalburgi	80	64.00	60	22.00	17	8.00	2	2.58	142	96.58
17	Hassan	84	73.03	120	21.34	187	6.44	3	16.7	207	117.51
18	Haveri	140	29.10	102	51.10	5	0.50	0	0.00	242	80.70
19	Kodagu	6	13.88	7	7.62	496.5	26.16	0	0.00	13	47.66
20	Kolar	118	88.81	81	28.00	7	0.81	1	0.75	200	118.37
21	Koppal	49	44.38	25	10.80	117	5.97	1	0.60	75	61.75
22	Mandya	176	250.87	321	20.85	6.05	52.40	1	15.97	208	340.09
23	Mysuru	92	86.02	107	51.20	20.65	4.90	0	0.00	199	142.12
24	Raichur	64	120.44	15	8.50	1310	123.50	0	0.00	79	252.44
25	Ramanagara	90	89.70	43	24.73	42	4.20	0	0.00	133	118.63
26	Shivamogga	390	218.28	443	62.00	76.2	21.90	8	63.65	841	365.83
27	Tumakuru	290	144.87	64	14.19	1.5	1.16	2	3.03	356	163.25
28	Udupi	3	2.00	5	0.63	4	0.85	0	0.00	8	3.48
29	Uttara Kannada	85	23.87	21	7.62	2.5	0.79	1	1.92	107	34.20
30	Yadgiri	74	27.04	20	6.00	10	1.25	0	0.00	94	34.29
Grand Total		3044	2030.72	2086	489.44	3276.54	340.63	34	211.62	5164	3072.41

DETAILS OF FISH SEED STOCKED YEAR 2018-19

(Seed Stocked: in lakh fingerlings)

Sl. No.	District	Dept. Tanks		G.P Tanks		Private Ponds		Reservoirs		Total	
		No.	Seed Stocked	No.	Seed Stocked	ha	Seed Stocked	No.	Seed Stocked	No.	Seed Stocked
1	Bagalkote	26	3.69	31	1.99	8.50	0.95	0	0.00	57	6.63
2	Bengaluru (Rural)	50	25.29	57	4.98	4.15	0.69	0	0.00	107	30.96
3	Bengaluru (Urban)	135	77.43	100	27.15	26	1.62	2	2.50	237	108.70
4	Belagavi	113	27.54	30	8.73	23	6.72	5	3.00	148	45.99
5	Bellary	62	16.35	1	1.50	785	50.00	0	0.00	63	67.85
6	Bidar	74	0.00	0	0.00	0	0.00	0	0.00	74	0.00
7	Vijayapura	122	44.66	25	4.90	18	0.72	3	12.40	150	62.68
8	Chamarajnagar	80	55.94	10	4.97	4.01	2.26	0	0.00	90	63.17
9	Chikballapur	131	14.16	35	1.00	1.72	1.29	0	0.00	166	16.45
10	Chikmagalur	82	64.21	67	7.54	140	14.09	2	3.90	151	89.74
11	Chitradurga	72	34.93	18	2.65	14.80	0.70	0	0.00	90	38.28
12	Dakshina Kannada	0	0.00	10	0.50	3.50	1.25	0	0.00	10	1.75
13	Davangere	101	62.50	55	22.39	12.08	5.41	0	0.00	156	90.30
14	Dharwad	96	39.01	46	9.70	8.50	1.90	1	0.25	143	50.86
15	Gadag	20	19.50	1	0.10	0.5	0.18	0	0.00	21	19.78
16	Kalburgi	60	65.00	70	25.00	17	8.00	6	1.10	136	99.10
17	Hassan	84	156.95	157	54.52	163	16.88	3	2.00	244	230.35
18	Haveri	143	23.61	80	2.70	3	0.26	1	7.00	224	33.57
19	Kodagu	6	11.35	13	2.39	639.30	28.28	0	0.00	19	42.02
20	Kolar	88	14.40	2	0.40	3.32	0.46	0	0.00	90	15.26
21	Koppal	19	22.46	40	5.75	35.68	8.57	0	0.00	59	36.78
22	Mandya	173	248.60	84	43.58	5.02	65.76	4	58.84	261	416.78
23	Mysore	93	129.07	112	45.34	20.84	4.12	3	4.00	208	182.53
24	Raichur	64	66.75	5	2.00	586	69.00	0	0.00	69	137.75
25	Ramanagara	83	92.39	15	8.25	43	4.39	0	0.00	98	105.03
26	Shivamogga	422	238.27	546	67.65	34.01	14.60	0	0.00	968	320.52
27	Tumakuru	236	167.74	83	23.95	8.10	7.26	0	0.00	319	198.95
28	Udupi	4	2.10	5	0.50	3.70	1.00	0	0.00	9	3.60
29	Uttara Kannada	85	23.87	21	7.62	2.5	0.79	0	0.00	106	32.28
30	Yadgiri	67	20.00	15	21.90	3	1.25	0	0.00	82	43.15
Grand Total		2791	1767.77	1734	409.65	2617.23	318.4	30	94.99	4555	2590.81

Chapter 1 Annexure 16

DISTRICT-WISE FISH SEED PRODUCTION DURING 2017-18

(in lakh fry)

Sl. No.	District	Department	Zilla Panchayat	T.B.Dam	Private	Total
1	Bengaluru (U)	12.00	0.00	0.00	0.00	12.00
2	Belagavi	22.55	0.00	0.00	0.00	22.55
3	Bellary	0.00	0.00	251.95	982.00	1233.95
4	Chikballapur	35.00	0.00	0.00	0.00	35.00
5	Kodagu	0.00	6.78	0.00	0.00	6.78
6	Kolar	33.00	37.50	0.00	0.00	70.50
7	Koppal	405.00	0.00	0.00	0.00	405.00
8	Mandya	43.00	0.00	0.00	0.00	43.00
9	Mysore	493.50	62.00	0.00	0.00	555.50
10	Shivamogga	2393.00	125.00	0.00	0.00	2518.00
11	Tumakuru	60.50	0.00	0.00	0.00	60.50
Total		3497.55	231.28	251.95	982.00	4962.78

DISTRICT-WISE FISH SEED PRODUCTION DURING 2018-19

(in lakh fry)

Sl. No.	District	Department	Zilla Panchayat	T.B.Dam	Private	Total
1	Bengaluru (U)	23.00	0.00	0.00	0.00	23.00
2	Belagavi	16.00	0.00	0.00	0.00	16.00
3	Bellary	0.00	0.00	225.07	1261.50	1486.57
4	Chikballapur	16.00	0.00	0.00	0.00	16.00
5	Kodagu	0.00	18.20	0.00	0.00	18.20
6	Kolar	47.00	20.00	0.00	0.00	67.00
7	Koppal	280.50	0.00	0.00	0.00	280.50
8	Mandya	0.00	0.00	0.00	0.00	0.00
9	Mysore	755.50	46.50	0.00	0.00	802.00
10	Shivamogga	3346.00	156.75	0.00	0.00	3502.75
11	Tumakuru	86.00	0.00	0.00	0.00	86.00
Total		4570.00	241.45	225.07	1261.50	6298.02
% Change		+30.66%	+4.40%	-10.67%	+28.46%	+26.91%

Chapter 1 Annexure 17

FISH SEED PRODUCED AT DIFFERENT FISH FARMS OF THE STATE

		(Fry in lakhs)					
S.No.	Name of the Fish Farm	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Department Fish Farms							
1	Heseragatta	31.00	27.00	30.00	23.00	12.00	23.00
2	Markonahalli	59.00	68.00	57.00	53.00	61.00	86.00
3	Shivpura	330.00	200.00	316.00	321.00	405.00	281.00
4	Bund breeding (B.R. Project)	1533.00	1902.00	1942.00	1620.00	1475.00	2119.00
5	National fish seed farm (B.R. Project)	1165.00	1241.00	1319.00	955.00	919.00	1227.00
6	Tippaganahalli	29.00	30.00	36.00	32.00	35.00	16.00
7	Markandeya	33.00	25.00	35.00	23.00	33.00	47.00
8	Nugu	0.00	0.00	47.00	182.00	229.00	356.00
10	Hosabudnuru	9.00	20.00	34.00	35.00	43.00	0.00
11	Kabini	135.00	165.00	281.00	274.00	250.00	400.00
12	Gundal	9.00	13.00	28.00	31.00	15.00	0.00
13	Hidkal	28.00	29.00	21.00	40.00	23.00	16.00
14	Kanva	13.00	0.00	0.00	0.00	0.00	0.00
Total (Department farms)		3373.00	3720.00	4146.00	3586.00	3498.00	4570.00
% Change			10.29%	11.45%	-13.51%	-2.45%	30.65%
Zilla Panchayat Farms							
15	Bethmangala	58.00	12.00	21.00	27.00	38.00	20.00
16	Kabini Industrial estate	42.00	34.00	50.00	51.00	62.00	47.00
17	Harangi	5.00	5.00	11.00	8.00	7.00	18.00
18	Gajanur	135.00	81.00	42.00	125.00	125.00	157.00
Total (Zilla Panchayat farms)		240.00	132.00	124.00	210.00	231.00	241.00
% Change			-45.00%	-6.06%	69.35%	10.00%	4.33%
Tungabhadra board							
19	T B board	330.00	284.00	233.00	228.00	252.00	225.00
% Change			-13.94%	-17.96%	-2.15%	10.53%	-10.71%
Private Farms							
20	Pragathi fish seed farm	650.00	347.00	633.00	730.00	8.00	579.00
21	Abhaya fish seed farm	360.00	796.00	780.00	245.00	974.00	683.00
22	Alanahalli fish seed farm	8.00	20.00	0.00	0.00	0.00	0.00
23	Durga fish seed farm	8.00	0.00	0.00	0.00	0.00	0.00
Total (Private farms)		1025.00	1163.00	1413.00	975.00	982.00	1262.00
% Change			13.46%	21.50%	-31.00%	0.72%	28.51%
Grand Total		4968.00	5300.00	5915.00	4999.00	4963.00	6298.00
% Change			6.68%	11.60%	-15.49%	-0.72%	26.90%

DISTRICT WISE DETAILS OF FISH FARMS

Sl. No.	District	No. of Farms			Total	WSA (ha)	Effective WSA (ha)	No of Ponds
		P&R	R	N				
Shivamogga Zone								
1	Chickmagalur	0	2	5	7	1.14	0.67	89
2	Chitradurga	0	1	5	6	3.09	0.83	102
3	Davangere	0	2	3	5	3.03	0.34	87
4	Shivamogga	3	1	4	8	28.87	22.54	392
Mysuru Zone								
5	Kodagu	1	0	3	4	2.56	1.06	98
6	Chamarajanagar	1	0	1	2	1.87	1.87	75
7	Mandya	1	2	5	8	4.63	0.99	121
8	Mysuru	3	1	4	8	6.90	5.94	236
9	Hassan	0	3	5	8	2.18	1.20	118
Mangalore Zone								
10	Dakshina Kannada	0	0	1	1	0.06	0.06	10
11	Udupi	0	1	0	1	0.08	0.04	11
Bellary Zone								
12	Koppal	1	1	0	2	3.74	1.00	46
13	Kalburgi	0	2	0	2	0.40	0.40	18
14	Bellary	0	2	0	2	8.64	6.35	350
15	Bidar	0	1	1	2	0.07	0.00	16
16	Raichur	0	0	2	2	0.07	0.07	22
17	Yadgiri	0	1	0	1	0.24	0.24	35
Belagavi Zone								
18	Dharwad	0	1	0	1	0.20	0.18	11
19	Vijayapura	0	1	1	2	12.50	2.02	402
20	Belgavi	1	2	0	3	3.47	1.79	210
21	Bagalkote	0	0	1	1	0.08	0.06	10
22	Haveri	0	0	3	3	0.98	0.13	9
23	Gadag	0	0	0	0	0.00	0.00	0
Bengaluru Zone								
24	Kolar	2	0	2	4	1.57	0.99	90
25	Tumakuru	1	0	8	9	0.14	0.13	94
26	Bengaluru	1	0	1	2	0.44	0.42	48
27	Bengaluru Rural	0	0	2	2	0.06	0.01	8
28	Ramanagara	0	3	0	3	0.94	0.63	43
29	Chikkaballapura	1	2	1	4	1.54	0.93	85
Karwar Zone								
30	Uttara Kannada	0	1	2	3	8.49	5.65	34
Grand Total		16	30	60	106	97.98	56.55	2870

Note: P&R: Production and Rearing, R: Rearing, N: Nursery

Chapter 1 Annexure 19**YEAR-WISE DETAILS OF FISH SEED STOCKED** (Fish Seed Stocked: in lakh fingerlings)

Year	Department Tanks		Gram Panchayat tanks		Private Ponds		Reservoirs		Total	
	No.	Seed stocked	No.	Seed stocked	ha	Seed stocked	No.	Seed stocked	No.	Seed stocked
2013-14	2211	1620.1	1748	394.57	3345.03	589.29	17	210.57	3976	2814.57
2014-15	3129	2040.8	1728	451.51	3982.06	317.87	20	267.86	4877	3078.065
2015-16	2863	1830.1	1712	405.54	2816.88	296.52	24	186.78	4599	2718.906
2016-17	2657	1307.9	1561	278.44	3112.34	274.25	30	173.42	4248	2034.066
2017-18	3044	2030.7	2086	489.44	3276.54	340.63	34	211.62	5164	3072.415
2017-18	2791	1767.8	1734	409.65	2615.5	318.4	30	94.99	4555	2590.816

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

Chapter 1 Annexure 20

FISH SEED PRODUCTION FOR THE PERIOD (2013-2019)

Year	Catla	Rohu	Mrigal	Common Carp	Others	Total
2013-14	1348.52	1332.99	738.35	1538.63	9.51	4968
	27.14%	26.83%	14.86%	30.97%	0.19%	
2014-15	1429	1510	773	1580	8	5300
	26.96%	28.49%	14.58%	29.81%	0.15%	
2015-16	1462.41	1455.37	1330.65	1661.55	5.03	5915
	24.72%	24.60%	22.50%	28.09%	0.09%	
2016-17	1487.02	1369.7	375.19	1750.18	16.91	4999
	29.75%	27.40%	7.51%	35.01%	0.34%	
2017-18	1346.89	1331.38	737.46	1536.77	9.5	4962
	27.14%	26.83%	14.86%	30.97%	0.19%	
2018-19	1760.92	1617.33	991.94	1913.96	13.86	6298
	27.96%	25.68%	15.75%	30.39%	0.22%	

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

Chapter 1 Annexure 21

FISH SEED PRODUCTION (SPAWN, FRY, AND FINGERLINGS IN LAKHS)

Year	Stage	Catla	Rohu	Mrigal	Common Carp	Others	Total
2016-17	Spawn	2974.00	2739.40	750.40	3500.40	33.80	9998.00
	Fry	1487.00	1369.70	375.20	1750.20	16.90	4999.00
	Fingerlings	743.50	684.90	187.60	875.10	8.50	2499.50
2017-18	Spawn	2693.80	2662.80	1474.90	3073.50	19.00	9924.00
	Fry	1346.90	1331.40	737.50	1536.80	9.50	4962.00
	Fingerlings	673.40	665.70	368.70	768.40	4.70	2481.00
2018-19	Spawn	3522.00	3234.60	1983.80	3828.00	27.60	12596.00
	Fry	1761.00	1617.30	991.90	1914.00	13.80	6298.00
	Fingerlings	880.50	808.70	496.00	957.00	6.90	3149.00

(Source: Handbook of Fisheries Statistics, Department of Fisheries, Govt. of Karnataka, July 2020)

Chapter 1 Annexure 22

DISTRICT WISE WATER LOGGED AND ALKALINE AREA IN THE STATE

Sl. No.	Districts	Area (ha)		Sl. No.	Districts	Area (ha)	
1	Bengaluru (U)	0	0.00%	16	Dakshina Kannada	6044	2.53%
2	Bengaluru (R)	4920	2.06%	17	Udupi	1550	0.65%
3	Ramanagara	1550	0.65%	18	Uttara Kannada	11765	4.92%
4	Tumakuru	7486	3.13%	19	Bellary	24718	10.35%
5	Kolar	2704	1.13%	20	Kalburgi	12526	5.24%
6	Chikkaballapur	2460	1.03%	21	Raichur	25149	10.53%
7	Shivamogga	2187	0.92%	22	Bidar	8558	3.58%
8	Chitradurga	13750	5.76%	23	Koppal	11785	4.93%
9	Chikkamagaluru	4244	1.78%	24	Yadgir	4618	1.93%
10	Davanagere	14705	6.16%	25	Belagavi	9476	3.97%
11	Mysuru	8693	3.64%	26	Dharwad	6354	2.66%
12	Mandya	6132	2.57%	27	Gadag	7540	3.16%
13	Chamarajanagar	3150	1.32%	28	Haveri	1540	0.64%
14	Kodagu	0	0.00%	29	Vijayapura	6240	2.61%
15	Hassan	8575	3.59%	30	Bagalkote	20474	8.57%

**SHRIMP/PRAWN PRODUCTION FROM AQUATIC SOURCES
(MARINE/ESTUARINE AND FRESHWATER)**

Year	Tiger Shrimp		<i>L. Vannamei</i>		Fresh Water Prawn (Scampi)		Total	
	AUC (ha)	EP (MT)	AUC (ha)	EP (MT)	AUC (ha)	EP (MT)	AUC (ha)	EP (MT)
2009-10	1484	1581	0	0	-	-	1484	1581
2010-11	1715	2090	0	0	-	-	1715	2090
2011-12	650	609	72	232	-	-	722	841
2012-13	240	180	154	484	49	60	443	724
2013-14	94	56	157	517	7	3	258	576
2014-15	688.65	498.73	124.76	623.2	0	0	813	1122
2015-16	1948	682	333	1045	0	0	2281	1727
2016-17	735	635	405	1457	-	-	1140	2092
2017-18	302	59	399	1465	-	-	701	1524
2018-19	690	94	219	918	0	0	908.58	1011.06
2019-20	590	34	539.97	1195.1	#	20	1129.97	1229.1

AUC - Area Under Culture in hectares

EP - Estimated Production in MT

– Area under village farms and reservoirs

Chapter 3 Annexure 1**LIST OF ISLANDS IN KARNATAKA**

Sl. No.	Name	Latitude	Longitude	Area (sq. m)	Elevation/MSL (m)
1	ARGE ISLAND	14.7582	74.1287	19000	0
2	ARGE ISLAND	14.7399	74.1558	136143	40
3	BASAVARAJA DURGA ISLAND	14.3137	74.402	1,79,773	0
4	BELLARI GUDDA ISLAND	14.7045	74.2527	7706	6
5	BELLARI GUDDA ISLAND	14.7043	74.2542	3092	3
6	COCONUT ISLAND	13.3796	74.6732	117189	9
7	DARYA BAHADURGARH ISLAND	13.3388	74.6882	81808	14
8	HADI MADI ISLAND 1	14.0838	74.4705	24997	0
9	HADI MADI ISLAND 2	14.0822	74.4785	3398	0
10	HADI MADI ISLAND 3	14.0874	74.4799	6428	0
11	HASIKALLU ISLAND 1	14.0196	74.4882	19396	0
12	HASIKALLU ISLAND 2	14.0177	74.4919	998	0
13	HOG ISLAND JALLIKUND GUDDA	14.0088	74.4809	171510	72
14	KEREKUND ISLAND	14.0252	74.4852	5644	0
15	KEREKUND ISLAND 2	14.0234	74.4857	48171	0
16	KUKRA ISLAND	14.7101	74.2396	102698	28
17	KUMTA POINT ISLAND	14.4165	74.3885	3008	0
18	MAGTODEV ISLAND	14.6608	74.2765	24254	0
19	NETRANI OR PIGEON ISLAND 1	14.0161	74.3268	322951	82
20	NETRANI OR PIGEON ISLAND 2	14.0096	74.3232	13673	-1
21	NORTH ISLAND	13.3441	74.6845	150123	15
22	UNNAMED	14.7136	74.2687	133055	5
23	UNNAMED	14.7130	74.2720	53190	4
24	SOUTH ISLAND	13.3322	74.6909	33476	9
25	ST. MARY ISLAND MIDDLE ROCK 2	13.3613	74.6819	1187	0
26	ST. MARY ISLAND MIDDLE ROCK 3	13.3607	74.6827	830	0
27	ST. MARY ISLAND MIDDLE ROCK 4	13.3602	74.6828	4419	0
28	KWADA ISLAND	14.7346	74.1646	11587	0

29	BUTTON ROCK	14.7249	74.1488	1805	0
30	BUTTON ROCK	14.7257	74.1481	30245	0
31	UNNAMED ROCK	14.7408	74.2292	2532	0
32	UNNAMED ROCK	14.6368	74.2734	3776	0
33	UNNAMED ROCK	14.6347	74.2822	6373	0
34	UNNAMED ROCK	14.6244	74.2730	3719	0
35	UNNAMED ROCK	14.6160	74.2769	7869	0
36	UNNAMED ROCK	14.5258	74.3091	1368	0
37	UNNAMED ROCK	14.5173	74.3189	13219	0
38	UNNAMED ROCK	14.5168	74.3186	4422	0
39	UNNAMED ISLAND	14.0296	74.5098	44871	0
40	UNNAMED ROCK	14.0009	74.5056		0
41	UNNAMED ROCK	13.3995	74.5057		0
42	UNNAMED ROCK	13.9988	74.5064	1995	0
43	UNNAMED ROCK	13.9974	74.5056	1801	0
44	UNNAMED ROCK	13.9817	74.5094	1988	0
45	UNNAMED ROCK	13.9750	74.5239	1456	3
46	FLAT ROCK	13.9736	74.5260	1820	2
47	UNNAMED ROCK	13.8898	74.5815	2590	0
48	WHITE ROCK	13.8886	74.5365	5076	-9
49	WHITE ROCK	13.8877	74.5369	5382	-9
50	UNNAMED ROCK	13.8281	74.6157	2517	0
51	UNNAMED ROCK	13.8278	74.6158	2115	0
52	UNNAMED ROCK	13.8274	74.6157	1447	0
53	UNNAMED ROCK	13.7762	74.6288	732	1
54	UNNAMED ROCK	13.6850	74.6363	7740	0
55	UNNAMED ROCK	13.6858	74.6247	915	-2
56	UNNAMED ROCKS	13.6811	74.6430	2722	0
57	UNNAMED ROCKS	13.6802	74.6425	3720	0
58	UNNAMED ROCK	13.6777	74.6382	1581	0
59	UNNAMED ROCK	13.6591	74.6523	8807	0
60	UNNAMED ROCK	13.6577	74.6522	3741	0
61	UNNAMED	13.6558	74.6513	8355	0
62	UNNAMED ROCK	13.6442	74.6843	427192	5
63	UN NAMED	13.6331	74.6772	103024	4
64	UNNAMED ROCK	13.4528	74.6653	18222	-4
65	UNNAMED ISLAND	13.4625	74.6968	1,11,560	8
66	UNNAMED ISLAND	13.4445	74.7158	176824	12

67	BALA ISLAND	13.4476	74.7139	101989	12
68	UNNAMED ISLAND	13.4238	74.7003	37051	10
69	UNNAMED ROCK	13.2728	74.7213	2812	0
70	CAHP ROCK	13.2428	74.7206	7323	0
71	UNNAMED ISLAND	12.8671	74.8283	127546	7
72	UNNAMED ISLAND	12.8597	74.8300	75865	5
73	UNNAMED ISLAND	12.8540	74.8318	9415	1
74	MULKI ROCKS	13.1988	74.6713	12828	-11
75	MULKI ROCKS	13.1968	74.6742	3368	-11
76	MULKI ROCKS	13.1962	74.6727	2231	-12
77	MULKI ROCKS	13.1939	74.6753	6268	-13
78	BLACK ROCK	13.2826	74.7005	23872	6
79	BLACK ROCK	13.2800	74.7000	31913	8
80	MULKI ROCKS	13.1954	74.6751	10291	-12
81	MULKI ROCKS	13.1976	74.6718	2243	-13
82	SOUTH ISLAND	13.3331	74.6903	3049	4
83	NORTH ISLAND	13.3446	74.6816	8956	4
84	NORTH ISLAND	13.3458	74.6821	4051	3
85	NORTH ISLAND	13.3471	74.6819	3653	2
86	NORTH ISLAND	13.3479	74.6824	14705	3
87	COCONUT ISLAND	13.3768	74.6744	3745	7
88	COCONUT ISLAND	13.3769	74.6748	4986	5
89	COCONUT ISLAND	13.3770	74.6737	825	6
90	COCONUT ISLAND	13.3774	74.6749		0
91	UNNAMED ISLAND	13.4601	74.6983	17067	5
92	UNNAMED	13.6565	74.6513	1826	0
93	UNNAMED ROCK	13.9819	74.5097		0
94	UNNAMED ROCK	13.9821	74.5093		0
95	UNNAMED ISLAND	11.7586	75.4735		0
96	UNNAMED ISLAND	11.7567	75.4759		0
97	UNNAMED ROCK	8.3855	76.9755	7951	2
98	GREEN ISLAND	11.7697	75.4506	32799	0
99	SHORUKULU	11.7557	75.4704	3153	0
100	SHORUKULU	11.7538	75.472	6456	0
101	ROCK ISLAND	11.3035	75.7491	2284	0

RELEVANT INTERNATIONAL CONVENTIONS AND NATIONAL POLICIES RELATED TO BLUE ECONOMY IN INDIA**INTERNATIONAL CONVENTIONS**

The following are International Maritime Organization (IMO) conventions dealing largely with marine pollution such as MARPOL, LC, OPRC & HNS Protocol etc.

1. International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto and by the Protocol of 1997(MARPOL)
2. International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (INTERVENTION), 1969
3. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (LDC), 1972 (and the 1996 London Protocol)
4. International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC), 1990
5. Protocol on Preparedness, Response and Co-operation to pollution Incidents by Hazardous and Noxious Substances, 2000 (HNS Protocol)
6. International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS), 2001
7. International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004
8. The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009

The following are some of the key international conventions dealing with Oceans, Biodiversity, Fisheries, Climate Change, Chemicals and Disasters.

1. Oceans

The United Nations Convention for the Law of the Sea (UNCLOS), as a law of the sea, came into operation and became effective from 16th November 1982.

2. Biodiversity

- a. The Convention on Biological Diversity (CBD) was signed at the Earth Summit in Rio de Janeiro, Brazil, in 1992 and entered into force on 29 December 1993.
- b. The Ramsar Convention on Wetlands is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. It was established in 1971 by UNESCO, which came into force in 1975.
- c. The Convention on Migratory Species (CMS), also known as the Bonn Convention, is an environmental treaty of the United Nations that provides a global platform for the conservation and sustainable use of terrestrial, aquatic and avian migratory animals and their habitats. Signed in 1979 in Bonn, West Germany, the Convention entered into force in 1983.

d. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement between governments that aims to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species. The CITES was signed in the United States of America, on 3 March 1973 and entered in force on 1 July 1975.

3. Fisheries

- a. The United Nations Fish Stocks Agreement (UNFSA) took effect in 2001. It was initiated as a response to a fisheries management crisis involving a class of transboundary fishery resources. These fish stocks were found both within the coastal State's exclusive economic zone (EEZ) and the adjacent high seas. While much of the threat resulted from overfishing and the prevalence of "illegal, unreported and unregulated" (IUU) fishing, the root cause of the crisis was linked to inconsistencies within the U.N Convention on the Law of the Sea (UNCLOS). This gave rise to the development of the UNFSA.
- b. The FAO Code of Conduct for Responsible Fisheries (CCRF) was adopted in 1995 by the FAO Conference. In adopting the CCRF, the Conference called on FAO, states and all those involved in fisheries to implement the CCRF including relevant actions to achieve responsible fisheries. The CCRF sets out principles and international standards of behavior for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity. The CCRF recognizes the nutritional, economic, social, environmental and cultural importance of fisheries and the interests of all stakeholders of the fishing and aquaculture industries.

Although India is also a signatory to FAO's Code of Conduct for Responsible Fisheries (CCRF) framed in 1995, it is yet to implement its national CCRF with a robust legal and institutional framework. In response to the need to strengthen the institutional framework, a new National Policy on Marine Fisheries, 2017 (NPMF, 2017) has been formulated. The Policy is based on seven pillars: sustainable development, socio-economic upliftment of fishers, principle of subsidiarity, partnership, inter- generational equity, gender justice and precautionary approach. The Government proposes to address issues and take advantage of opportunities related to fisheries management, Monitoring, Control and Surveillance, collection of fisheries data and analysis, island fisheries, mariculture, post-harvest and processing, trade, marine environment and pollution, climate change, fisher welfare, social security and institutional credits, gender equity, additional/alternative livelihoods, blue growth initiative, international agreements, regional cooperation, and institutional aspects.

- c. International Guidelines for Securing Sustainable Small-Scale Fisheries (VG-SSF). The SSF Guidelines are aimed at all actors striving to secure sustainable small-scale fisheries, to end hunger and poverty and strengthen human rights. They are a tool to guide dialogue, policy processes, and action at all levels, from local communities to global fora. The final text of the SSF Guidelines was negotiated by FAO Members and endorsed by The Committee on Fisheries (COFI) in 2014, confirming a strong commitment from both governments and civil society to bring about positive change in small-scale fisheries.

- d. Fishing Labor Conventions: Work in Fishing Convention, 2007 (No. 188) and Work in Fishing Recommendation, 2007 (No. 199)- The objective of this convention and recommendation is to ensure that fishers shall have decent conditions of work on board fishing vessels with regard to minimum requirements for work on board, conditions of service, accommodation and food, occupational safety and health protection, medical care and social security.

4. Climate Change

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty addressing climate change, negotiated and signed by 154 states at the United Nations Conference on Environment and Development, informally known as the Earth Summit, held in Rio de Janeiro from 3 to 14 June 1992. It entered into force in March 1994. Its ultimate objective is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic human-induced interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

5. Chemicals

- a. The Stockholm Convention on Persistent Organic Pollutants is an international environmental treaty, signed in 2001 and effective from May 2004, that aims to eliminate or restrict the production and use of persistent organic pollutants.
- b. The Basel Convention is an international treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries (LDCs). The Convention puts an onus on exporting countries to ensure that hazardous wastes are managed in an environmentally sound manner in the country of import. The convention was opened for signature on 21 March 1989, and entered into force on 5 May 1992.

6. Disasters

The Sendai Framework for Disaster Risk Reduction (2015–2030) is an international document that was adopted by the United Nations member states between 14 and 18 March 2015 at the World Conference on Disaster Risk Reduction held in Sendai, Japan, and endorsed by the UN General Assembly in June 2015. The Sendai Framework sets four specific priorities for action i.e., Understanding disaster risk; Strengthening disaster risk governance to manage disaster risk; Investing in disaster risk reduction for resilience and Enhancing disaster preparedness for effective response, and to "Building Back Better" in recovery, rehabilitation and reconstruction.

NATIONAL POLICIES

1. National Marine Fishing Policy, 2017

In April 2017, Government of India has notified the 'National Policy on Marine Fisheries, 2017' (NPMF), which provides guidance for promoting 'Blue Growth Initiative' which focus on ushering 'Blue Revolution' (NeeliKranti) by sustainable utilization of fisheries wealth from the marine and other aquatic resources of the country for improving the lives and livelihoods of fishermen and their families.

2. Draft National Fishing Policy, 2020

Aiming to accelerate the development of the fisheries sector, the Indian government has released the draft National Fisheries Policy 2020 that intends to integrate all components – marine and inland, capture and culture, and post-harvest – in a single document and create an environment to increase investments in the sector, double exports, and incomes of fishers and fish farmers.

It tries to encompass elements of the 'Blue Growth Initiative', the Agriculture Export Policy 2018 and the targets set under the Sustainable Development Goals. The policy also looks at integrating the fisheries sector with other areas like agriculture, coastal development and ecotourism to meet the goals of "Blue Economy" while keeping the "socio-economic upliftment and economic prosperity of fishers and fish farmers" especially traditional and small-scale fishers.

3. Policy for Eco-tourism in Forest and Wildlife Areas in India

Forests and wildlife are inseparable elements of environmental integrity and therefore, a participatory approach towards building the intricate interface between humans and forests is imperative. With a view to practice ecotourism in an eco-friendly manner, a policy has been prepared by the Ministry of Environment, Forest and Climate Change, Wildlife Division, Government of India. The Ecotourism Policy is primarily prepared for wildlife, forest and areas having significant aesthetic appeal for nature.

4. Sagarmala

The Sagarmala Program is an initiative by the government of India to enhance the performance of the country's logistics sector. The program envisages unlocking the potential of waterways and the coastline to minimize infrastructural investments required to meet these targets.

5. India's Blue Economy- A Draft Policy Framework September 2020

The draft policy document outlines the vision and strategy that can be adopted by the government to utilise the plethora of oceanic resources available in the country.

The document has recognised seven thematic areas: National accounting framework for the blue economy and ocean governance; coastal marine spatial planning and tourism; marine fisheries, aquaculture, and fish processing; manufacturing, emerging industries, trade, technology, services, and skill development; logistics, infrastructure and shipping, including trans-shipments; coastal and deep-sea mining and offshore energy and security, strategic dimensions and international engagement.

The policy document aims to enhance the contribution of the blue economy to India's GDP, improve lives of coastal communities, preserve marine biodiversity, and maintain the national security of marine areas and resources.

**PROMINENT ACTS AND RULES PERTAINING TO PROTECTION AND CONSERVATION
OF ENVIRONMENT IN INDIA (DIRECT OR INDIRECTLY RELATED TO WATER
RESOURCES/BIODIVERSITY)**

Environmental laws	Year of Legislation	Brief Description
Easement Act	1882	This law allows private rights to use a resource that is, groundwater, by viewing it as an attachment to the land. It also states that all surface water belongs to the state and is a state property.
Indian Fisheries Act	1897	This law establishes two sets of penal offences whereby the government can sue any person who uses dynamite or other explosive substance in any way (whether coastal or inland) with intent to catch or destroy any fish or poisonous fish in order to kill.
River Boards Act	1956	This law enables the states to enroll the central government in setting up an Advisory River Board to resolve issues in inter-state cooperation.
Karnataka Forest Act	1963	The Act grants the State government the powers to constitute reserved forests, district forest and village forests in the State. The Act also lays down the process by which the government may gain control over private forest land in the State.
Merchant Shipping Act	1970	It aims to deal with waste arising from ships along the coastal areas within a specified radius.
Wildlife Protection Act	1972-73 (Amended 1991)	It provides for the protection of birds and animals and for all matters that are connected to it whether it be their habitat or the waterhole or the forests that sustain them.
Water (Prevention and Control of Pollution) Act	1974	It establishes an institutional structure for preventing and abating water pollution. It establishes standards for water quality and effluent. Polluting industries must seek permission to discharge waste into effluent bodies. The CPCB (Central Pollution Control Board) was constituted under this act.
Water (Prevention and Control of Pollution) Cess Act	1977	It provides for the levy and collection of cess or fees on water consuming industries and local authorities.
Water (Prevention and Control of Pollution) Cess Rules	1978	This law contains the standard definitions and indicates the kind of and location of meters that every consumer of water is required to affix.
Forest (Conservation) Act and Rules	1980-81	It provides for the protection of and the conservation of the forests.
Air (Prevention and	1981	It provides for the control and abatement of air

Control of Pollution) Act		pollution. It entrusts the power of enforcing this act to the CPCB.
Air (Prevention and Control of Pollution) Rules	1982	This law defines the procedures of the meetings of the Boards and the powers entrusted to them.
Karnataka Fishing Harbor Terminals Authority Act	1986	To provide for Fishing Harbor Terminals Authority for development and conservancy of Fishing Harbor Terminals in the State of Karnataka.
Environment (Protection) Act	1986	It authorizes the central government to protect and improve environmental quality, control and reduce pollution from all sources, and prohibit or restrict the setting and /or operation of any industrial facility on environmental grounds.
Environment (Protection) Rules	1986	It lays down procedures for setting standards of emission or discharge of environmental pollutants.
Manufacture, Use, Import, Export, and Storage of hazardous Microorganisms/ Genetically Engineered Organisms or Cells Rules	1989	It was introduced with a view to protect the environment, nature, and health, in connection with the application of gene technology and micro-organisms.
National Environmental Tribunal Act	1995	This has been created to award compensation for damages to persons, property, and the environment arising from any activity involving hazardous substances.
Karnataka Inland Fisheries (Conservation, Development and Regulation) Act	1996	To conserve, develop and regulate inland fisheries in the State.
National Environment Appellate Authority Act	1997	This has been created to hear appeals with respect to restrictions of areas in which classes of industries etc. are carried out or prescribed subject to certain safeguards under the EPA.
Noise Pollution (Regulation and Control) (Amendment) Rules	2000	Noise Pollution (Regulation and Control) (Amendment) Rules
Ozone Depleting Substances (Regulation and Control) Rules	2000	This has been laid down for the regulation of production and consumption of ozone depleting substances.
Biological Diversity Act	2002	It is an act to provide for the conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the use of biological resources and knowledge associated with it.

Disaster Management Act	2005	The Disaster Management Act was enacted with the aim of providing for the efficient management of disasters
The Forest Rights Act (FRA)	2006	It recognizes the rights of the forest dwelling tribal communities and other traditional forest dwellers to forest resources, on which these communities were dependent for a variety of needs such as livelihood, habitation and other socio-cultural needs.
Environment Impact Assessment (EIA) Notification	2006	A management tool to minimize adverse impacts of developmental projects on the environment and to achieve sustainable development through timely, adequate, corrective and protective mitigation measures.
National Green Tribunal Act (NGT Act)	2010	For effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources.
Solid Waste Management Rules (SWM)	2016	This law applies to every municipal authority responsible for the collection, segregation, storage, transportation, processing, and disposal of municipal solid wastes.
Hazardous and Other Wastes (Management & Transboundary Movement) Rules	2016	To control the generation, collection, treatment, import, storage, and handling of hazardous waste.
Plastic Waste Management Rules	2016	To promote and improve plastic waste management system
Plastic Waste Management (Amendment) Rules	2018	To phase out Multi-layered Plastic (MLP) which are “non-recyclable, or non-energy recoverable, or with no alternate use.”
Biomedical waste Management (Amendment) Rules	2018	It is a legal binding on the health care institutions to streamline the process of proper handling of hospital waste such as segregation, disposal, collection, and treatment.
Coastal Regulation Zone Notification	2019	This law puts regulations on various activities, including construction. It gives protection to the backwaters and estuaries.

LIST OF STAKEHOLDER INSTITUTIONS IN BLUE ECONOMY CONTEXT

1. Department of Fisheries, Government of Karnataka
2. Department of Energy, Government of Karnataka
3. Department of Forest, Ecology and Environment, Government of Karnataka
4. Department of Infrastructure Development, Ports & IWT, Government of Karnataka
5. Department of Rural Development and Panchayat Raj, Government of Karnataka
6. Department of Skill Development, Entrepreneurship and Livelihood, Government of Karnataka
7. Public Works Department (PWD), Government of Karnataka
8. Department of Home, Government of Karnataka
9. Department of Revenue, Government of Karnataka
10. Department of Social Welfare, Government of Karnataka
11. Directorate of Municipal Administration, Government of Karnataka
12. Department of Watershed Development, Government of Karnataka
13. Department of Personnel and Administrative Reforms, Government of Karnataka
14. Karnataka Biotechnology and Information Technology Services (KBITS), Government of Karnataka
15. Karnataka State Pollution Control Board (KSPCB)
16. Karnataka State Natural Disaster Monitoring Centre (KSNDMC)
17. India Meteorological Department (IMD)
18. Marine and Coastal Survey Division, Geological Survey of India (GSI)
19. National Institute of Ocean Technology (NIOT)
20. National Institute of Oceanography (NIO)
21. Department of Tourism, Government of Karnataka
22. Karnataka State Remote Sensing Applications Centre (KSRSAC)
23. Space Applications Centre (SAC)
24. Directorate General of Hydrocarbons (DGH)
25. Karnataka State Small Industries Development Corporation (KSSIDC)
26. Department of Mines & Geology (DMG)
27. Indian Institute of Sciences (IISc)
28. National Institute of Technology, Surathkal (NITK)
29. Mangalore University, Mangaluru (MU)
30. Karnataka Power Corporation Limited (KPCL)
31. National Centre for Sustainable Coastal Management (NCSCM)
32. Ministry of Earth Sciences (MoES)
33. Rural Drinking Water and Sanitation Department (RDWSD)
34. Marine Products Export Development Authority (MPEDA)
35. National Institute of Advanced Studies (NIAS)
36. Central Institute of Coastal Engineering for Fishery (CICEF)
37. Indian Fish Meal and Fish Oil Exporters Association (IFMFOEA)
38. Deputy Commissioner, Dakshina Kannada District
39. Deputy Commissioner, Udupi District
40. Deputy Commissioner, Uttara Kannada District

41. Society for Marine Research & Conservation (SMRC)
42. Pilikula Nisargadhama
43. Central Inland Fisheries Research Institute (CIFRI)
44. Central Marine Fisheries Research Institute (CMFRI)
45. Central Institute of Freshwater Aquaculture (CIFA)
46. Central Institute of Fisheries Education (CIFE)
47. Central Institute of Brackish water Aquaculture (CIBA)
48. Central Institute of Fisheries Technology (CIFT)
49. National Bureau of Fish Genetic Resources (NBFGR)
50. Coastal Aquaculture Authority (CAA)
51. National Fisheries Development Board (NFDB)
52. Karnataka Fisheries Development Corporation (KFDC)
53. Rajiv Gandhi Centre for Aquaculture (RGCA)
54. National Centre for Sustainable Aquaculture (NaCSA)
55. Network for Fish Quality Management and Sustainable Fishing (NETFISH)
56. Central Institute of Fisheries Nautical & Engineering Training (CIFNET)
57. Nature Conservation Foundation (NCF)
58. FSL, India
59. Dakshin Foundation
60. Society for Marine Research and Conservation (SMRC)
61. Jungle Lodges and Resorts (JLR)
62. Karnataka State Tourism Development Corporation (KSTDC)
63. Karnataka Renewable Energy Development Ltd. (KREL)
64. Centre for Advanced Training in Earth System Sciences and Climate
65. Ashoka Trust for Research in Ecology & the Environment (ATREE)
66. Canara Green Academy (CGA)
67. Center for Research in Alternative Farming Technologies (CRAFT)
68. Tungabhadra Board
69. Department of Salt
70. Coastal Security Police (CSP)
71. Coastal Development Authority (CDA)
72. Fisheries Research & Information Centre (FRIC)
73. National Institute of Fisheries Post harvest technology and Training (NIFPHATT)
74. National Bank for Agriculture and Rural Development (NABARD)
75. Karnataka Biodiversity Board (KBB)
76. Indian Coast Guard (ICG)
77. Centre for Environment Education (CEE)
78. Environmental Management & Policy Research Institute (EMPRI)
79. Fishery Survey of India (FSI)
80. Karnataka Veterinary, Animal & Fisheries Sciences University (KVAFSU)
81. College of Fisheries, Mangaluru (CoFM)
82. New Mangalore Port Trust (NMPT)
83. Mangalore Refinery and Petrochemicals Limited (MRPL)
84. National Federation of Fishers Cooperatives Ltd. (FISHCOPFED)

