

INTERACT-Bio: Integrated sub-national action for
Biodiversity: Supporting implementation of
National Biodiversity Strategy and Action Plans
(NBSAP) through the mainstreaming of biodiversity
objectives across City-Regions



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INTERACT-Bio
Integrated action on biodiversity

SCOPING REPORT- INDIA

APRIL, 2018

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Deliverable	Date	Document Status

ACRONYMS

ACA:	Asian Cities Adapt
ACCCRN:	Asian Cities Climate Change Resilience Network
ACE:	Autonomous Community Efforts
ADC:	Autonomous District Council
ANERT:	Agency for Non-conventional Energy and Rural Technology
ATREE:	Ashoka Trust for Research in Ecology and the Environment
BASF:	Badische Anilin- and Soda-Fabrik
BIOFIN:	Biodiversity Finance Initiative
BIS:	Bureau of Indian Standards
BMC:	Biodiversity Management Committee
BPCL:	Bharat Petroleum Corporation Limited
BPL:	Below Poverty Line
CAA:	Constitutional Amendment Act
CADA:	Command Area Development Authorities
CAMPA:	Compensatory Afforestation Fund Management and Planning Authority
CBD:	Convention of Biological Diversity
CBUD:	Capacity Building of Urban Development
CCA:	Community Conserved Areas
CCP:	Corporation of the City of Panaji
CDP:	City Development Plan
CEBPOL:	Centre for Biodiversity Policy and Law
CESS:	Centre for Earth Science Studies
CMFRI:	Central Marine Fisheries Research Institute
CMZ:	Coastal Management Zones
CPCB:	Central Pollution Control Board
CPHEEO:	Central Public Health and Environmental Engineering Organisation
CRS:	City Resilience Strategy
CRZ:	Coastal Regulatory Zones
CSD:	Commission on Sustainable Development
CSP:	City Sanitation Plan
CWRDM:	Centre for Water Resources Development and Management
CZA:	Central Zoo Authority
CZMA:	Coastal Zone Management Authority
CZMP:	Coastal Zone Management Plan
DAHDF:	Department of Animal Husbandry, Dairying and Fisheries
DEE:	Department of Ecology and Environment

DGMS:	Directorate General of Mines Safety
EBA:	Endemic Bird Area
EDC:	Economic Development Corporation
EDC:	Eco-development Committee
EEZ:	Exclusive Economic Zone
EIA:	Environmental Impact Assessment
EPIP:	Export Promotion Industrial Park
FAO:	Food and Agriculture Organization
FDA:	Forest Development Agencies
FRC:	Forest Rights Committee
FSI:	Forest Survey of India
FYP:	Five-Year Plan
GCF:	Green Climate Fund
GDP:	Gross Domestic Product
GDDPTA:	Goa, Daman and Diu Preservation of Trees Act
GDDPTR:	Goa, Daman and Diu Preservation of Trees Rules
GEF:	Global Environment Facility
GFM:	Gradient Fingerprint Mapping
GHG:	Green House Gas
GI:	Galvanized Iron
GIAHS:	Globally Important Agricultural Heritage System
GOI:	Government of India
GSIDC:	Goa State Infrastructure Development Corporation
GW:	Giga Watt
ICLEI:	International Council for Local Environment Initiatives
IEA:	International Energy Agency
IGCC:	Integrated Gasification Combined Cycle
IPCC:	Inter-Governmental Panel for Climate Change
IPF:	Intergovernmental Panel on Forestry
ISRO:	Indian Space Research Organization
IUCN:	International Union for Conservation of Nature
IT:	Information Technology
IWRM:	Integrated Water Resource Management
JFM:	Joint Forest Management
JFMCs:	Joint Forest Management Committees
JNNURAM:	Jawaharlal Nehru Urban Renewal Mission
KFRI:	Kerala Forest Research Institute
KINFRA:	Kerala Industrial Infrastructure Development Corporation

KIOCL:	Kudremukh Iron Ore Company Ltd
Km:	Kilometre
KMC:	Kochi Municipal Corporation
KSCSTE:	Kerala State Council for Science, Technology and Environment
KTCE:	Karnataka Tree Cover Enhancement
KWA:	Kerala Water Authority
KWBS:	Kuttanad Water Balance Study
LPA:	Local Planning Area
LVB:	Low Value By-catch
MCC:	Mangalore City Corporation
MCF:	Mangalore Chemicals and Fertilizers Ltd
MDT:	Multiday trawlers
MLD:	Millions of Litres per Day
MoEF:	Ministry of Environment and Forest
MoEFCC:	Ministry of Environment, Forest and Climate Change
MoHUPA:	Ministry of Housing and Urban Poverty Alleviation
MoTA:	Ministry of Tribal Affair
MoUD:	Ministry of Urban Development
MPEDA:	Marine Products Export Development Authority
MPG:	Miles per Gallon
MRDA:	Minerals Regulation and Development Amendment
MRPL:	Mangalore Refinery and Petrochemicals Ltd
MT:	Metric Ton
MUDA:	Mangaluru Urban Development Authority
MULT:	Multi-user Liquid Terminal
NAAS:	National Academy of Agriculture Science
NAFCC:	National Adaptation Fund for Climate Change
NAPCC:	National Action Plan on Climate Change
NBA:	National Biodiversity Authority
NBARD:	National Bank for Agriculture and Rural Development
NBAGR:	National Bureau of Animal Genetic Resources
NBAP:	National Biodiversity Action Plan
NBSAP:	National Biodiversity Strategy and Action Plan
NBSAP:	National Biodiversity Strategy and Action Plans
NBWL:	National Board for Wildlife
NBT:	National Biodiversity Target
NDMA:	National Disaster Management Authority
NDMP:	National Disaster Management Plan

NFP:	National Forest Policy
NGO:	Non-Government Organization
NGPDA:	North Goa Planning and Development Authority
NGT:	National Green Tribunal
NH:	National Highway
NIE:	National Implementing Entity
NLCP:	National Lake Conservation Plan
NMT:	Non -Motorised Transport
NOC:	No Objection Certificate
NPCA:	National Plan for Conservation of Aquatic Eco-systems
NRCP:	National River Conservation Plan
NRM:	Natural Resource Management
NTCA:	National Tiger Conservation Authority
NTFP:	Non-timber Forest Products
NWCP:	National Wetlands Conservation Programme
ODP:	Outline Development Plan
PAT:	Perform, Achieve and Trade
PBR:	People's Biodiversity Register
PCCF:	Principal Chief Conservator of Forests
PIB:	Press Information Bureau
PIK:	Potsdam Institute for Climate Impact Research
PLIA:	Public Liability Insurance Act
PPP:	Public Private Partnership
PRI:	Panchayati Raj Institutions
PWD:	Public Works Department
RGCB:	Rajiv Gandhi Centre for Biotechnology
R&D:	Research and Development
SACON:	Salim Ali Centre for Ornithology and Natural History
SAPCC:	State Action Plans on Climate Change
SBB:	State Biodiversity Board
SBSAP:	State Biodiversity Strategy and Action Plan
SCP:	Smart City Proposal
SDT:	Single Day operating Trawlers
SEZ:	Special Economic Zone
SFDS:	State Forest Departments
SFM:	Sustainable Forest Management
SG:	Sacred Groves
SLR:	Sea Level Rise

SPCB:	State Pollution Control Board
SWM:	Solid Waste Management
STP:	Sewage Treatment Plant
TBGRI:	Tropical Botanic Garden & Research Institute
TCPD:	Town and Country Planning Department
TDR:	Transfer of Development Rights
TERI:	The Energy and Resources Institute
TGCS:	Tree Growers' Cooperative Societies
UFW:	Unaccounted for Water
ULB:	Urban Local Body
UGC:	University Grants Commission
UNDP:	United Nations Development Programme
UNEP:	United Nations Environment Programme
UNESCO:	United Nations Education Scientific and Cultural Organization
UNFCCC:	United Nations Framework Convention on Climate Change
URDPFI:	Urban and Regional Development Plans Formulation and Implementation
UT:	Union Territory
VFC:	Village Forest Council
VSS:	Vana Samrakshana Samithi
VEDC:	Village Eco-development Committee
WCCB:	Wildlife Crime Control Bureau
WHO:	World Health Organisation
WPA:	Wildlife (Protection) Act
WUCS:	Water User Cooperative Society
WWF:	World Wildlife Fund
ZSI:	Zoological Survey of India

EXECUTIVE SUMMARY

Introduction and Background

India, a mega biodiverse country, with four of 35 global biodiversity hotspots and 10 biogeographic zones, and a signatory to the Convention of Biodiversity (CBD), is facing rapid urbanisation. Although the country produced an updated version of its National Biodiversity Strategy and Action Plan (NBSAP) in 2014, there have been several limitations to implementation of the actions. The INTERACT-Bio project aims to, within this context, support the implementation of the NBSAP at the subnational level, in line with Aichi Target 2. Additionally, the project also supports Aichi Targets 1 and 17.

The scoping study is a document which aims at establishing the baseline and providing the information and context within which project interventions can be identified and prioritized. This scoping study report is divided into four parts. The first three parts capture the scoping analyses and assessments and the last part sets out the proposed interventions concepts. The baseline situation scoping intends on allowing for a clearer understanding of the current situation regarding biodiversity mainstreaming and NBSAP implementation. This includes assessing and understanding the legal and policy frameworks; institutional arrangements and governance systems; economic and social priorities, development pressures and challenges that drive change and biodiversity loss; and opportunities for near and long term development and biodiversity gains. The technical scoping focusses on nature's benefits and adopting an ecosystem services perspective. Ecosystem services offer various benefits, which can be classified into four categories- provisioning, regulating, supporting, and cultural that play a significant role in urban life.

Primary (interviews, stakeholder meetings and discussions) and secondary (review of published and unpublished literature) means of data collection were adopted. The information thus generated was fitted within the framework of the report to ultimately establish a baseline, identify the gaps and propose project intervention entry points.

National Biodiversity Status

India harbours eight percent of the world's recorded species having more than 45,000 species of plants and 100,000 species of animals. Four of the global biodiversity hotspots represented by the Himalayas, the Western Ghats, the North-east, and the Nicobar Islands are present here. The Western Ghats, considered one of eight "hottest hotspots" of biological diversity around the world is on the UNESCO World Heritage List. Due to a number of factors including geomorphology, and an intersection of varied climatic regions, almost all the major ecosystem types of the world are represented in the country.

An important feature of India's biodiversity is its high level of endemism. Endemism is significant across different plant groups with about 4,045 species of flowering plant (angiosperms) of 141 genera belonging to 47 families being endemic. In terms of endemism of vertebrate groups, India's global ranking is 10th in birds (69 species), fifth

in reptiles (187 species), and seventh in amphibians (110 species). It is one of eight recognised centres of origin of cultivated plants, and is the centre of origin of rice. India has 15 agro-climatic zones which has enabled a reported diversity of 811 cultivated plants and 902 of their wild relatives. Additionally a wide gamut of native breeds of domesticated ungulates and poultry also contribute to a rich repertoire of domestic faunal diversity.

India developed its first NBSAP in 1999, which since then has undergone two revisions. In 2008, the National Biodiversity Action Plan (NBAP) was defined, which was then updated through an addendum in 2014. The 2014 Addendum primarily comprises of 12 National Biodiversity Targets (NBTs) which link with the Aichi Biodiversity Targets and the 175 actions of the 2008 National Biodiversity Action Plan (NBAP). Some limitations of the NBAP which impact mainstreaming of biodiversity concerns, include its lack of decisive and well formulated action plans to address the issues it sets out, absence of plans for sustainable use and benefit sharing, plan timelines that are too flexible and the narrow enforcement channels of the objectives of the plans i.e. through schemes and programs of the relevant ministries. The new generation of NBSAPs should focus more on the implementation mechanism, measureable targets and the incorporation of the biodiversity-poverty reduction linkage. Improving sectoral ownership at the central and state level, increasing vertical and parallel (Civil Society, NGO involvement) cooperation will strengthen the implementation of the NBTs and lead to mainstreaming.

29 states and the seven union territories have prepared State Biodiversity Strategy and Action Plans in 2003 including the three project states, Kerala, Karnataka and Goa. However, as of 2017, revisions to the SBSAPs have not been completed to synergise with the NBAP 2008 or the NBAP Addendum 2014, although some states have started the process. This needs to be taken up immediately as it will lead to state ownership thereby leading to mainstreaming of Biodiversity Planning at this level.

No Local Biodiversity Strategy and Action Plans have been developed. The project will generate the first in the country for the city of Kochi.

Institutional Landscape and Policy Framework

Five types of biodiversity governance models in India include territorial forests and protected areas which fall under the protected area governance model and autonomous community efforts, co-management of forests and decentralized governance of biodiversity which are community based conservation models.

Biodiversity conservation is both a National and State subject and the institutional setup spans all three levels- National, State and Local. The nodal agency at the national level is the Ministry of Environment, Forest and Climate Change which is responsible for the planning, promotion, co-ordination and overseeing of the implementation of India's environmental and forestry policies and programmes, including biodiversity considerations. The judiciary has played a proactive and facilitative role in environmental protection, including biodiversity conservation. Particular to the Indian

Biological Diversity Act 2002, is the National Biodiversity Authority (NBA) which implements the former through a decentralised set-up. State Level Authorities of significance include State Forest Departments and State Biodiversity Boards while Panchayati Raj Institutions and Biodiversity Management Committees are of local importance.

While India's growth priorities have been clearly biased towards economic growth and development, it does have a rich policy and legal tapestry when it comes to Biodiversity Management and Protection. Protection of the environment, including biodiversity, is enshrined in the Constitution of India. Some of the key policies that have been developed include: (i) National Forest Policy, 1988 which is presently being revised; (ii) National Conservation Strategy and Policy Statement on Environment and Development, 1992; (iii) National Agriculture Policy, 2000; (iv) National Seeds Policy, 2002; (v) National Environment Policy, 2006; (vi) National Water Policy, 2012; and (vii) National Marine Fishing Policy, 2017. Some important laws include The Indian Forest Act, 1927; The Forest (Conservation) Act, 1980; The Joint Forest Management (JFM) Circular, 1990; The Wildlife (Protection) Act, 1972; The Environment (Protection) Act, 1986; The Water (Prevention and Control of Pollution) Act, 1974; The Air (Prevention and Control of Pollution) Act, 1981, Biological Diversity Act (2002). At the State level, these policies and laws have been framed and modified according to the local context.

Of late however, recent revisions of these policies and legal notifications lay emphasis on Public-Private-Partnership (PPP), leading to erosion in the level of protection provided earlier by the laws and policies. The recent draft of the 1988 forest policy, the draft CRZ 2018 notification and EIA notification of 2016 are such examples. There should be cognizance of the fact that a large body of work recognises overwhelming benefits that a healthy environment and biodiversity has on socio-economic sectors.

At the local level, the policy and legal landscape is sparse. Fewer sector specific frameworks exist and most come under the broad heading of City Development Plans or City Sanitation Plans. Often, directives and constitutional provisions do not trickle down at the local level, for eg; the complete devolution of powers granted by the 73rd and 74th Constitutional Amendments. This is especially felt at the city level.

City Region Scoping

The project's selected city-regions, Kochi, Panaji and Mangaluru, are fast-growing cities, located within areas of globally unique biodiversity and complex development challenges. Kochi has been selected as the model city while Panaji and Mangaluru are satellite cities.

Situated in Ernakulam district, on the west coast of India, Kochi is the largest urban agglomeration in Kerala, with an area of 107.13 km². It is an important trade and commerce centre in the state, due to its all-weather harbour, presence of large and medium scale industries as well as Special Economic Zones (SEZ) and a popular tourist site. It has a population of 601,574 according to the 2011 Census and scores high on human development indicators such as education levels and literacy. As the city grew,

land-use and land patterns shifted affecting primary sectors of agriculture and fisheries to favouring that of secondary (industrial) and tertiary and ones. The city's iconic canal system fell into disrepair with the development of road and rail facilities and the city itself underwent rapid change due to sudden urbanisation and influx of population from surrounding areas and states. Being at the core of developmental and economic growth, the slum population also shown a steady increase. Urban services and planning has been unable to keep pace with rapid urbanisation and the city has to deal with its population of landless poor increasing, disproportionate increase in traffic versus infrastructure management and population spill-over outside its municipal boundaries. Climate Change adds to another layer of complexity to the management of infrastructure and services. Kochi can expect an increase in precipitation and temperature and sea-level rise in years to come, which will have significant impacts on infrastructure, human health (increased incidences of dengue-related morbidity), fisheries industry, and tourism. Kochi's development focus lies in augmenting urban services and improving the quality of life for its citizens.

Although a comprehensive survey of the biodiversity of the city is lacking, it has emerged through a review of available literature, and ecosystem service appraisal and discussions with stakeholders, that two ecosystems are critical to the city- the mangroves of the city and the backwaters (including the Vembanad Lake also called the Kochi Lake in the city). Each of these ecosystems hosts a unique assemblage of species and renders significant ecosystem services to the city. Home gardens and a special type of rice cultivation, known as Pokkali (cultivating a saline-tolerant variety of rice) are also good reservoirs of biodiversity. Land-use planning of the city is mostly carried out through regional and city development plans and although the plan acknowledges the need for enforcement of strict land use control in and around environmentally sensitive areas, this is rarely followed. Mainstreaming of biodiversity concerns in planning and developmental projects is limited to environmental education in schools and promotion of organic farming. However, since the commencement of the project, there has been a significant change and the city has incorporated biodiversity related initiatives in the municipal budget for 2018-2019. While Kochi has constituted its BMC, work remains to be taken up under this institution.

Kochi is in the most urbanized region of Kerala; in Ernakulam District the percentage of urban population (47.56 percent) is far beyond that of the state (25.96 percent). The influence of development in the city and the immediate surroundings extends much further than just the district. There has been considerable increase in built up areas by way of conversion of the natural vegetation especially in low lying and cultivated areas. The city's low lands which were used for paddy cultivation are steadily being lost to reclamation. The iconic canal system which was used for navigation now functions either as wastewater drains or has been encroached upon. All of these changes have exacerbated flooding and water logging within the city. The foremost environmental issue for most of the urbanised areas of the state is water pollution. Degradation of aquifers and rivers is due to release of effluents (agricultural, industrial and domestic), over-extraction of ground water and saline water ingress. Another urban issue is solid waste management. Most of the waste is either dumped in landfills or on the road

sides, drains and canals. Slums mushrooming around narrow streets and canals combined with the lack of awareness on hygiene have created large scale environmental problems for the Corporation to deal with. A large part of Kochi falls under a coastal ecosystem which is under threat due to clearing of vegetation, pollution, over-extraction, negligence and reclamation. Poor management strategies, a lack of awareness and technical capacity impede recovery measures.

Mangaluru, the administrative headquarters of the Dakshin Kannada district is a rapidly growing city and the fourth largest in the state. Mangaluru is the highest populated urban centre in the Dakshin Kannada District with a population of 499,487 according to the 2011 Census. Like Kochi it evolved as a trading centre with an economy that was principally based on agricultural processing and port-related activities. However, over the years it has become a multi-functional city with business (trade and commerce), skilled jobs (industries) and administration emerging as important sources of employment. Mangaluru is one of the fastest growing and urbanizing coastal cities of the Karnataka state largely due to high rates of rural to urban migration. Mangaluru can expect a decrease in precipitation, but an increase in temperature and sea-level rise in years to come, which can threaten the submergence of some parts of the city. Despite significant threats to the city from Climate Change and Urbanisation, the city's focus for the future primarily rests on the revitalisation of industries, balancing production and transportation with service and digital economies.

Biodiversity of the city has been poorly documented. From the available literature, it appears that the Gurupura River and the wetlands of Kenjar may be significant ecosystems within the city. Land-use planning takes place through the Master Plan for Mangaluru. Over the years there has been a great deal of conversion of agricultural land into other uses at a rapid pace and although a large proportion of the open space areas fall under Coastal Regulatory Zone (CRZ) and Coastal Management Zone (CMZ) as required under the Environmental (protection) Act 1986, the city does not have an active Coastal Zone Management Plan (CZMP) in place. There is an absence of any prioritisation of biodiversity mainstreaming and management in the city.

Urbanisation and industrial development have gone hand in hand in the city. While the city's fast paced growth, industrialization and modernization, has positively impacted its image as an attractive real estate destination in Karnataka, it has also resulted in a number of hazards within the surrounding urban environment. Like most other Indian cities, Mangaluru has been unable to match up with increased growth and urbanisation, leading to greater pressure on the existing urban water supply and sanitation systems, problems of industrial pollution, solid waste and sewerage disposal and over exploitation of coastal natural resources. Expanding infrastructure facilities is leading to agricultural land conversion into built-up areas. Unchecked sand mining and reclamation of wetlands are not only impacting biodiversity in these areas but also the city's resilience to cope with climate change.

Panaji is Goa's capital city, a commercial and administrative centre and the largest urban agglomeration in the state. Bound by several water bodies, the city lies in an ecologically sensitive zone and occupies an area of 8.12 km². As there is a shortage of

developable land in Panaji, urban sprawl is constrained severely. According to the Census 2011 data, there is a population of 40,017, and being the state capital, a major tourist destination, it attracts a large floating population daily. Like the other coastal cities detailed above, literacy levels are high. Panaji has a mixed economic base, agriculture and tourism being the more significant amongst them. The city's local and international popularity for coastal tourism has led to the growth of a number of industries such as the hospitality industry, transport industry, retail industry and unorganised sectors. With a large portion of the city under commercial activities, Panaji has grown substantially from being a small fishing village to the most influential city in Goa. Tourism has given way to a rapidly urbanizing coastal belt of Goa. With development of real estate, trade and commerce and educational institutions in the city, a steady stream of migrants from rural Goa and the neighbouring states of Karnataka and Maharashtra have led to the formation of slum pockets in some areas. In terms of climate change, Panaji can expect an increase in precipitation and temperature. Sea level rise also poses a threat down the line, which will impact the city's GDP, coastal wetland ecosystems and increase the number of climate migrants. The city's priorities are on sustainable development and growth, while improving urban services and strengthening blue green infrastructure to meet the needs of its citizens and the large floating population.

Like Mangaluru, Panaji too lacks a comprehensive assessment of its biodiversity. In its City Development Plan, there is the mention of a study conducted by the Goa State Biodiversity Board which recorded 404 species in Panaji city out of which 46 percent comprised of flora and 54 percent comprised of fauna. The Mandovi and Zuari Rivers, along with the Arabian Sea provide the city with a high aquatic diversity. The city has formed its BMC, however, a biodiversity strategy and action plan is yet to be developed.

Panaji is located in an eco-sensitive zone and high urbanisation and land reclamation for development is impacting it adversely. The city's resilience to various natural disasters has been compromised due to loss of green spaces to rampant construction, inefficient basic service provision, and growth of urban slums in an unplanned manner. Large tracts of ecologically sensitive areas/ecosystems, i.e. mangroves, sand-dunes and Khazan lands are being lost due to encroachment and conversion of land. Natural and constructed drains are choked with solid and liquid waste, which in turn leads to contamination of ground water. Saline intrusion is increasing due to unfettered withdrawal of water to meet real-estate development needs. Tourism and urbanisation have been the biggest threats to Panaji's ecosystems. With a growing need to develop more infrastructure to cater to the growing population and tourists, mangroves are being cleared, sand dunes are being destroyed, over exploitation of fishery resource is taking place, wetlands and agricultural lands are being reclaimed and water bodies are being polluted.

Recommendations and Way Forward

Policy recommendations and interventions planned

Inclusion of biodiversity conservation and nature based solutions in city level planning is most visible through the annual budget of the city municipal corporation. In the city of Kochi, the project has attained success in this regard. The city has earmarked funds worth INR 230 million, for several activities on conservation of urban biodiversity and sustainable utilization of the same, in the budget for the financial year of 2018-19.

A road map for developing green and sustainable cities through nature based solutions for each project city needs to be developed. This road map will consist of a basket of interventions (short term implementation as well as long term implementation) that the city government can prioritize and take steps for implementation of the same. Some of the interventions which have been shortlisted for Kochi include

- 1) Development of an action plan for Vembanad Lake: An action plan for the lake taking into account restoration, rejuvenation and sustainable livelihood options for the fishermen folk living around the lake will be developed.
- 2) Development of a policy brief to make the case for mainstreaming ecosystem services (mangroves in particular) into city planning and decision making.
- 3) Well rejuvenation: This intervention involves mapping all the wells in the city of Kochi, along with their ownership which will feed into a plan aimed at the rejuvenation of wells and maintaining the public wells as a source of drinking water for the city.
- 4) Development of a city resilience plan using nature-based solutions: This is a long term intervention and will focus on the development of a city resilience plan for Kochi, with focus on nature based solutions and the integration of the same into urban planning.

Vertical and horizontal integration

In order to promote effective vertical integration, a project steering committee has been formed which comprises of representatives at the National, State and City levels. The committee is headed by the Additional Secretary, MoEFCC. Members of the committee include the Chairperson of the NBA, representatives of the three concerned SBBs and the three city municipal corporations, along with ICLEI South Asia.

Various stakeholder workshops and events are being organised in the model city (Kochi) in order to promote horizontal integration. These workshops are also attended by representatives from the satellite cities and the concerned SBBs.

Capacity building recommendations and interventions planned

The city authorities and stakeholders in all the three project cities are not very well aware of the concept of ecosystem services and steps that can be taken to promote integration of nature based solutions into urban planning. In order to ensure deeper impacts of project in the long run, regular consultations, capacity building and interaction with stakeholders need to be sustained. Already three workshops have been

organised in Kochi which have resulted in identification of the critical ecosystems and the services provided by the same. Schools have already been targeted through a series of activities like lecture series, painting competitions, quiz competitions etc. Various interventions, other than workshops have been shortlisted. These include activities which aim at biodiversity communication with the citizens. One of such activities planned is summarised below.

- 1) Development of butterfly gardens in schools: The project in association with the city municipal corporation will be developing butterfly gardens in 20 schools in Kochi. These butterfly gardens will support the propagation of indigenous species of plants and insects, which will on one hand, enhance the urban biodiversity of the city and on the other hand will also serve as demonstration sites for students. The financial support for this initiative will be extended by the city corporation of Kochi and technical support will be provided through the project.

Ecosystem-based pilot projects

For mainstreaming interventions to succeed they need to be packaged in a way that resonates with local priorities and do not come across as being anti-development. Secondly, the identification and design of mainstreaming interventions and pilot demonstration projects should be in consensus with ideas and thoughts of the city leadership as well as citizens. To facilitate ongoing buy-in and commitment to mainstreaming, interventions and projects must deliver visible and concrete results at an early stage in the project. However, to ensure that mainstreaming is sustained, embedded institutionally and scaled up, it is necessary to balance short term quick wins with policy and paradigm shifting interventions that have a longer term impact on horizon and incentivize decision-making and promote behavioural change.

Some pilot project ideas identified for the city of Kochi include:

- 1) Restoration of Thevara Canal: Thevara Canal, a heavily silted and polluted canal of the city will be restored by providing solutions to waste dumping presently carried out by the government fish market that is located in its vicinity, restoring its banks with native vegetation and organising awareness generation activities.
- 2) Mangroves: A study on and mapping of the ecosystem services provided by the mangroves will build the case for the protection of the presently unprotected mangrove patches around Mangalavanam and other areas like Edakochi. Awareness generation workshops will be carried out with the owners and stakeholders in order to communicate the significance of mangrove conservation.
- 3) Mangalavanam Bird Sanctuary: Sewage discharge into the sanctuary can be arrested with some engineering solutions between the polluting line and an alternate pipeline. This can be addressed through the project.
- 4) City heat island: The heat islands in the city will be mapped and nature based solutions such as permeable solutions, rooftop/rain gardens and plantations will

be encouraged in those areas. These will on one hand improve ground water recharge and on the other hand reduce the heat island effect. The project of roof top gardening offers a good opportunity to involve the households and can also be linked to KMC's initiative to award the best woman roof top gardener.

The interventions identified in this report contain a mix of hard and soft measures. Implementing these will promote the agenda of mainstreaming of biodiversity conservation into city planning.

PART A INTRODUCTION AND METHODOLOGY

1 INTRODUCTION AND BACKGROUND

This report is submitted as the result of Work Package 1 and specifically to meet Indicators I.1 and I.2 of Output I which require the delivery of scoping studies and intervention concepts for each of the three project countries respectively. The scoping studies and intervention concepts for India are consolidated in this Report. The indicator descriptions are captured in Table 1:

Table 1 Output 1 indicators

OUTPUT I: The baseline of the project regarding biodiversity management within the project countries and city-regions is determined by preliminary studies, and intervention concepts are developed. In a scoping study, decisive drivers for the loss of biodiversity in the selected city-regions have been identified and intervention methods are defined.

Indicator I.1:		
By the end of 2018 in all three (3) project countries (Brazil, India and Tanzania) and the three (3) selected city-regions, scoping studies on the initial situation are completed.		
Unit	Baseline (start of project)	Target value and planned date of attainment
Number of country and city-region baseline assessment documents (scoping studies)	0	3 scoping studies for each project country and 3 assessment documents for each target city-region
Means of verification: Scoping studies are submitted by ICLEI to the relevant authorities at the national level and municipalities.		
Indicator I.2:		
By the end of 2018, four (4) intervention concepts are developed (one (1) concept per city-region, as well as one (1) concept to up-scale on the national level)		
Number of intervention concepts for developing project methodology	0	4
Means of verification: 4 intervention concepts submitted		

1.1 Outline of the INTERACT Bio Project

INTERACT-Bio is a four-year project designed for improving the utilization and management of nature within fast-growing cities and the regions surrounding them. It aims to provide expanding urban communities in the Global South with nature-based solutions and associated long-term benefits. The project is being implemented in Brazil, India and Tanzania.

The project aims to enable governments at all levels – from local to national – to integrate their efforts for mainstreaming biodiversity and ecosystem services into core subnational government functions such as spatial planning, land-use management, local economic development and infrastructure design. INTERACT Bio supports city-regions to understand and unlock, within their specific local context, the potential of nature to provide essential services and new or enhanced economic opportunities, while simultaneously protecting and enhancing the biodiversity and ecosystems on which these services and opportunities depend. These actions in turn place the participating city-regions on a more resilient and sustainable development path.

The INTERACT-Bio project supports several Aichi Biodiversity Targets as well as the Sustainable Development Goals and various other international agreements and associated targets. Through the project, city-regions will align their planning with their National Biodiversity Strategy and Action Plans (NBSAPs), which are required by the Convention on Biological Diversity (CBD). Subnational action in support of the NBSAPs will be promoted and enabled through strengthened cooperation between the different levels of government. Such collaborative approaches will ultimately support nations that are signatories to the CBD to accelerate attainment of the Aichi Biodiversity Targets, which are part of the Strategic Plan for Biodiversity 2011-2020, adopted by all CBD Parties.

1.1.1 Project aims and objectives

The overarching project aim or outcome is that *biodiversity and ecosystem management in the three model city-regions in Brazil, India and Tanzania is recognized as a cross-sectoral task (horizontal integration) and as such integrated in their sub-national BSAPs (Biodiversity Strategy and Action Plans). Simultaneously, those sub-national BSAPs contribute to the NBSAPs of their countries, in which the sub-national level is increasingly acknowledged as an actor with own targets, as well as implementation partner for national goals (vertical integration).*

Specifically INTERACT-Bio aims to:

- **Connect** national and subnational government decision-makers to work together towards integrating biodiversity considerations into city-region planning and decisions;

- **Strengthen** the capacity of city-regions to integrate biodiversity and nature-based solutions into land use, infrastructure and development planning, and to develop supporting policy instruments; and
- **Mainstream** biodiversity considerations across sectors at the subnational and national level.

In doing so, INTERACT-Bio will:

- **Promote** nature-based solutions as economically sound and sustainable investment options;
- **Demonstrate** the effectiveness of nature-based city-region development through pilot projects; and
- **Multiply nature-based approaches** by connecting city-regions with one another, and by building capacity and raising awareness that nature offers significant value in an urban context.

1.1.2 Project Work Packages and Outputs

The project will be delivered at three levels, as illustrated in the figure below:



Figure 1: Project activities at city-region, national and global levels

INTERACT Bio comprises five discrete Work Packages, each with its own output, planned activities and indicators. These are summarised in the table below:

Table 2 Summary of Work package outputs and indicators

Output I Baselines, scoping & intervention concepts	Output II Sub-national BSAPs & integration into spatial planning	Output III Demonstration projects & investment cases	Output IV Vertical integration	Output V Global awareness of mainstreaming biodiversity
By end 2018	By end 2020	By June 2019 By end 2020	By end 2019	By end 2020
I.1 Scoping studies & assessments for each model city & country	II.1 Multi-sectoral & multi-disciplinary forums setup in each model city	III.1 3 Demonstration projects initiated/ implemented in model cities	IV.1 At least 8 biodiversity-focused dialogues in each country	V.1 At least 2 side events & 4 presentations at international conferences
I.2 4 intervention concepts – national & 3 city regions	II.2&3 Model cities have sub-national BSAPs & include 8 NBSAP priorities	III.2 1 investment case in each model city	IV.2 Model cities generate reports from Reporting Platform	V.2 3 case studies in each country published

1.2 Selection of city-regions

Within the context of the INTERACT Bio project, a city-region is defined as combination of several cities, towns, informal settlements, smaller urban settlements, semi-urban and rural surroundings that are linked by functional ties. They can be demarcated by an administrative boundary, such as a metropolitan development area, or topographical features, such as watersheds, and depend on the same ecosystem services and natural assets, like water catchments and biodiversity corridors. A city-region includes the entire functional area under the city government administration, with at least one higher level of subnational government administration.

In each project country the project is implemented in three city-regions: in Brazil, Campinas, São Paulo State and Belo Horizonte and Londrina; in India, Kochi, Mangaluru and Panaji; and Dar es Salaam, Arusha and Moshi in Tanzania. All these city-regions are fast-growing cities located within areas of globally unique biodiversity and complex development challenges.



Figure 2: Map of city-regions in the three project countries

The city-selection process differed in each of the project countries.

City-selection in India: The Ministry of Environment, Forest and Climate Change, Government of India extended support to the project in India. To support the smooth implementation of the project a project steering committee, under the chairmanship of Additional Secretary, Ministry of Environment, Forest and Climate Change has also been formed. Detailed discussions were carried out the Ministry on city selection. The criteria that were kept in mind while selecting cities included:

- Proximity to a biodiversity hotspot or an area of high biodiversity value
- Dependent on ecosystem services provided from surrounding areas
- Development pressures are having direct adverse impacts on ecosystems and species
- Easy to access from a logistical perspective
- Politically stable

A comparison matrix of the shortlisted cities was developed (Appendix 1). The same was discussed with the Ministry. After elaborate discussions, the city of Kochi was chosen as the model city and cities of Panaji and Mangaluru were selected as the project satellite cities in India.

1.3 Purpose and structure of the Scoping Report

The Report is divided into four parts. The first three parts capture the scoping analyses and assessments and the last part sets out the proposed interventions concepts. Part A, Introduction and Methodology, introduces the project and city selection and describes the scoping methodology and approach. Part B, Country Scoping, addresses the requirement, of Indicator I.1, to establish a country level baseline. It starts by providing a brief overview of India's global and national biodiversity status. This is followed by an overview of the institutional landscape and policy framework that is relevant to biodiversity in the country. Part C, City-region scoping, focuses on establishing the city level baseline as required by Indicator I.1. It first describes the political, socio-economic and developmental context and challenges of the selected city-regions, before elaborating on the status of biodiversity and ecosystem services in the city-regions. Part C concludes with an analysis of the drivers of change and biodiversity loss at the local level. Part D, Project Interventions, pulls everything and sets out a proposed strategy and recommendations for concept project interventions. It concludes by highlighting the key findings and proposing a concrete action plan for implementing project interventions.

2 SCOPING METHODOLOGY AND APPROACH

2.1 Purpose of scoping within the context of the INTERACT Bio Project

Work Package 1 provides for scoping studies on the baseline situation to be undertaken in all three project countries, Brazil, India and Tanzania, and in the three selected model city-regions, Campinas, Kochi and Dar es Salaam respectively. The work package called for scoping to be undertaken at national and city-region level.

The scoping studies are intended to establish the baseline and provide the information and context within which project interventions can be identified and prioritized. As such scoping forms the foundation for developing a strategy for project interventions across all work packages. The key scoping activities are to:

- a) assess the *status quo* at national level of the context within which the National Biodiversity Strategy and Action Plan (NBSAP) is interpreted and implemented and sub-national engagement with, and contribution to, the NBSAP in each of the three project countries;
- b) assess existing and planned sub-national integration of NBSAPs into local economic development, land use planning and biodiversity management within each of the model city-regions, including an analysis of their existing land-use planning and development strategies to identify optimal entry points for the incorporation of biodiversity and ecosystem service considerations;
- c) identify and engage local champions and sub-national government officials, as well as stakeholder groups in the model and observing city-regions to secure local input and commitment to the project and to ground truth the baseline situation analyses; and
- d) conduct technical scoping engagements and preliminary investigations into potential project interventions in the model city-regions.

The purpose of **baseline situation scoping**, is to gather and analyse baseline information, to understand better the current (baseline) situation regarding biodiversity mainstreaming and NBSAP implementation. This includes assessing and understanding the legal and policy frameworks; institutional arrangements and governance systems; economic and social priorities, development pressures and challenges that drive change and biodiversity loss; and opportunities for near and long term development and biodiversity gains.

Given the design and overall duration of the INTERACT Bio project, the baseline situation scoping exercise is not intended as a comprehensive full scoping exercise. Instead, a more strategic, focussed and rapid appraisal scoping is appropriate and sufficient.

Baseline situation scoping is key to shaping and informing the technical scoping, which in the context of INTERACT Bio, adopted an ecosystem services perspective. Through the analysis of information gathered during baseline situation

scoping, key themes for mainstreaming and nature's benefits emerge which inform and guide the assessments undertaken in the technical scoping exercise.

The justification for focusing on nature's benefits and adopting an ecosystem services perspective in the **technical scoping** exercise is based on the on-going challenge that local government leaders and city managers around the world face in providing municipal services with scarce resources (human, financial and natural), while also having to address issues of rapid urbanisation, poverty, unemployment, and inadequate living conditions. Ecosystem services offer various benefits that can contribute to thriving cities. The benefits of adopting a focus on ecosystem services include:

- **Enhancing citizens' quality of life in urban areas** – a city with a healthy environment provides a higher quality of life for its citizens. Locally generated ecosystem services, such as air filtration, micro-climate regulation, noise reduction, rainwater drainage, sewage treatment, and recreational and cultural services, have a substantial impact on human well-being in urban areas;
- **Reducing public management costs** – local governments work with limited budgets and need to find the most cost effective solutions to provide their municipal services. Some municipal concerns such as water supply, road maintenance and flood regulation, are highly dependent on healthy ecosystems;
- **Fostering economic growth in the area** – a healthy and safe environment is a key factor for attracting business and industry with its commensurate job opportunities and wealth creation;
- **Reducing poverty** – there is a clear connection between livelihoods and ecosystems, which in the case of the poor is even more direct. In rural areas many people rely directly on ecosystems for food, water and fuel. Though less pronounced, the same holds true for many cities;
- **Protecting against environmental disasters** – a range of ecosystems act as important buffers for natural hazards, mitigating the damage caused by extreme events such as floods, droughts and landslides;
- **Alleviation of pressures on the resource base of regions surrounding cities** – degradation of near-urban ecosystems can jeopardize food/water supply and urban resilience. A sound understanding of urban dependency on ecosystem services is indispensable for informing sustainable land use nearby;
- **Becoming a political frontrunner** – local government pioneers get recognition. Cities that have been proactive in protecting their ecosystems and halting biodiversity loss are (inter)nationally renowned;
- **Well-informed choices** – if the likely consequences of a decision (e.g. regarding a land use change) with regard to the full range of ecosystem services are considered, the risk of high (social) costs due to unintended side-effects is reduced; and

- **Convincing arguments** – it is often a challenge to communicate to the public and to specific stakeholders (e.g. the municipal treasury, or the corporate sector) the importance of maintaining healthy ecosystems within and adjacent to urban areas. A focus on ecosystem services provides arguments for maintaining ecosystems as an asset for the local economy, and as a pre-requisite for secure livelihoods.

Adopting a focus on ecosystem services' implies to jointly (re-)consider and (re-)appraise already available environmental knowledge and data (and to complement it with missing data) in light of questions such as:

- Who depends on which functions/aspects from a certain ecosystem? or
- How can a certain problem be better tackled by taking into account the benefits that flow from an ecosystem to one or several groups of people? or
- How can the losses that would be incurred in case of ecosystem degradation, be better addressed by taking into account the ecosystem service benefits?

2.2 Scoping methodology

Typically scoping comprises of the following key iterative steps:

- ✓ Gather data and information and undertake desktop research;
- ✓ Conduct stakeholder mapping exercise;
- ✓ Engage and consult stakeholders to gather further information, compliment missing data gaps, test and verify data and assumptions and jointly involve them in the assessment;
- ✓ Analyse and assess information:
 - mapping the 'landscape' for biodiversity mainstreaming entry points;
 - identify and consider nature's benefits (ecosystem services);
 - clarify and prioritise key themes for mainstreaming biodiversity; and
- ✓ Present scoping results and findings to stakeholders.



Figure 3: Scoping generic methodology

Within this broader framework, the ecosystem services assessment followed a step-wise approach, with the first step, “preparing”, dovetailing with the baseline situation scoping process. The step-wise approach adopted for the ecosystem services assessment is illustrated in the figure below:

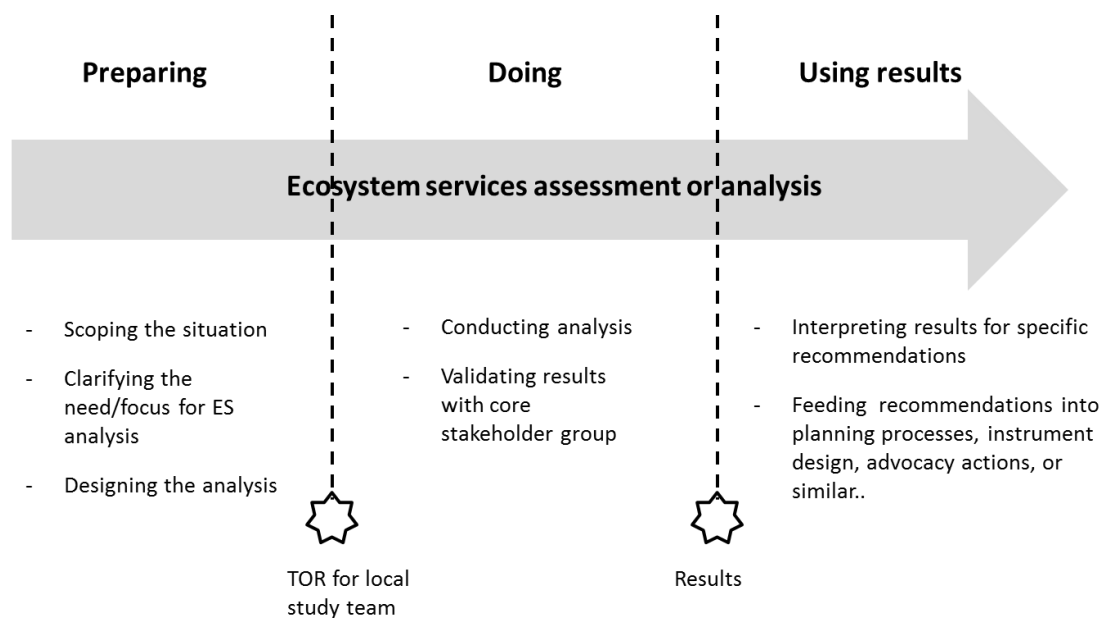


Figure 4: Step-wise approach to ecosystem services assessment

Regular and ongoing engagements with key actors and stakeholders during scoping create opportunities to stimulate and support key relationships that secure local input and commitment to both the INTERACT Bio project as a whole, and specific project interventions; help validate baseline situation analyses; and

facilitate biodiversity mainstreaming within the city-region during project implementation and post project closure; and provide opportunities for co-production which further strengthens relations and commitment.

ICLEI Cities Biodiversity Center developed a series of technical guidance notes (TGN) to guide the implementation of scoping studies within the project countries while allowing for country specific circumstances and requirements to shape the nature of the baseline and technical scoping exercises. The TGN provided guidance on how to undertake baseline situation and technical scoping; identifying scoping information needs; and identifying stakeholders and served as basis for designing a scoping intervention suited to the particular circumstances and requirements of the three project countries. INTERACT Bio project staff in each of the project countries were responsible for designing and implementing the country and local scoping studies. Helmholtz - Zentrum für Umweltforschung (UFZ) supported the technical scoping undertaken in each country.

2.3 Outline of scoping undertaken in India and Kochi city-region

2.3.1 Scoping process:

The scoping process included collection of primary and secondary information. Detailed review of all relevant existing laws, acts, policies at the National, State and City levels was carried out. This process was aimed at understanding the existing situation and also identify the gaps in the same. The National Biodiversity Strategy Action Plan, State Biodiversity Strategy Action Plan and all available city level plans were reviewed in detail. As part of the scoping study, detailed discussions were carried out with an array of stakeholders in all the project cities- Kochi, Panaji and Mangaluru. These included discussions with city government officials and elected leaders, academia, NGOs and prominent citizens of the cities.

In the city of Kochi, detailed scoping was carried out. Stakeholders, ranging from city government officials, city leaders, scientists and NGOs were met and one to one discussions were carried out on issues related to biodiversity conservation in the city. Discussions focussed on the following topics:

- The key actors (national, subnational and city authorities / agencies)
- Existing institutional arrangements (for vertical and horizontal integrations); key mandates; and challenges and capacity levels
- Main policy frameworks and legal instruments to regulate and administer and regulate land use and development planning and challenges faced
- Main policy frameworks and legal instruments in place for management of natural assets, ecosystem services and biodiversity in the city and challenges faced

- Drivers of biodiversity loss and the key threats to natural assets, ecosystem services and areas of high biodiversity value
- Drivers of change and key development pressures and how they impact biodiversity, ecosystem services and areas of high biodiversity value

The results of these one to one discussions were consolidated and presented in a stakeholder consultation in October 2017. Through this consultation, stakeholders were provided a common platform to discuss issues related to biodiversity conservation and ecosystem services. This stakeholder consultation also led to identifying the critical ecosystems of Kochi (mangroves and back waters) in a participatory manner. The information gathered in the stakeholder consultation was also useful to develop the natural asset map of Kochi. The critical ecosystems, thus identified were analysed in further detail (through discussions with the stakeholders, site visits and secondary literature review) to develop the reference material for the ecosystem service assessment workshop. In this workshop ecosystem service assessment of both the critical ecosystems of the city were carried out in a participatory manner. Through this workshop, a list of possible pilot interventions was also drawn up. The scoping report details all these aspects further.

2.3.2 Assumptions and limitations

The limited capacity of city officials with regard to appreciating the significance of biodiversity conservation in sustainable urban development has been a challenge which the team faced during the initial scoping discussions.

The exercise of ecosystem service assessment could not be completed in the satellite cities, prior to completion of this report. This exercise will be completed in both the satellite cities in the coming months.

PART B COUNTRY SCOPING

3 OVERVIEW OF GLOBAL AND NATIONAL BIODIVERSITY STATUS

3.1 Global biodiversity hotspots and areas of high conservation value

Characteristically described as a mega-diverse country comprising eight percent of the world's recorded species, India occupies only 2.4 percent of the total global land area. The country has more than 45,000 species of plants and 100,000 species of animals with new species like *Uropeltis bhupathyi* (a snake) (Jins *et al.*, 2018; see figure 5), *Fimbristylis agasthyamalaensis* (a sedge like plant) (Viji and Preetha, 2018; see figure 6), and *Pellenes iva* Caleb sp. n. (a jumping spider) (Caleb and Kumar, 2018; see figure 7) being recent additions in 2018. India was one among a few nations to have developed a biogeographic classification for conservation planning, and has comprehensively mapped biodiversity-rich areas. Four of the 35 global biodiversity hotspots, are present in India, represented by the Himalayas, the Western Ghats, the North-east, and the Nicobar Islands (Conservation International, 2013) (Figure 8). The Western Ghats, was inscribed on the United Nations Education Scientific and Cultural Organization (UNESCO) World Heritage List in 2012 (MoEF, 2014) and is considered one of eight “hottest hotspots” of biological diversity around the world. Parts of North-east India falling under the Indo-Burma hotspot also make up another of the “hottest hotspots”. More information on the four hotspots found in India can be found in Appendix 2.



Figure 5: *Uropeltis bhupathyi* (Source: <https://india.mongabay.com/2018/07/05/scientists-describe-new-species-of-shieldtail-snakes-found-in-anaikatti-hills/>)



Figure 6: *Fimbristylis agasthyamalaensis* (Source: <https://www.thehindu.com/news/national/kerala/new-plant-species-found-in-western-ghats/article23418765.ece>)



Figure 7: *Pellenes iva* Caleb sp. n. (Source: John Caleb in https://www.researchgate.net/figure/Figures-1-4-Pellenes-iva-sp-n-holotype-male-ZSI-SRC-I-SP-34-1-Dorsal-view-2_fig1_324543482)

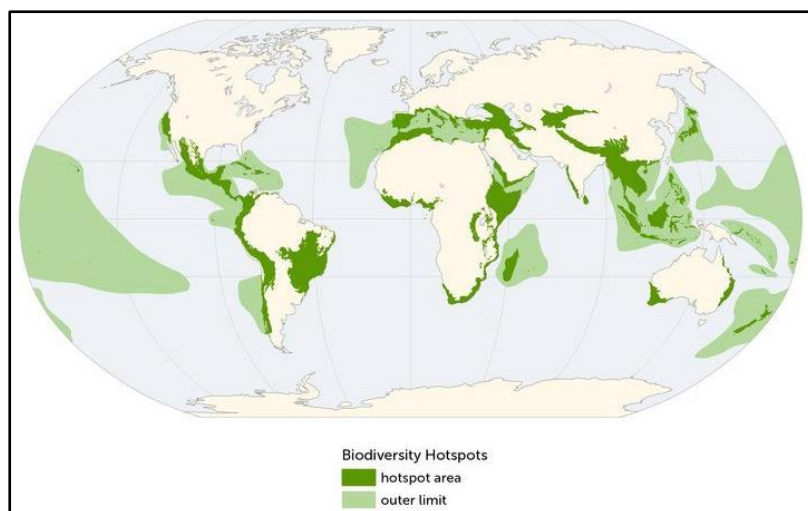


Figure 8: 35 Global Hotspots (Source: Mittermeier *et. al.* 2011)

India has 18 Biosphere Reserves (Figure 9). Seven of these have been included under UNESCO's World Network of Biosphere Reserves. 25 wetlands are Ramsar sites and six protected areas have been recognised as UNESCO World Heritage sites (MoEF, 2014).

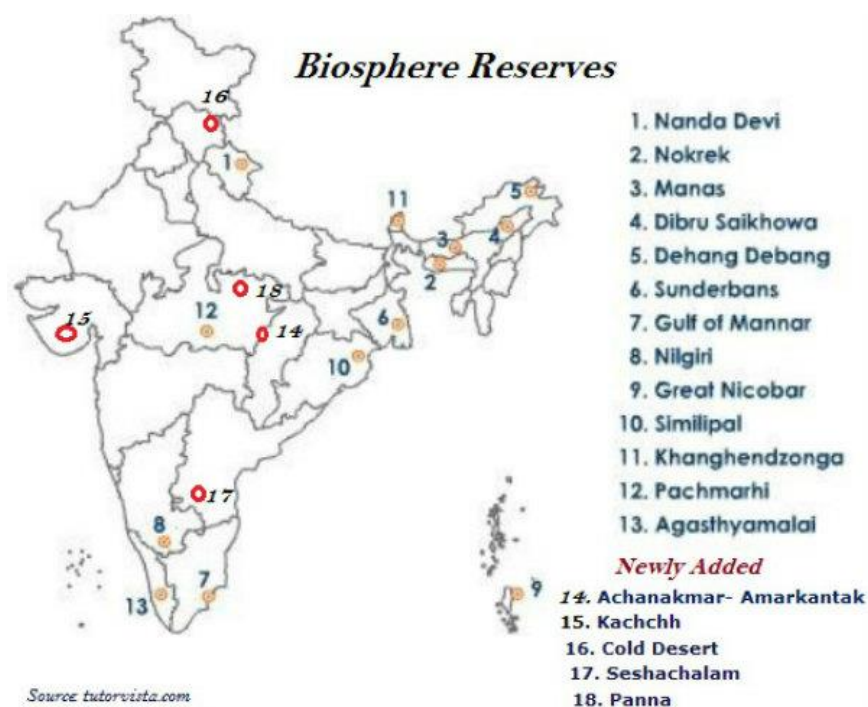


Figure 9: India's 18 Biosphere Reserves. (Source: <http://www.tutorialspoint.com/>)

3.2 Country level biodiversity status

Geomorphologically, India has a unique position. Separated from the rest of Asia by the Himalayas, it is bordered by the Arabian Sea and Bay of Bengal on the west and east respectively and it gradually tapers off into the Indian Ocean. The mainland could be divided into four main regions, viz., the Great Mountain Zone containing some of the highest peaks in the world, the Indo-Gangetic

Plain, a vast stretch of flat, fertile alluvium, the Desert Region and the southern Peninsula characterised by the Deccan plateau. India also has two archipelagos – Lakshadweep Islands (coral) in the Arabian Sea and the Andaman and Nicobar Islands (volcanic) in the Andaman Sea (Krishnan *et. al.*, 2012).

Three exceptional factors give India its biological superiority. First, the sheer spectrum of habitats and ecosystems existing over a wide range of latitudes and longitudes is impressive. Overlaying these with varied climatic regimes, have resulted in an astounding range of bio-physical environments. Second, India lies at the junction of three Biogeographic Realms, viz., Indo-Malayan, Eurasian and Afro-tropical. Its flora and fauna have been enriched by elements from each of these realms. For example, *Shorea robusta* (an Angiosperm) and Sambar deer (*Cervus unicolor*) are of Indo-Malayan origin, *Nageia wallichiana* (a Gymnosperm) and Nilgiri tahr (*Nilgiritragus hylocrius*) of Eurasian origin and *Acacia chundra* (an Angiosperm) and Blackbuck (*Antelope cervicapra*) of Afro-tropical origin. Third, India has a legacy of coexistence of humans and nature and a longstanding tradition of conservation (*ibid.*).

India has a network of 769 protected areas (Figure 10) comprising 103 National Parks, 544 Wildlife Sanctuaries, 76 Conservation Reserves and 46 Community Reserves (National Database Cell, Wildlife Institute of India, 2018). This network extends over 16.2 million hectares or 4.9 percent of the country's geographical area. Although a majority are concerned with terrestrial fauna, there are some which are focussed on freshwater, marine habitats or plants such as wild citrus, rhododendrons and orchids (MoEF, 2001). By and large, these protected areas are managed through 'the ecosystem approach' with a core-buffer strategy for conservation. Outside of these four main types, there are other, often overlapping, categories as well. For example, under different national laws, biodiversity-rich areas requiring conservation focus have also been established. Six areas – Matheran, Mahabaleshwar-Panchgani, Murud-Janjira, Mount Abu, Sultanpur and Dahanu Taluka – have been declared as 'ecologically sensitive areas' under the Environment (Protection) Act, 1986 (Kapoor *et. al.*, 2009). Under the Biological Diversity Act, 2002, 11 sites across India have been designated as 'Biodiversity Heritage Sites' (National Biodiversity Authority, 2017).

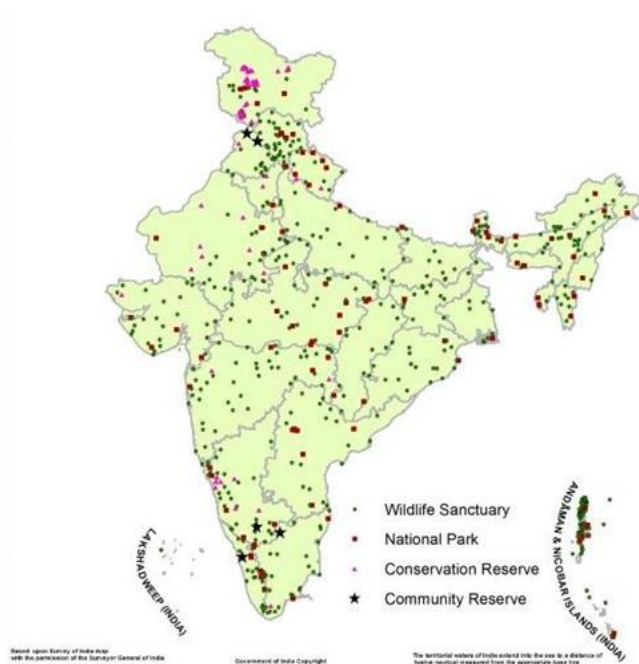


Figure 10: India's protected area network. (Source: WII, undated)

Ecosystem diversity

Due to a number of factors including geomorphology, and an intersection of varied climatic regions, India has a spectrum of ecosystems across its mountains, coasts, wetlands and hinterlands. Ranges of mountains such as the Himalayas in the north, Aravallis in the west-central region, the Vindhyas and Satpuras in the central highlands and the Eastern Ghats and the Western Ghats in peninsular India are found here. The Indian Himalayan region contains the origins of many of the country's rivers such as the Indus, the Brahmaputra, the Kosi, and the Sutlej (Krishnan *et. al.*, 2012). The country has both cold and hot deserts as well as Mawsynram in Meghalaya, the wettest place on Earth (*ibid.*). The Thar Desert and the White Salt Desert of Kutch are unique in India's range of ecosystems (*ibid.*). A coastline of 7,517 km, alpine pastures, montane forests, tropical rain forests, moist and dry deciduous forests, mangroves, scrub-savannah, and grasslands form life-sustaining montages which lend the country its unique and profuse biodiversity (*ibid.*).

India has been divided into ten biogeographic zones (Rodgers *et. al.*, 2002) covering a vast range-

- 1) Trans Himalaya zone, north of the Himalayas, an extension of the Tibetan Plateau,
- 2) Desert zone in north-west India comprising of the country's hot sand and salt deserts,
- 3) Western Ghats with evergreen forests,
- 4) North-East zones that support evergreen forests,
- 5) Semi-Arid zone where grasslands and shrub lands dominate the landscape,

- 6) Himalayas with its alpine forests and meadows,
- 7) Deccan Peninsula characterised by the Deccan plateau,
- 8) Gangetic Plain with its flat alluvium and
- 9) Coasts and
- 10) Islands zones, known for their mangroves, coral reefs and lagoons.

Ecosystems and habitats

Almost all the major ecosystem types in the world can be found in India whether they are restricted to the country or transcend national boundaries. Ranging from forests to grasslands, from marshes to deserts, from mountain to islands, India's most important ecosystems are discussed in Appendix 3.

India has taken significant steps in chronicling its vast and diverse biological richness. India harbours a large number of lichen species, with at least 2300 species belonging to 305 genera and 74 families having been reported (Mamta, 2015). With over 200 diatom species, 90 dinoflagellates, 844 marine algae and 39 true mangrove species, the marine floral biodiversity of India is remarkable. The flora and fauna reported in 2013 from Indian Marine Waters include 1284 species of fish, 3271 species of molluscs, 765 species of echinoderms, 519 species of sponges, 345 species of coral, and 607 species of crustaceans (Raghuraman *et al.*, 2013). Endemism is significant across different plant groups in India. About 4045 species of flowering plant (angiosperms) of 141 genera belonging to 47 families are endemic to India. In terms of endemism of vertebrate groups, India's global ranking is 10th in birds, with 69 species, fifth in reptiles, with 187 species, and seventh in amphibians, with 110 species. Only 44 species of Indian mammals have a range that is confined entirely to within Indian territorial limits (Puri, 1994). Being one of eight recognised centres of the origin of cultivated plants, India is also recognised as the centre of origin of rice. India has 15 agro-climatic zones which has enabled a reported diversity of 811 cultivated plants and 902 of their wild relatives. Additionally a wide gamut of native breeds of cattle (34), buffaloes (12), goat (21), sheep (39) and chicken (15) also contribute to a rich repertoire of domestic faunal diversity. The range of traditional farming systems and practices as well as the livestock sector in different parts of India contribute to the food and economic security of its population (MoEF, 2009).

Table 3: Comparison between the Number of Species reported from India and the World, (Puri, 1994).

Group	Number of species in India (SI)	Number of species in the world (SW)	SI/SW (%)
Mammals	350(1)	4,629(7)	7.6
Birds	1224(2)	9,702(8)	12.6
Reptiles	408(3)	6,550(9)	6.2
Amphibians	197(4)	4,522(10)	4.4
Fishes	2546(5)	21,730(11)	11.7
Flowering Plants	15,000(6)	250,000(12)	6.0

Wild biodiversity

Faunal diversity: Recording a total of 91,514 species, India contributes to 6 percent of the faunal species diversity of the world (ZSI, 2015). A significant proportion of species under many taxa is found in India. This includes as many as half of Merostomata, a third of Echiura and over a quarter of Phoronida and Chaetognatha species. Among vertebrates, India accounts for 14.85 percent of avifauna, 9.7 percent fish, 7.42 percent mammal, 5.47 percent reptile and 5.12 percent amphibian species in the world (ZSI, 2015). In terms of the world's species-richness, India is fifth in reptiles, seventh in mammals and ninth in birds (Government of India, 2014).

Floral diversity: India's contribution to global floristic diversity accounts for 11.4 percent of the world's flora (ranking at 10th place) with 47,513 recorded species (Singh and Dash, 2014). The largest taxonomic group is Angiosperms with 18,043 species, followed by Fungi and Algae that have 14,883 species and 7,284 species respectively. 7.35 percent of the world's gymnosperm species are found in India (Arisdason and Lakshminarasimhan, 2017).

Domesticated biodiversity

Crop diversity: Agriculture is the dominant land use in the country with a net sown area of 140 million hectares i.e. over 42 percent of the country's geographical area (Planning Commission, 2010). With around 20 agroecological regions in the country (Figure 11), a rich diversity occurs among several crop plants and their wild progenitors (MoEF, 2009). The country supports over 800 crop species across all major groups and an estimated 166 crop species (6.7 percent of the global total) are believed to have originated in India (MoEF, 2014). Furthermore, over 1,500 wild edible plant species are widely exploited by native tribes. These include 145 species of roots and tubers, 521 of leafy vegetables/ greens, 101 of buds and flowers, 647 of fruits and 118 of seeds and nuts. In addition, nearly 9,500 plant species of ethno botanical uses have been

reported from the country, of which around 7,500 are for ethno medicinal purposes and 3,900 are multipurpose/ edible species (NAAS, 1998).

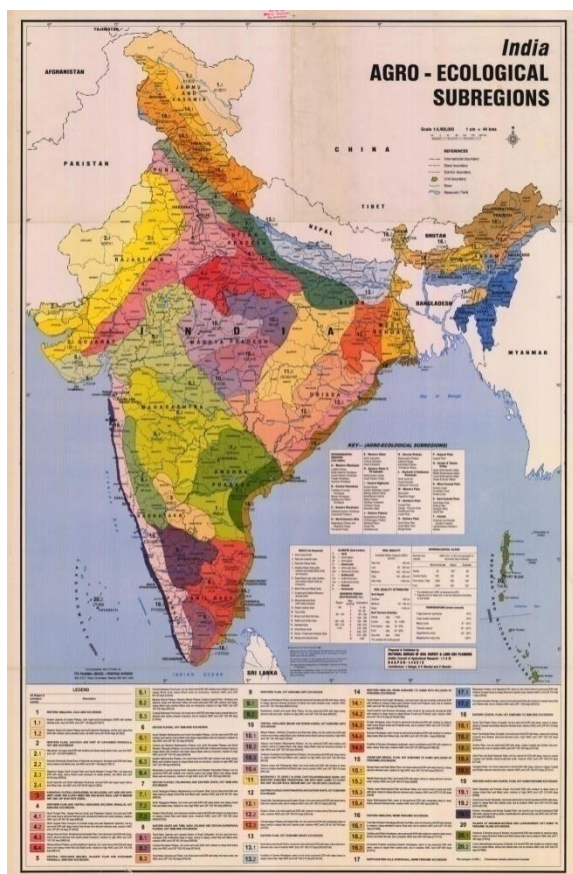


Figure 11: Agro-ecological Sub regions of India. (Source: National Bureau of Soil Survey & Land Use Planning, 1996)

Livestock diversity: India is a major producer of animal husbandry products having nearly 530 million livestock and 650 million poultry (DAHDF, 2012). It is home to the largest cattle population (13.1 percent of world's cattle population) in the world which constitutes 37.3 percent of its total livestock (*ibid*). With the presence of more than 140 breeds of various livestock, its diversity is unparalleled (NBAGR, undated). These animal genetic resources are of immense value to the agrarian economy of the country.

Endemism

An important feature of India's biodiversity is its high level of endemism. Among faunal groups, one group (Mesozoa) shows 100 percent endemism. Other invertebrate taxa that show high degree of endemism include Acanthocephala (88.64 percent), Oligochaeta (77.80 percent) and Platyhelminthes (71.88 percent). Among vertebrates, Amphibia (61.24 percent) and Reptilia (47 percent) are noteworthy. Among floral groups, the highest level of endemism is seen in Angiosperms (35.3 percent), followed by Algae (26.8 percent), Bryophytes (25.1 percent), Fungi (24.0 percent) and Lichens (23.7 percent) (Krishnan *et. al.* 2012).

As Kochi, which is situated in the state of Kerala, has been chosen as the model city of the project, the next section presents information regarding the biodiversity of Kerala State.

3.2.1 Kerala

The state of Kerala is a coastal strip lying between the Western Ghats and the Arabian Sea in the South of the Indian Peninsula. Different climatic and geomorphologic features juxtapose here to form three distinct regions as one travels from east to west (State Planning Board, Government of Kerala, 2014).

Highlands: The highlands comprise the most prominent province of the state and comprises of the Western Ghats. This zone lies at altitudes between 600m to 2500m and contains the highest peak of the Western Ghats- the Anamudi. The highlands are characterized by large forest tracts having a total recorded forest area of 11.3 thousand square kilometres, which is 28.99 per cent of the total area of the state (Forest Survey of India, 2011). The climate here is cool and wet.

Midland: The midland is a region of undulating topography, ranging between 300m to 600m in elevation and is made up of lateritic plateau. The area consists of dissected peneplains with numerous floodplains, terraces, valley fills and colluviums. At some places, this unit borders the sea without intervening coastal plains (Kerala State Council for Science, Technology and Environment, 2007).

Coastal lowlands: With most of this area showing a relief 4-6 m above sea level, the coastal lowlands are low lying, alluvial and fertile. Beach dunes, ancient beach ridges, barrier flats, coastal alluvial plains, flood plains, river terraces, marshes and lagoons dissect this area (*ibid.*). It is the most densely populated among the three regions.

Other than these zones, Kerala is characterized by a network of backwaters and wetlands.

Backwaters: Receiving water from streams and rivers that flow through the state, the backwaters of Kerala are a unique ecosystem of lagoons, lakes, canals, estuaries and deltas which run parallel to the sea coast. The backwaters of Kerala are made up of over 900 km of interconnected waterways, rivers, lakes and inlets (Sivasankar, 2013).

Wetlands: 4.13 percent of the state comprises of wetlands, which occupy a total area of 160,590 ha (MoEF, 2011). Excluding wetlands of area less than 2.25 ha (2,592 in number), there are 1,762 wetlands (ISRO, 2010). These are primarily of two types – inland and coastal. A majority of the inland wetlands are natural whereas man-made inland wetlands mostly consist of reservoirs/barrages. Kerala has 169 natural coastal wetlands with a total area of 409,000 ha.

The diverse physical features of Kerala have resulted in 13 agroclimatic zones and a variety of ecosystems such as forests, grasslands, cane brakes, freshwater swamps, mangroves and aquatic ecosystems (KFRI, 2005). Accounting for 2.87 percent of the total forest area of the country (FSI, 2017), a variety of forests are found distributed across all three altitudinal zones described above. Ranging from tropical deciduous forests, dry deciduous, bamboo forests, semi-evergreen and tropical wet evergreen, Shola forests, montane forests and savannah grasslands, the floristic composition of the state is extensive (State Planning Board, Government of Kerala, 2014). Approximately 51 percent (4,835 km²) of the forestland is protected while 2,035 km² (22 percent) of natural forests including grasslands are wildlife sanctuaries and national parks. Production forests are those areas in the foothills, where forestry operations are carried out. 1,531 km² of these areas with gentle slopes and deep soils; have been converted into commercial plantations of teak (*Tectona grandis*), *Eucalyptus*, match-wood, fuel wood and so on. The mangroves of Kerala are localized to certain areas such as the upper reaches of lagoons or backwaters and creeks, and are distributed in eight coastal districts of which Kannur has the largest area followed by Kozhikode, Ernakulam, Alappuzha, and Kottayam. The total area under mangroves in Kerala in the remote past had been reportedly about 700 km² (Basha and Nair, 1991). Since 2004 the total area occupied by them has reduced from 50 km² to about 17 km² (KFRI, 2005; State Planning Board, Government of Kerala, 2014). Some characteristic species found are *Acanthus ilicifolius*, *Acrostichum aureum*, *Aegiceras corniculatum*, *Avicennia marina*, *Avicennia officinalis*, *Bruguiera gymnorhiza*, *Bruguiera parviflora*, *Ceriops tagal*, *Derris trifoliata*, *Excoecaria agallacha*, *Excoecaria indica*, *Kandelia candel*, *Lumnitzera racemosa*, *Rhizophora apiculata*, *Rhizophora mucronata* and *Sonneratia caseolaris*.

18.2 percent of one of the eight hottest hotspots- the Western Ghats, falls within the state of Kerala (Gadgil *et al.*, 2011). 95 percent of the flowering plants in the Western Ghats and 90 percent of the vertebrate fauna are found here (Sreedharan, 2004). 19 out of 39 sites in the Western Ghats listed under the UNESCO World Heritage list are found in Kerala. The landmass harbours 25.69 percent of flowering plant species and 26.59 percent of Pteridophytes in India. Kerala is rich in amphibian diversity with 44.1 percent and 38 percent of bird species found in India (Laladhas *et al.*, 2016). The Kuttanad below sea level farming has been recognized as a globally important agricultural heritage system (GIAHS) (*ibid*). In 2017 of the 652 new plant and animal species discovered, the highest number was reported from Kerala (ZSI, 2017; BSI 2017). Three endemic centres have been identified in Kerala- Agasthyamalai, Anamalai high ranges and Silent Valley- Wayanad. Agasthyamalai and its environs have been identified as one of the three centres of plant diversity within India (*ibid*). The Kerala coast hosts 716 species of fishes, and 25 out of the 26 species of marine mammals found in India (*ibid*). The short-neck clam fishery in the Ashtamudi Lake in Kerala has received India's first Marine Stewardship Council (MSC) certification in 2010 (*ibid*).

Flora

Around 5,094 taxa (4,606 species and 110 subspecies) under 1,537 genera and 221 families of flowering plants are distributed in Kerala (Sasidharan, 2012). Herbs constitute 50.1 percent, shrubs 15.8 percent, and trees 15.08 percent of the total flowering plant species of the state. A total of 1,709 taxa that are endemic to peninsular India are found in Kerala of which 237 species distributed in 47 families are exclusive to the state (Nayar *et al.*, 2008). 858 exotic species were introduced in the state (via agriculture, forestry or accidentally) of which 200 species have become naturalized. Gymnosperms are represented by five species belonging to three genera while pteridophytes are represented by 337 species (Easa, 2003) and bryophytes by 465 taxa (Manju *et al.*, 2008). 866 species of algae, 4800 species of fungi and 520 species of lichens have been reported (Jayaraman *et al.*, 2008). Marine flora is represented by mangroves (33 species recorded), seaweed (118 species recorded) and phytoplankton (468 species recorded) (Laladhas *et al.*, 2016).

Fauna

Vertebrate diversity is represented by 1,847 species in 330 families and 81 orders, fish being the most diverse group (905 species), followed by birds (500 species), reptiles (173 species), amphibians (151 species) and mammals (118 species) (KFRI, 2005; Laladhas *et al.*, 2016). Of the terrestrial vertebrates, 36 percent are endemic to the Western Ghats and Kerala. Endemism is greatest in amphibians (90 percent in the Western Ghats) with 24 percent being endemic to Kerala. Of the 1,847 vertebrates of Kerala, 205 species are listed as threatened in the IUCN Red List of which 23 are Critically Endangered, 90 are Endangered and 92 are Vulnerable (Nameer *et al.*, 2015). Invertebrate diversity is primarily marine, of which 251 species of Zooplankton, 91 species of sponges, 151 species of Coelentrates, 154 species of Annelids, 218 species of Crustaceans, 112 species of Echinids, 34 species of Gorgonids and 730 species of Molluscs are found in Kerala (Laladhas *et al.*, 2016). A total of 3,327 insect species (Chandra, 2011) have been reported from Kerala including 316 butterfly species (Palotet *et al.*, 2012) and 130 Orthoptera species (Dhaneesh *et al.*, 2018).

Agrodiversity

Indigenous crop diversity of Kerala includes traditional cultivars, wild relatives and weedy relatives. A large number of agriculturally important plants- 142 belonging to 104 genera and 43 families are grown in the state. Kerala has a high diversity of the genus *Amaranthus*, of the 10 species found in India, eight are available in Kerala. 35 of the 54 species of *Ipomoea* and four of five species of *Vanilla* are found in the State (Nayar, 2010).

The total number of indigenous breeds of domesticated animals in Kerala includes- nine cattle species, two goat species, one pig species and four fowl species (KFRI, 2005). The Vechur cow of Kerala has been listed under the World Watch List of Domestic Animal Diversity (FAO, 2000) as a category of critical breeds.

3.3 Status of the NBSAP

In 1999, India released its National Policy and Macro level Action Strategy on Biodiversity in response to becoming a Party to the Convention on Biological Diversity (MoEF, 1999). This document was meant to provide the framework for preparing detailed action programmes at the microlevel for conservation and sustainable use of biodiversity in the country. Between 2000 and 2003, as part of an externally funded Global Environment Facility (GEF) project, the Ministry of Environment and Forests (MoEF) initiated the development of a National Biodiversity Strategy and Action Plan (NBSAP) (TPCG and Kalpavriksh, 2005). The exercise was considered one of the largest participatory exercises in the country under which 33 state level, 10 eco-region level, 18 local level and 13 thematic action plans were prepared. The NBSAP was released as a final technical report in 2004. During this time as well the Biological Diversity Act was enacted in 2002 (MoEF, 2003) and the rules notified in 2004. In 2006, India adopted its National Environment Policy, as a result of which in 2008, the National Biodiversity Action Plan (NBAP) was developed (MoEF, 2008). As the NBAP of 2008 was drafted prior to the CBD Strategic Plan for Biodiversity 2011-2020, it was updated in 2014 with an addendum (MoEFCC, 2014). The NBAP Addendum primarily comprises of 12 National Biodiversity Targets (NBTs) which link more or less with the Aichi Biodiversity Targets. The NBTs were also crafted to crosslink with the 175 actions of the NBAP 2008 allowing for monitoring and reporting at a national level and contributing at an international level to Aichi targets. More information on India's NBTs and NBAP can be found in Appendix 4.

While the NBAP provides good overviews of the state of biodiversity and the issues at hand, it reads more like a broad strategy paper and lacks decisive and well formulated action plans to address the issues. The plans for sustainable use and benefit sharing are missing and the new developments as a result of the Forest Rights Act, 2006 are not incorporated (Faizi, 2013). Ministries detailed in the road map are indicative and adoption of the NBAPs does not lead to the allocation of funds. Instead, they provide a guiding framework for further development within the Ministries. Timelines within the plans are flexible and objectives of the plans can only be enforced through schemes and programs of the relevant ministries. This will impede monitoring of the NBTs. So far in India, mainstreaming of biodiversity has achieved some success in the forestry sector which is directly under the control of the MoEFCC, however in sectors such as agriculture, water resources and so on; it is proving to be more challenging (CBD, 2016).

With the 10th Conference of Parties calling for the development of second generation NBSAPs, India must set the focus of its strategy on the implementation mechanism, measureable targets and the incorporation of the biodiversity-poverty reduction linkage. Mainstreaming of biodiversity can be improved by focussing on improving sectoral ownership at the central and state level and increasing vertical cooperation. Furthermore, by reaching out to NGOs and the civil society to contribute to the process, enhanced implementation of the NBTs and a more comprehensive NBSAP will be possible (CBD, 2016).

3.4 Status of the State Biodiversity Strategy and Action Plans (SBSAP)

A total number of 29 states and the seven union territories prepared SBSAPs as part of the extensive NBSAP process in 2000-2003 (TPCG and Kalpavriksh, 2005). All three project states, Kerala, Karnataka and Goa, have published SBSAPs as part of the original SBSAP exercise of 2003. All the SBSAPs take into account inputs received from a gamut of stakeholders which were obtained through consultations, Participatory Rural Appraisals, radio broadcasts and newspaper articles, expert reports and inputs from members of the Steering Committee and Thematic Working Groups during workshops/meetings/ public hearings (TPCG and Kalpavriksh, 2005). However, as of 2017, revisions to the SBSAPs were not made to synergise with the NBAP 2008 or the NBAP Addendum 2014, although some states have started the process. States are not put under any obligation to develop State Biodiversity Action Plans unlike the State Climate Change Action Plans. In order to effect mainstreaming of Biodiversity Planning, state ownership of the NBAP and NBTs is essential.

4 OVERVIEW OF INSTITUTIONAL LANDSCAPE AND POLICY FRAMEWORK

4.1 System of governance and institutional arrangements

4.1.1 System of governance

India is a sovereign, socialist, secular, democratic republic with three levels of governance, National/Federal, State and Local. The elected Head of the State of India is the President who is also Commander-in-Chief of the Indian Armed Forces. The executive authority of the President is vested with the Prime Minister and his Council of Ministers. Similarly in states there is a Council of Ministers with the Chief Minister as its head, who advise the Governor, the representative of the President in the state. India has devolved considerable powers to local self-government institutions which are known as Panchayati Raj Institutions (PRIs) in rural areas and municipal councils or municipal corporations in urban areas through 73rd and 74th Constitutional Amendments.

India is a federal country with 29 states and seven union territories. The Constitution of India delegates responsibilities of governance between the centre and states. Matters such as forests and wild animals and birds, over which both the centre and states have the power to legislate, are termed as 'concurrent' matters.

Krishnan *et al.* (2012) detail out five types of biodiversity governance models that aid in conservation, sustainable use, and fair and equitable sharing of biological resources across different landscapes in India. Of the five models, two – territorial forests and protected areas– fall under the protected area type of biodiversity governance models. The other three – autonomous community efforts, co-management of forests and decentralized governance of biodiversity – are considered more closely under community based conservation.

- 1) **Territorial forests:** Nearly a fifth of India's geographical area is classified as forest land. Territorial forests are classified into two main categories – reserved and protected forests – that mainly differ in the extent of rights and privileges accorded to the local people. The management of territorial forests are now based on the principles of sustainable forest management (SFM) through working plans, emphasizing conservation and meeting subsistence needs of local communities as per the National Forest Policy issued in 1988.
- 2) **Protected areas:** Protected areas cover around 4.9 percent of the country's geographical area. With the enactment of the Wildlife (Protection) Act, 1972 and the launch of Project Tiger in 1973 this network began to gain more ground and post the 1980s after the biogeographic classification for the country was developed, many more protected areas, including coastal and marine protected areas, were established. Since the 1990s, there have been attempts to introduce a participatory approach in

the management of protected areas as seen from the 'Community Reserves' and 'Conservation Reserves' established.

- 3) **Autonomous community efforts:** Autonomous Community Efforts (ACE) are initiated by communities for conservation and management of biological resources. ACEs in India can be broadly classified into two categories – 1) Community Conserved Areas (CCAs) and 2) Sacred Groves (SGs). In many areas of the North Eastern states, Autonomous District Councils (ADCs) play a central role in the management of natural resources.
- 4) **Co-management of forests:** Co-management of state-owned natural resources such as forests or Joint Forest Management (JFM) involves the State Forest Department entering into an agreement with the local community, which is allowed greater access to the forest resources as well as a share in revenue, in return for protection of the forests against unauthorized extraction, encroachment and damage. There are presently over 118,000 Joint Forest Management Committees (JFMCs) that protect/manage around 23 million hectares of forest lands.
- 5) **Decentralized governance of biodiversity:** The Panchayati Raj Institutions (PRI) which govern rural areas have a three tier structure with Gram Sabha and Gram Panchayat as the basic unit, which are usually at the level of a village. The Constitution (73rd Amendment) Act, 1992 has included minor forest produce, social forestry, farm forestry and fisheries as subjects devolved to the PRIs. The PRIs play an important role in the implementation of the Biological Diversity Act, 2002. Presently, 72,304 Biodiversity Management Committees (BMC) are functioning across 26 states. Local self-government institutions have a particularly significant role in the implementation of several laws that are important from a biodiversity conservation perspective, most notably the Panchayats (Extension to the Scheduled Areas) Act, 1996 and the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006.

4.1.2 National authorities

Biodiversity conservation in India is a concurrent subject as mentioned above, and is the responsibility of both the National and Sub-national Governments. Institutional structures for managing this are set up from the central level to the local level. Post the UN Conference on the Human Environment (Stockholm, 1972), India set up the National Council for Environmental Policy and Planning within the Department of Science and Technology in 1972. This Council later evolved into a full-fledged MoEF in 1985 (MoEF, 2002), which later included climate change in its subjects to become the Ministry of Environment, Forest and Climate Change (MoEFCC) in 2014.

The MoEFCC is the nodal agency in the administrative structure of the National Government for the planning, promotion, co-ordination and overseeing of the

implementation of India's environmental and forestry policies and programmes, including biodiversity considerations. It is in charge of formulating legislation, policy and other statutory functions under various environmental, forest and wildlife laws including granting clearances for various activities or projects based on their potential environmental impacts (CBD, 2016). The Wildlife wing in MoEFCC is headed by the Additional Director General of Forests (Wildlife) while the management of territorial forests is under the overall supervision of the Director General of Forests and the Additional Director General of Forests (Forest Conservation).

The Indian judiciary has played a proactive and facilitative role in environmental protection, including biodiversity conservation. An important contribution has been widening the scope of Article 21 of the Indian Constitution (right to life and personal liberty) to include right to clean and healthy environment. The courts have given various orders such as regulation of tree felling and a ban on mining in specific areas (e.g. parts of the Aravalli hill range- M.C. Mehta vs Union of India & Ors on 18 March, 2004). The courts have also ruled on the need for an approved working plan for forestry operations, the collection of 'net present value' for diversion of forest lands for non-forest purposes, and the establishment of the Compensatory Afforestation Fund Management and Planning Authority (CAMPA) (Supreme Court Order dated 30.10.2002). 'Public Interest Litigation' – i.e., litigation for the protection of public interest, has played a key role in judicial intervention in environmental issues (Krishnan *et al.*, 2012). Under Article 32 and Article 226, the Supreme Court and the High Court have played a proactive role in the conservation of biodiversity. In 2013, the Supreme Court of India set up a 'Green Bench' to deal with environmental issues replacing the existing Forest Bench (MoEF, 2014).

National Board for Wildlife (NBWL): Formerly known as the Indian Board for Wildlife, NBWL is a multidisciplinary body comprising government functionaries, NGOs, conservationists and ecologists constituted under the Wildlife (Protection) Act, 1972, and chaired by the Prime Minister. NBWL advises the government on wildlife conservation, illegal trade and poaching, management of protected areas, impact assessment of projects, and other related issues.

National Tiger Conservation Authority (NTCA): The Authority is a statutory body established in 2006 by an amendment to the Wildlife (Protection) Act, 1972. The NTCA deals with all aspects of the management and operation of the tiger habitats, ecologically sustainable land use in them, management of tourism and human animal conflict, and conservation research among others.

Wildlife Crime Control Bureau (WCCB): Established in 2007, the Bureau is the national agency to deal with wildlife crime. WCCB complements the efforts of state governments and other enforcement agencies.

Other federal institutions empowered to prevent and investigate forest and wildlife offences include Indian Coast Guard, Border Security Force, Indo-Tibetan Border Police, Railway Police Force, Customs Bureau, Central Bureau of Investigation among others.

Central Zoo Authority (CZA): The Authority was created in 1992 to enforce minimum standards and norms for the upkeep and healthcare of animals in Indian zoos so that they complement and strengthen national efforts on the conservation of wild fauna. The National Wildlife Action Plan (2002-2016) emphasises the role of zoos for ex-situ breeding of endangered species and their rehabilitation in the wild as per IUCN guidelines for reintroduction.

(CAMPA) National Advisory Council: CAMPA is meant to promote afforestation and regeneration activities as a way of compensating for forest land diverted to non-forest uses. The mandate of the National CAMPA Advisory Council is to lay down broad guidelines for State CAMPA, facilitate scientific, technological and other assistance that may be required by State CAMPA, make recommendations to State CAMPA based on a review of their plans and programmes and provide a mechanism to State CAMPA to resolve issues of an inter-state or Centre-State character.

National Biodiversity Authority (NBA): The Biological Diversity Act (2002) is implemented through a decentralized system including the NBA, State Biodiversity Boards (SBBs) and BMCs with defined jurisdictions and responsibilities. NBA regulates activities related to access to biological resources and fair and equitable sharing of benefits by granting approvals, advises the Federal Government on conservation of biodiversity, its sustainable use and equitable sharing of benefits, selection and management of Biodiversity Heritage Sites and is responsible for the NBAP revision, preparation of National Reports to the CBD and initiatives such as The Biodiversity Finance Initiative (BIOFIN) and The Centre for Biodiversity Policy and Law (CEBPOL).

National Green Tribunal (NGT): The NGT was established under the National Green Tribunal Act, 2010, for effective and expeditious disposal of cases related to environmental protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto. It is a specialized body equipped with the necessary expertise to handle environmental disputes involving multi-disciplinary issues.

4.1.3 Subnational authorities

State Board for Wildlife: Chaired by the state's Chief Minister, the board advises the state government on the selection and management of protected areas and other matters related to wildlife conservation.

Wildlife Department: This is the most important agency involved in the management of protected areas. Headed by the Chief Wildlife Warden, the Wildlife Department deals with wildlife offence, undertakes habitat enrichment activities, and conducts research, outreach and eco-development programmes.

Forest Department: This department is headed by the Principal Chief Conservator of Forests (Head of Forest Force), who is assisted by other Principal Chief Conservator of Forests (PCCFs), Additional PCCFs and Chief Conservator of Forests for handling responsibilities like production, conservation, protection, development, working plans, research, budget, planning, policy, eco-development and tribal welfare, social forestry and community forestry, forest management information systems, human resource management, vigilance and administration.

In addition to Forest Departments, states also have a **Department of Environment and Climate Change/Ecology** to encourage and promote Environment and Climate Change related activities as well as to enforce various Environmental Acts and Rules. For eg; In Karnataka, **the Department of Ecology and Environment (DEE)**, Government of Karnataka oversees protection and conservation in accordance with central acts and rules. Although DEE and Karnataka Forest Department have a common secretariat, DEE does not have a line department and therefore does not enforce laws directly. In Kerala, the **Department of Environment and Climate Change** was constituted to carry out the functions on the subject matters allotted to the Environment Department, to scrutinize the environment related proposals prepared by different departments/ organizations and to co-ordinate the execution of the schemes, and is also the nodal Department to co-ordinate with other departments on matters related with Environment, awareness generation, and climate change management. In Goa, the **Department of Science, Technology and Environment**, conducts regular and periodic activities to promote science and technology and environmental projects, awareness drives, drafts and implements legislation related to the environment as well as develops plans to manage natural resource assets within the state. The Goa State Pollution Control Board, Goa Coastal Management Authority, Goa State Council of Science and Technology, Goa Energy Development Agency and the Goa Environment Protection Council are statutory/advisory authorities under the Department.

State Biodiversity Board (SBB): The function of the SBBs is to advise the State Government, subject to any guidelines issued by the Central Government, on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of the benefits arising out of the utilization of biological resources. Further, the SBBs regulate commercial utilization or bio-survey and bio-utilization of any biological resource by Indians, by granting of approvals.

State CAMPA: Intended as an instrument to accelerate activities for preservation of natural forests, management of wildlife, infrastructure development in the sector and other allied works the prime task of State CAMPA is to aid in the regeneration of natural forests and building up the institution engaged in this task in the State Forest Department.

Forest Development Agencies (FDA): For better coordination, guidance and monitoring of the village level JFMC, FDAs were formed under the National Afforestation Programme (NAP) in 2002. The FDA is a federation of all JFMCs/EDCs at the forest division level and may include up to 55 JFMCs. The FDAs help individual JFMCs/EDCs in micro-planning and implementation of their programmes and activities. Forest Development Agencies and JFMCs/EDCs together coordinate with government departments to dovetail their schemes and programmes regarding afforestation or conservation in a holistic manner and develop partnerships with the private sector and other organizations working on rural livelihoods.

Forest Development Corporations (FDC): Following the recommendations of the National Commission on Agriculture in 1976, many state governments set up FDCs to cater to commercial aspects of forestry. Along with the original mandate of timber harvesting, wasteland afforestation, promotion of commercial tree plantations and cash crops, the FDCs now cover issues relating to NTFP marketing, ecotourism, training of forest personnel and rehabilitation of displaced forest communities.

Some additional Sub-national Authorities are:

4.1.3.1 Kerala

Kerala State Council for Science, Technology and Environment (KSCSTE): Replacing the existing State Committee for Science, Technology and Environment (STEC), the KSCSTE was constituted in 2002. It is headed by the Chief Minister of Kerala as the ex-officio President of the Council. The Council is an autonomous body to encourage and promote Science and Technology related activities in the Kerala State through plans and grants. In order to strengthen the research and development (R&D) efforts required in the field of environmental science, the Kerala Government had established KSCSTE and a number of autonomous R&D centres such as the Centre for Earth Science Studies (CESS), the Tropical Botanic Garden & Research Institute (TBGRI), the Kerala Forest Research Institute (KFRI), the Centre for Water Resources Development and Management (CWRDM), the Rajiv Gandhi Centre for Biotechnology (RGCB), National Transportation Planning and Research Centre (NATPAC) and Agency for Non-conventional Energy and Rural Technology (ANERT) (State Planning Board, 2014).

4.1.3.2 Karnataka

Karnataka Ecotourism Board: The Karnataka Ecotourism Development Board was set up in 2013 with the forest minister of Karnataka serving as the

Chairman. The board was formed so as to provide support in protecting the wildlife, creating awareness about it, encouraging eco-tourism, forest safaris and also prevent damage to eco-system in the name of tourism.

4.1.3.3 Goa

Goa Environment Protection Council (GEPC): Headed by the Governor, this 40 member Council of the most important functionaries and NGOs of Goa State dealing with the environment, is an advisory body. The functions of the Council includes review of work relating to the environment undertaken in the State by Government and non-governmental organisations, advise the State Government on environmental issues, and identify areas requiring investigations, research and restoration in the field of environment.

4.1.4 City and local authority

PRI: Panchayats or village local self-government is listed under the Directive Principles of the Indian Constitution, directing states to set up Panchayats and provide them with requisite power and authority to function as units of self-government at the grassroots level. However, it was only after the 73rd Constitutional Amendment in 1992, that these institutions received the appropriate powers. A third of the elected membership of PRIs is reserved for Scheduled Castes and Scheduled Tribes and women, allowing for representation of the most disadvantaged sections of society. The Amendment provided a list of 29 subjects over which PRIs are conferred powers by devolution, of which 11 are related to natural resources.

JFMC: These are village-level institutions established based on state government's adaptation of the JFM guidelines issued by the central government. JFMCs enter into formal partnerships with the Forest Department on forest protection and management. They frame rules for the effective management of the earmarked forests, determine rights of collection, and distribution of benefits arising from management.

ADC: Within the north eastern states, which contain large populations of tribals, are several autonomous administrative divisions to which the central government has given varying degrees of autonomy within the state legislature. The establishment and functions of most of these autonomous councils are based on sixth schedule to the constitution of India which lays down a framework of autonomous decentralized governance with legislative and executive powers over subjects like water, soil, land, local customs and culture. These bodies have also been given judicial powers to settle certain types of civil and criminal cases.

Eco-development committee (EDC): While JFMCs function mostly in degraded forests/deforested areas lying outside protected areas, EDCs function within protected areas under the eco-development programme. They are village institutions that partner with protected area managers for the protection, preservation and propagation of wildlife in protected areas. In several

protected areas, EDCs have evolved into excellent ‘social fences’ for the conservation of biological resources and have started to benefit from the economic opportunities created (e.g. Periyar Tiger Reserve in Kerala).

Tree Growers’ Cooperative Societies (TGCS): Within the forestry sector, one of the pioneering attempts in community involvement was the establishment of TGCS to reclaim wastelands by establishing tree plantations. Membership of each cooperative was generally limited to one village, although in practice other villagers could also participate. The cooperatives established fuel wood and fodder plantations on the leased land and contracted local guards to protect the plantations against illicit grazing, tree felling and collection of various forest products (Cronkleton *et al.*, 2012). The programme was guided by an organization that became known as the National Tree Growers’ Cooperative Federation Limited (NTGCF).

Vana Samrakshana Samithis (VSS)/ Village Forest Councils (VFC): India’s National Forest Policy (NFP) of 1988 created space for community participation and establishment of VFCs in the management of forest resources of the country in 1990. This was a result of an increasing focus on people-centred policies, bottom-up planning processes, and decentralised governance. In many southern states of India including Kerala (State Planning Board, 2016), the VFCs are called VSS. Each village (hamlets/settlements) forms a VSS bearing the same name as the village. These *Samithis* function under the FDAs.

BMC: Under the Biological Diversity Act, 2002, every local body has to constitute a BMC for the purpose of promoting conservation, sustainable use and documentation of biological diversity. An important function of the BMC is the preparation of a People’s Biodiversity Register (PBR) that contains comprehensive information on availability and use of local biological resources, or any other traditional knowledge associated with them.

4.1.5 Coordinating structures

There are no coordinating structures at present outside of the national, subnational and local institutions described above.

4.2 Macro policy frameworks

4.2.1 Growth and development policy frameworks

Five Year Plans

National developmental planning, in India, was carried out through Five-Year Plans (FYPs) that are centralized and integrated national economic programs. The First FYP was launched in 1951 by the first Prime Minister, Jawaharlal Nehru. The Planning Commission was set up in March 1950 to develop these five year plans to promote a rapid rise in the standard of living of the people by efficient exploitation of the resources of the country, increasing production and employment (Ministry of Statistics and Programme Implementation, 2015).

The twelfth FYP (Planning Commission, 2013) had an objective of promoting inclusiveness and sustainability and seeks to accelerate agricultural GDP as well as a faster growth in manufacturing, with an emphasis on improving access to education, health, sanitation and clean drinking water. A major indicator relevant to biodiversity protection is the indicator which details increasing green cover by 1 million hectare each year and reducing the emission intensity of GDP. More information on the 25 core indicators within the plan can be found in Appendix 5.

New System of Planning

In 2014 the Planning Commission was replaced with NITI Aayog. The mandate of the Planning Commission, and NITI Aayog, is general planning for the country, while the more detailed planning mainly occurs within the different sectors (CBD, 2016). NITI Aayog is more of a think tank and cannot impose policies it has formulated. However, the new organizational model gives more power to the states, more flexibility in the timeline of planning cycles and encourages decentralisation to focus on state specific priorities.

The new government which came into power at the national level in 2014 ended the system of the FYPs. The decades-old FYPs are now replaced by a three-year action plan, which will be part of a seven-year strategy paper and a 15-year vision document (NITI Aayog, 2017). The 12th Plan was the last of the FYPs which came to an end on March 31, 2017, though it has been given an extension of six months to allow ministries to complete their appraisals.

The aim of the long-term 15 year vision document is to formulate various ways through which India can achieve its broader social objectives to meet the UNDP's 2030 sustainable goals and act as a roadmap on transformation required in the planning system to sync it with the 14th Finance Commission recommendations (NITI Aayog, 2017). The Vision document draws from the PM's vision which hopes to transform India into a prosperous, highly educated, healthy, secure, corruption-free, energy-abundant, environmentally clean and globally influential nation by 2031-32. The three year action agenda which is embedded within the vision document includes some 300 specific action points which are outlined in seven parts covering multiple facets of the Indian economy. These seven areas include revenue and expenditure, economic transformation in major sectors, regional development, growth enablers, and reforms in governance, social sectors and sustainability. In terms of the environment, the government has outlined water conservation measures such as ground water banking and national water framework act. Focus on reduction of air pollution in cities is also mentioned. The plan advocates that all linear projects such as road, power lines and rail projects that cut through forests "incorporate mitigation measures at all stages of planning, construction, and maintenance" as that will allow projects to go ahead without cutting off migration corridors that are essential to prevent species from going extinct.

States are yet to align their planning with the national process and therefore in the section below only details of their FYPs are provided.

4.2.1.1 Kerala

The Approach of the 12th FYP (2012-17) for Kerala is based on the needs of the citizens and aimed at improving the status of each individual. Its strategic intent is to lay the foundation for creating an economy which is productive, competitive, sustainable and inclusive (State Planning Board, 2013). The state aimed at an average growth rate in GSDP of 9.50 percent (at constant prices) during the 12th plan. The major share of the proposed outlay of the 12th FYP is earmarked for the social services sector (almost 45 percent) followed by Industry, Transport and Science & Technology (32.55 percent). Agriculture and allied sectors shared 8.66 per cent of the proposed outlay.

4.2.1.2 Karnataka

The 12th FYP of Karnataka (State Planning Board, 2013) focuses on infrastructure development. It aimed to achieve a growth rate of 10 percent within the time period. Twelve sectors created for this purpose were agri-infrastructure and irrigation, education, energy, healthcare, industrial infrastructure, rural development, sports and youth services, telecommunication, tourism, transport and logistics, housing, urban and rural infrastructure. The plan also intended on keeping agricultural growth above six percent. The allocation for infrastructure projects has increased by 45 percent in the period 2012-16 over 2008-12. Overall, sector wise, Agriculture and its allied sectors including irrigation receive 26.7 percent of the budget while the social sector comes second receiving 21.4 percent of the outlay.

4.2.1.3 Goa

In the absence of a 12th FYP document of Goa, the project team reviewed the budget outlay described in the annual budget release for the year 2013-2014 which was released by the Directorate of Planning, Statistics and Evaluation. Figure 12 presents the outlay across various sectors. Overall, sector wise, social services (Education, Public Health, Housing, Sanitation and Water Supply, Social welfare) receives the largest outlay of 50 percent followed by agriculture and irrigation/flood control at 10 percent, followed by transport at nine percent and then energy at eight percent. It is also important to note that three percent of the budget (INR 7.09 billion) was allotted to Science, Technology and the Environment.

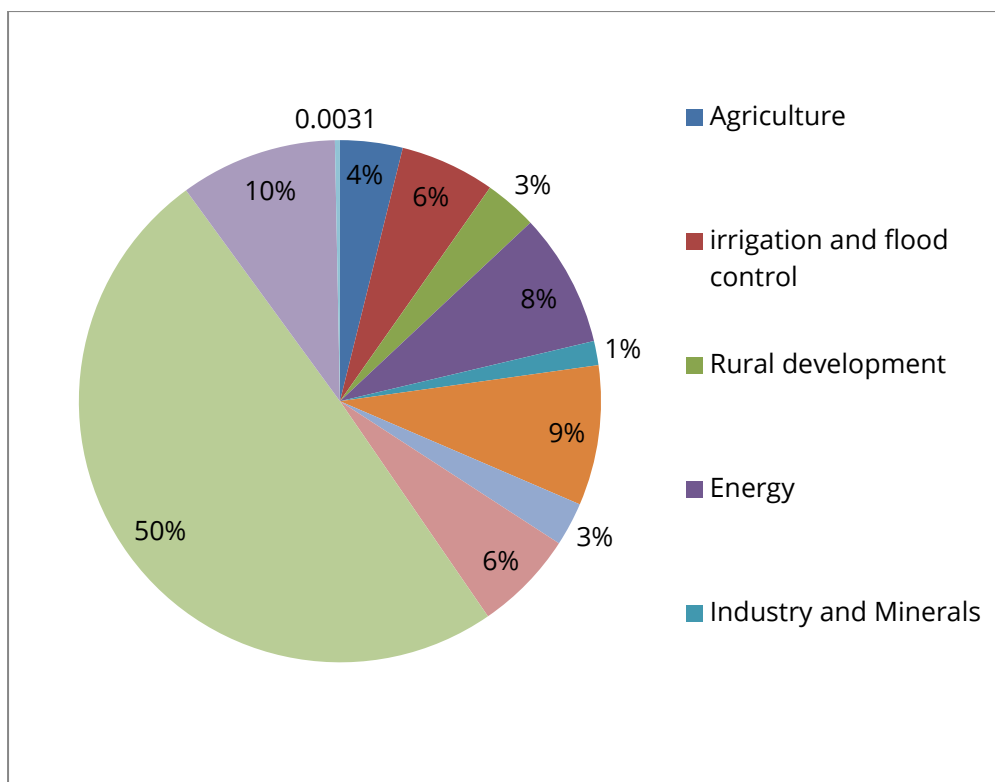


Figure 12: Budget outlay of Goa's 12th FYP

4.2.2 Climate change and disaster risk management policy frameworks

4.2.2.1 Climate Change

India is the fourth largest greenhouse gas (GHG) emitter, accounting for 5.8 percent of global emissions. Under the Copenhagen Accord, India pledged to reduce its CO₂ intensity (emissions per GDP) by 20 to 25 percent by 2020 compared to 2005 levels (MoEF, 2010). On October 1, 2015, India formally submitted its intended nationally determined contribution (INDC) to the climate agreement due in December 2015 in Paris (Box 1) (Government of India, 2015). India has also ratified the Paris agreement in 2016 and according to some reports (Goswami, 2017), it is among a handful of major polluters that is on track to achieve the national targets set to address climate change under the Agreement.

Box 1: Key Elements of India's INDC

- To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level.
- To achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030, with the help of transfer of technology and low cost international finance including from Green Climate Fund (GCF).
- To create an additional carbon sink of 2.5 to 3 billion tonnes of CO₂ equivalent through additional forest and tree cover by 2030.

Policies Contributing to Climate Mitigation

National Action Plan on Climate Change (NAPCC), 2008: India has a number of policies that contribute to climate mitigation by reducing or avoiding GHG emissions. India's first NAPCC was released in 2008 (Government of India, 2008), which identified eight core 'national missions' to advance India's development and climate change-related objectives. These are detailed below,

- 1) **National Solar Mission:** The Mission aims to promote the development and use of solar energy for power generation and other uses, with the ultimate objective of making solar competitive with fossil-based energy options
- 2) **National Mission for Enhanced Energy Efficiency:** The National Mission for Enhanced Energy Efficiency implements the Perform, Achieve and Trade (PAT) Mechanism, covering the country's largest industrial and power generation facilities. PAT covers more than 50 percent of fossil fuel use and set a target to reduce energy consumption at participating facilities 4-5 percent in 2015 compared to 2010 levels.
- 3) **National Mission on Sustainable Habitat:** The National Mission on Sustainable Habitat also includes initiatives such as the Energy Conservation Building Code, mandated for commercial buildings in eight states, and actions to support recycling, waste management, and improved urban planning.
- 4) **National Water Mission:** The NAPCC sets a goal of a 20 percent improvement in water use efficiency through pricing and other measures to deal with water scarcity as a result of climate change.
- 5) **National Mission for Sustaining the Himalayan Ecosystem:** This particular mission sets the goal to prevent melting of the Himalayan glaciers and to protect biodiversity in the Himalayan region.

- 6) **Green India Mission:** This mission aims at afforestation of six million hectares of degraded forest lands and expanding forest cover from 23 to 33 percent of India's territory.
- 7) **National Mission for Sustainable Agriculture:** Climate adaptation in agriculture through the development of climate-resilient crops, expansion of weather insurance mechanisms, and agricultural practices will be supported in this mission.
- 8) **National Mission on Strategic Knowledge for Climate Change:** The Mission aims to gain a better understanding of climate science, impacts, and challenges, through a new Climate Science Research Fund, improved climate modelling, and increased international collaboration.

The NAPCC also describes other ongoing initiatives that are as follows:

Power generation: The government is mandating the retirement of inefficient coal-fired power plants and supporting the research and development of Integrated Gasification Combined Cycle (IGCC) and supercritical technologies.

Renewable energy: Under the Electricity Act 2003 and the National Tariff Policy 2006, the central and the state electricity regulatory commissions must purchase a certain percentage of grid-based power from renewable sources.

Energy efficiency: Under the Energy Conservation Act 2001, large energy-consuming industries are required to undertake energy audits and an energy-labelling program for appliances has been introduced.

Proposals for health sector: The proposed program comprises two main components, namely provision of enhanced public health care services and assessment of increased burden of diseases due to climate change.

Implementation: Ministries with lead responsibility for each of the missions are directed to develop objectives, implementation strategies, timelines, and monitoring and evaluation criteria to be submitted to the Prime Minister's Council on Climate Change. The Council will also be responsible for periodically reviewing and reporting on each mission's progress. To be able to quantify progress, appropriate indicators and methodologies will be developed to assess both avoided emissions and adaptation benefits.

India's 12th FYP (2012-2017) (Planning Commission, 2013) included goals to:

- Reduce emissions intensity in line with India's Copenhagen pledge; and
- Add 300,000 MW of renewable energy capacity.

Some other policy directives and initiatives which have been taken up include the following

- Renewable energy – At the federal level, India has implemented two major renewable energy-related policies: the Strategic Plan for New and

Renewable Energy (2011-2017) (Government of India, 2011), which provides a broad framework, and the National Solar Mission, which sets capacity targets for renewable (Government of India, National Solar Mission, 2012). The original Solar Mission includes the following targets for 2017: 27.3 GW wind, 4 GW solar, 5 GW biomass and 5 GW other renewables.

- Coal – In 2010, a tax on coal was introduced which has raised \$2.85 billion for India's clean energy fund. The tax rose in July 2014 from INR 50 (\$0.80) to INR 100 (\$1.60) per ton, and doubled again in March 2015 to INR 200 (\$3.20) per ton and further to INR 400 (\$6.40) per ton in 2016. Unfortunately, as of April 2017 funds collected are being used by the present government in the GST Compensation Fund, a fund meant to compensate various state governments for any loss in revenue arising out of the goods and services tax – giving funding of climate change combat a go-by (Ramesh, 2017).
- Transportation - In early 2014, India announced new vehicle fuel-economy standards (Indian Corporate Average Fuel Consumption standard) of 4.8 litres per 100 kilometres (49 MPG) by 2021-2022, a 15 percent improvement. Biofuel legislation has set a target of 20 percent blending of ethanol and biodiesel in 2017 (Data from IEA, 2014).
- Smart Cities Mission– The present Prime Minister, Mr. Narendra Modi, has launched an initiative to create 100 “smart cities” with better transport systems, utilities, blue-green infrastructure and energy networks to address the challenges of urban growth (Data from the New Climate Economy, 2014).

National Bank for Agriculture and Rural Development (NABARD): NABARD has been accredited as a National Implementing Entity (NIE) for India for the Adaptation Fund created under the United Nations Framework Convention on Climate Change (UNFCCC) and has generated several feasible projects on climate change adaptation in diverse agro-climatic regions and livelihood sectors. Additionally, NABARD is implementing several developmental projects to promote sustainable livelihoods through Natural Resource Management (NRM) such as watershed development and sustainable livelihood for tribal communities, which are helping build climate change resilience and adaptive capacities of rural communities.

States are mandated to develop their own **State Action Plans on Climate Change (SAPCC)** which would include a vulnerability analysis, known information about how climate change is currently affecting particular districts and sectors within the state, and provide some estimates of the future situation, along with mitigation and adaptation strategies and plans (Action on Climate Today, 2012). These plans are based on a common framework provided MoEFCC. In certain states, a comprehensive scientific process was carried out to assess the level of

vulnerability of the state to climate change. A large number of SAPCCs focus on adapting to the impacts of climate change, however, a few also consider how the state is contributing to climate change. Actions/ project proposals are detailed out for the approach or strategy for each sector primarily based on inputs from the relevant line department along with costing, time frame and plans for implementation.

4.2.2.1.1 Kerala

Kerala SAPCC, 2014: Implementation of Kerala's SAPCC has begun and the state has secured funding under the National Adaptation Fund for Climate Change (NAFCC), for a project titled "Promotion of Integrated Farming System of Kaipad and Pokkali in Coastal Wetlands of Kerala" with a budget of INR 250 million (NABARD, 2016). The SAPCC outlines the strategy for actions on the aspects which could be relevant in the context of climate change and enumerates the sectors and scope of coverage of action for adaptation to climate change. The document only shows the indicative possibilities in the state, based on the information, available literature and understanding. Long term action plans are yet to be developed (Government of Kerala, 2014).

4.2.2.1.2 Karnataka

Karnataka SAPCC, 2013: Besides outlining a need for further research, Karnataka's SAPCC identifies scope for immediate actions defining around 200 of them. 31 of these are highlighted as priorities or entry points based on their contribution to sustainable development, their relevance to strengthening climate preparedness and the fact that their implementation is not hampered by uncertainties attached to climate projections. For example, an improvement of institutional preparedness or a further improvement of the performance of programmes currently implemented by Government of Karnataka (Government of Karnataka, 2013).

4.2.2.1.3 Goa

Goa is still in the process of finalising its SAPCC, after which it will be available for review in the public domain.

4.2.2.2 Disaster Management

India is vulnerable to a large number of natural as well as man-made disasters. 58.6 percent of the landmass is prone to earthquakes of moderate to very high intensity; over 12 percent of land is prone to floods and river erosion; of the 7,516 km long coastline, close to 5,700 km is prone to cyclones and tsunamis; 68 percent of the cultivable area is vulnerable to drought and hilly areas are at risk from landslides and avalanches (NDMA, 2016). Vulnerability to disasters/emergencies of chemical, biological, radiological and nuclear origin also exists.

The National Policy Framework includes the National Policy on Disaster Management, 2009 and the National Disaster Management Plan, 2016. The framework was

prepared keeping in view the National Vision to “build a safe and disaster-resilient India by developing a holistic, proactive, multi-disaster and technology-driven strategy for Disaster Management” (NDMA, 2009, 2016). This will be achieved through a culture of prevention, mitigation and preparedness to generate a prompt and efficient response during disasters. Community participation receives a lot of attention within the framework and the collective involvement of government agencies, NGOs to sustain the former is also highlighted.

This Policy framework is also in conformity with the International Strategy for Disaster Reduction, the Rio Declaration, the Millennium Development Goals and the Hyogo Framework 2005-2015, and the Sendai Framework (2015-2030).

National Policy on Disaster Management, 2009: The 2009 policy (NDMA, 2009) marks the institutionalization of a paradigm shift in disaster management in India, from a “relief-centric approach to one of proactive prevention, mitigation and preparedness”. It underlines that adequate mitigation and disaster risk reduction measures can prevent hazards from turning into major disasters. The National Policy suggests a multi-pronged approach for disaster risk reduction and mitigation consisting of the following:

- Integrating risk reduction measures into all development projects
- Initiating mitigation projects in identified high priority areas through joint efforts of the Central and State Governments
- Encouraging and assisting State level mitigation projects
- Paying attention to indigenous knowledge on disaster and coping mechanisms
- Giving due weightage to the protection of heritage structures

National Disaster Management Plan (NDMP), 2016: With the release of the first National Plan in 2016 (NDMA, 2016), a critical gap in the country's disaster management system was addressed¹. The plan is based on the four priority themes of the Sendai Framework (Appendix 6) and details roles and responsibilities of all levels of Government right up to Panchayat and Urban Local Body (ULB) level in a matrix format. Provisions in the plan provide for horizontal and vertical integration among all the agencies and departments of the Government. Although the Plan provides a generalized framework for recovery and offers flexibility to assess a situation and build back better as well as identifies major activities to serve as a checklist for agencies responding to a disaster, these are much too generic (Chakrabarti, 2016). Specific timeframes for implementation, a monitoring and evaluation framework are lacking, as well as any roadmap, probably due to the complexities of the tasks involved.

¹While most states and districts have prepared their plans, the national plan that was supposed to guide this process at the sub-national level was missing

4.2.2.2.1 Kerala

Kerala is vulnerable to a multitude of disasters and is categorized as a multi-hazard prone state (Department of Revenue and Disaster Management, 2010). It experiences heavy rainfall and flood during the southwest monsoon, with subsequent damage to life and property. Drought conditions have also become more frequent during the pre-monsoon period and at times with the failure of southwest monsoon and /or northeast monsoon. Coastal erosion along the coastal areas is very severe, necessitating frequent evacuation and rehabilitation of the coastal people. Incidences of biological disasters such as epidemics, pest attack are also on the rise. Fatalities in road and rail accidents, manmade accidents, lightning and boat capsizing are very high in the state. Landslide or landslip is another hazard of the hilly regions of the state. The tsunami that struck Kerala Coast in 2004 has added a new dimension to the disaster scenario of the state as most of the low lying and mid land areas in the State have an altitude of only 4-6 meters.

Kerala State has established a Policy, Institutional and Techno-Legal Framework for disaster management in the state, which creates an enabling regulatory environment and compliance regime and facilitates the activities of different phases of disasters.

The State Disaster Management Policy 2010, formulated by Department of Revenue and Disaster Management and promulgated by State Disaster Management Authority acts as the guiding principle for disaster management in the State (Department of Revenue and Disaster Management, 2010). It aims to establish an optimum system for dealing with disasters, avoiding disruption of economic activity and ensuring continuity in developmental activities without damaging the environment. The policy framework is structured in such a way that Kerala State Disaster Management Authority provides the overall direction and guidance to various entities leveraging the resources and capability of existing entities and building new capabilities without treating disaster management as a separate sector or discipline. The goal of the Kerala Disaster Management Policy is to institute structures and systems and to establish directive principles for effective risk reduction and crisis management in order to minimise human, infrastructure, property, environment and livelihood losses and to contribute to the sustainability of development and better standards of living for poor and vulnerable sections.

4.2.2.2.2 Karnataka

The physical location of Karnataka, on the western coast of India makes it vulnerable to hazards such as cyclone, winds and coastal erosion. A large part of the state falls within the Krishna, Cauvery and Godavari basins and almost all districts of Karnataka are vulnerable to severe or moderate floods along these areas. Areas along the Western Ghats are prone to landslides in the rainy season. Drought is one of the major natural disasters of the state. Groundwater levels are depleting due to successive droughts and quality of water is getting

deteriorated in terms of fluoride, nitrate and salinity (Karnataka State Disaster Management Authority, 2011).

The goal of Karnataka's draft Disaster Management Policy (*ibid.*) is to institute state specific structures and systems and establish directive principles for strengthening administrative response and community participation in effective disaster risk and crisis management towards minimizing human, property, environment and livelihood losses. While accepting that disasters are inevitable, the policy lays down comprehensive measures to minimise impact of disasters on the community. The policy was drafted in 2011 but has not been finalized to date.

4.2.2.2.3 Goa

The Goa State Disaster Management Plan is still awaiting approval from the NDMA (Herald Goa, 2017) although the state has developed its regional plans.

4.2.3 Environment and biodiversity policy frameworks

India has developed a robust legislative and policy framework for biodiversity governance which includes protection, conservation as well as sustainable use, access and benefit sharing. Protection of the environment, including biodiversity, is enshrined in the Constitution of India. It instructs both the Government and citizens to take appropriate steps in this direction. The policy framework for biodiversity governance comprises a number of sector-specific and cross-sectoral policy statements issued over the years. Some of the key policy statements are: (i) National Forest Policy, 1988 which is presently being redrafted; (ii) National Conservation Strategy and Policy Statement on Environment and Development, 1992; (iii) National Agriculture Policy, 2000; (iv) National Seeds Policy, 2002; (v) National Environment Policy, 2006; (vi) National Water Policy, 2012; and (vii) National Marine Fishing Policy, 2017. Agricultural, fishery and water related policies are detailed in the subsequent section.

National Forest Policy, 1988: India has maintained a Forest Policy since 1894. With the revision of the 1952 policy (Government of India, 1952), the 1988 policy (MoEF, 1988) held sway for over 30 years. The policy concerns itself with protection, conservation and development of forests giving weight to the protective role of forests in maintaining ecological balance and environmental stability. The policy underlined that "The national goal should be to have a minimum of one-third (33 percent) of the total land area of the country under forest cover which should be two-third of the area in the hills and mountainous regions (in order to prevent erosion and land degradation and to ensure the stability of fragile ecosystems)". Preservation and conservation of forests would enable the maintenance of environmental stability and restoration of ecological balance. The other main objectives of the policy are the conservation of the country's natural heritage and biological diversity, increasing the productivity of degraded forests, and meeting the local needs of the people and encouraging their participation in the protection and management (through joint

management programmes) of forests. The derivation of direct economic benefit is to be subordinated to these objectives (MoEFCC, 2007). Afforestation and social forestry programmes are promoted as a way to increasing the forest cover on public land, together with farm forestry and agroforestry schemes on private land.

National Draft Forest Policy 2018: In March 2018, modifications to the 1988 Forest Policy were suggested by the MoEFCC (MoEFCC, 2018). The draft contains proposals to protect the country's green cover such as **urban greens** (Box 2), public private partnership models for afforestation, strengthening forest fire prevention measures and plantations in catchment areas to rejuvenate water bodies. This new draft policy has been widely reviewed by an array of stakeholders. A strong view that has emerged is that it appears to be an attempt to "shift the approach towards forestry in India – specifically, from a local community- and ecology-centric approach emphasised in the 1988 policy to focusing on timber and forest-based industries" (Agarwal, 2018). This is in direct contrast with the 1988 policy. It identifies "production forestry" and plantations as the new thrust area and dilutes the rights of local, forest-dependent communities. There are however some suggestions which bear merit such as economic valuation of ecosystem services, forest certification, national forest ecosystem management information system and an incorporation of climate change concerns in all forest and wildlife areas working/management plans and Community Ecosystem Management Plans.

Box 2 : Urban Greens Inclusion in the New Draft Forest Policy, 2018

On promoting urban greens which include woodlands, wetlands, parks, wood in institutional areas, gardens, avenue plantations and block plantations, the draft says, "They need to be managed as urban forest ecosystems to enhance optimal urban forest cover and to nurture and sustain urban health, clean air and related benefits". Management plans for urban green will be prepared and implemented in consonance with the development plan of cities.

National Conservation Strategy and Policy Statement on Environment and Development, 1992: Released in response to the need for laying down the guidelines that will help to weave environmental considerations into the fabric of India's national life and development process, the strategy and policy statement (MoEF, 1992) is an expression of India's commitment for reorienting policies and action in unison with the environmental perspective. It presents the nature and dimensions of the environmental problems, actions taken in response to the problems and lists out priorities and strategies for action. It also views development policies from environmental perspectives and the support policies and systems required.

National Environment Policy, 2006: In 2006, India brought out a comprehensive policy statement, the National Environment Policy (MoEF, 2006), in response to the

Constitutional mandate of a clean environment as set down in Articles 48 A and 51 A (g). The policy intends to ‘infuse a common approach’ and to achieve ‘balance and harmony between economic, social and environmental needs of the country’ through seven main objectives. It also lays down a number of principles including *inter alia* the ‘public trust doctrine’, ‘precautionary approach’, ‘polluter pays’, ‘equity’ and ‘entities with incomparable values’. The dominant theme within the policy is sustainable use of natural resources. It states that “...while conservation of environmental resources is necessary to secure livelihoods and wellbeing of all, the most secure basis for conservation is to ensure that people dependent on particular resources obtain better livelihoods from the fact of conservation, than from degradation of the resource”.

Apart from the statements and legislations, other important components of the policy and legal framework are ‘Action Plans’. The three major Action Plans relevant to biodiversity governance are the National Forestry Action Programme (1999), the NBAP (2008) and Addendum (2014) and the National Wildlife Action Plan (2017-2031). Furthermore, plans such as the National River Conservation Plan (1995), National Lake Conservation Plan (2001) and National Wetlands Conservation Programme (1985) also hold merit in terms of relevance to biodiversity conservation. The latter two were merged in 2013 into a new integrated scheme called the National Plan for Conservation of Aquatic Ecosystems (NPCA). The NAPCC which has been discussed in the previous section is likely to have a positive impact on biodiversity through its missions such as Green India, Sustainable Agriculture, Himalayan Ecosystem and Strategic Knowledge.

National Forestry Action Programme (1999): It is a comprehensive workplan for sustainable development of forests in the country in next twenty years as well as to achieve the national goal of 33 percent geographic area of the country under the forest and tree cover as enshrined in the National Forest Policy, 1988 (MoEF, 1999). This exercise has been undertaken as a part of the programme recommended by the United Nations Conference for Environment and Development (UNCED) and its subsequent forum, the Commission on Sustainable Development (CSD) and Intergovernmental Panel on Forestry (IPF) for the launch of National Forest Programmes globally.

NBAP (2008) and Addendum (2014): The National Environmental Policy of 2006 was the framework for the NBAP (2008). As the NBAP (MoEF, 2008) was developed prior to the CBD Strategic Plan for Biodiversity 2011-2020, it was updated in the form of the addition of an addendum in 2014. The addendum (MoEFCC, 2014) builds synergies between the NBAP and Aichi Biodiversity Targets through the formulation of 12 National Biodiversity Targets (NBTs). More on the NBAP and Addendum can be found in section 3.3 of this report.

National Wildlife Action Plan (2017- 2031): The plan (MoEFCC, 2017) is a framework strategy which acts as a road map for wildlife conservation. The latest plan

recognises the concerns relating to climate change impact on wildlife and stresses on integrating actions that need to be taken for its mitigation and adaptation into wildlife management planning processes. This is the first plan of the series to do so. The government has also underlined an increased role of private sector in wildlife conservation. The plan lays down that the Centre would ensure that adequate and sustained funding including Corporate Social Responsibility (CSR) funds are made available for the National Wildlife Action Plan implementation.

National River Conservation Plan (NRCP): This is a centrally funded scheme launched in 1995 aimed at preventing the pollution of rivers. It covers 39 rivers and considerable efforts have been made to improve water quality through pollution abatement (MoEF, 2012).

National Plan for Conservation of Aquatic Ecosystems (NPCA): Under this Plan are two centrally funded schemes including the National Lake Conservation Plan (NLCP) (*ibid.*) and National Wetlands Conservation Programme (NWCP), which aim to restore and conserve the urban and semi-urban lakes and wetlands of the country and other unique freshwater ecosystems, degraded due to waste water discharge. The schemes follow an integrated ecosystem approach. Projects for conservation of as many as 61 lakes have been taken up since 2001 under the NLCP. Under the NWCP, 115 wetlands have been identified for conservation (*ibid.*).

Apart from conserving critical habitats through the protected area network, another important strategy adopted is species-focused conservation. The two flagship schemes are Project Tiger and Project Elephant. More information on this can be found in Appendix 7.

4.2.3.1 Kerala

Kerala is one of the first states in India to constitute a State Pollution Control Board (SPCB) for monitoring and regulating measures for the abatement of pollution. The Government has also taken initiatives for the conservation and management of its forest and wildlife resources through the Department of Forests and Wildlife.

The Kerala State Forest Policy, 2009: The Forest Policy (Government of Kerala, 2009) of the state is guided by the 1988 National Forest Policy. The strategies adopted within the policy for the development of forests envisage maintenance of environmental stability through preservation and reduction of degraded forests, conservation of biodiversity, increasing productivity of forests, increasing forest cover through afforestation and developing participatory forest management. Specific problems and issues related to the conservation of forests and biodiversity of the state as well as the livelihood needs of the forest dependent communities are also detailed. The Forest Management Policy of the state includes technology improvement, biodiversity conservation and development of partnership with the forest dependent

communities and fringe dwellers. Special thrust is also given for protecting certain species of plants and animals.

Kerala State Environment Policy, 2009: This policy document (Government of Kerala, 2009) sets the context for the need for conservation of natural resources in the state of Kerala, given the increasing exploitation of resources and state of environment. The Policy borrows heavily from the National Environmental Policy (2006). It endeavours at mainstreaming environmental concerns in all the developmental activities and securing livelihoods based on conservation rather than degradation of natural resources. The document highlights the current environmental concerns in the state, the initiatives taken up by the state government, makes suggestions on the future potential strategies and the agencies that need to be involved to aid in optimal utilisation of natural resources without adversely affecting the people or the environment.

Kerala SBSAP, 2005: Kerala's SBSAP is a comprehensive document outlining its biodiversity profile, drivers of change, initiatives and institutions and strategies and actions. The document published in 2005, consists of 75 strategies, 190 actions grouped under 12 thematic groups. The thematic groups are diverse and encompass the following,

1. Economics and biodiversity,
2. Culture, lifestyles, livelihoods, tribals and intellectual property rights,
3. Health and biodiversity,
4. Domesticated biodiversity,
5. Wild animal diversity,
6. Wild plant diversity,
7. Microorganism diversity
8. Natural terrestrial ecosystem,
9. Natural aquatic ecosystem
10. Policy, laws and institutions,
11. Education, awareness, training and research,
12. Technology, industry and biodiversity.

Within each theme, overarching issues are dealt with through strategies and actions particular to them.

4.2.3.2 *Karnataka*

Karnataka does not have a separate state level environmental or forest policy. It follows the national level policies in this matter. The Department of Forests, Ecology and Environment (DEE), Government of Karnataka oversees protection and conservation in accordance with central acts and rules.

Karnataka Tree Cover Enhancement (KTCE) Policy, 2016: The policy (Government of Karnataka, 2016) intends to promote and incentivize growing of trees in other than notified and deemed forest areas, in the lands suitable for planting and owned or under occupancy by government departments, government and non-government institutions, private layouts, individuals including farm lands,

or any other suitable lands in the state of Karnataka. The policy primarily seeks to enhance the tree cover and thereby enhance the total forest and tree cover to meet the national target of 33 percent of the geographical area in the state.

Karnataka SBSAP, 2004: Published in 2004, the SBSAP deals with six themes encompassing the different facets of biodiversity within the state which includes,

- (a) Protected areas
- (b) Medicinal plants
- (c) Freshwater fishes
- (d) Wetlands
- (e) Cultural traditions of conservation, and
- (f) Land races of cultivated plants.

The SBSAP flags key concerns which are broadly addressed and can be considered within the national context as well as the local context. A total of six strategies are put forward and each deals with specific challenges and action plans that comprise proposed programmes, projects and activities to address the challenge.

4.2.3.3 Goa

Goa State Forest Policy, 2009: The policy (Government of Goa, 2009) aims to merge the basic principles of the National Forest Policy (1988) with the state's needs. Maintenance of environmental stability through preservation and restoration of the ecological balance and conserving the state's natural heritage by preserving the natural forests of Western Ghats, are among its frontline objectives. The policy envisages measures to control erosion, increase tree cover and protect forest areas through a host of measures, including securing people's involvement and control on poaching and illegal trade in wildlife. Promotion of ecotourism, medicinal plants and consolidation of forest boundaries are also proposed in the policy.

Goa SBSAP, 2002: Goa's SBSAP was released in 2002 having been prepared by the Goa State Steering Committee. The SBSAP proposed that post the release of the SBSAP, this entity would be renamed the Goa Biodiversity Protection Council whose purpose would be to act as a monitoring and pressure group on biodiversity issues. The SBSAP in itself is comparatively a short document. It outlines the state's profile, current range and status of biodiversity, major actors and their roles, ongoing biodiversity related initiatives and their efficacy. The main part of the SBSAP is the gap analysis and strategies and actions to fill these gaps. Gaps have been grouped into four main categories- information, vision, policy and legal structure and institutional and human capacity. Based on these eight strategies and a variety of actions have been proposed. The strategies and associated actions are specific, outline the agency who should take up the proposed actions as well as a timeframe for the actions. This differentiates the Goa SBSAP from the other two states.

Although the Kerala SBSAP is the most voluminous and quite detailed, it is quite circumlocutory. Specifics and measurable actions are missing. The Karnataka SBSAP sets out a well-structured strategy and action plan, however the actions in themselves while specific do not ascribe any responsibility nor set a target for achievement. In this regard, the Goa SBSAP sets SMART goals which are likely to result in some progress towards better biodiversity conservation and sustainable use.

4.2.4 Sector policy frameworks

4.2.4.1 Agriculture

National Agricultural Policy, 2000: In India, agriculture falls under the jurisdiction of the states, however some related subjects fall under the federal list. Each state is required to formulate their agricultural policies in accordance with the national agenda. While agriculture has always been addressed in the five year plans since 1950, India's first comprehensive national policy was developed in 2000 (Government of India, 2000). Targeting equitable inclusive growth and sustainability in terms of efficient use of resources, the policy seeks to promote technically sound, economically viable, environmentally non-degrading, and socially acceptable use of natural resources for the sustainable development of agriculture. The conservation of bio-resources through their ex-situ preservation in Gene Banks and in-situ preservation in their natural habitat through biodiversity parks is emphasised. It also aims at promoting special measures for conserving and enriching soils, using watershed approaches, promotion of balanced and optimum use of fertilizers together with organic manures.

National Seed Policy, 2002: The 1988 New Policy on Seed Development (Government of India, 1988) was developed to remove the roadblocks in import of horticultural seeds and to allow import of limited quantity of seeds such as cereals, pulses and oilseeds. However, this policy was flawed due to nonexistence of Intellectual Property Rights laws and several restrictions on import and exports. In 2002, the National Seed Policy (Government of India, 2002) was released with the purpose of providing intellectual property protection to stimulate investment in research and development of new plant varieties and set up institutions for planned development of the seeds sector. The policy also aimed to protect the interest of farmers and encourage conservation of agro-biodiversity. The 10 thrust areas of the policy are outlined in Box 3.

Box 3: National Seed Policy Thrust Areas

- 1) Varietal development and plant varieties protection
- 2) Seed production
- 3) Quality assurance
- 4) Seed distribution and marketing.
- 5) Infrastructure facilities
- 6) Transgenic plant varieties
- 7) Import of seeds and planting material
- 8) Export of seeds
- 9) Promotion of domestic seed
- 10) Strengthening of monitoring system

National Policy for Farmers 2007: The policy (Department of Agriculture and Cooperation, 2007) primarily aims to improve the economic viability of farming by substantially improving the net income of farmers through improved productivity, appropriate price policies and risk management measures. It identifies the importance of protecting and improving natural resources and aims to do so through bringing about an economic stake in conservation. It also mentions that the bio-security of crops, farm animals, fish and forest trees should be strengthened as they directly impact livelihoods, trade and income security within the country.

National Livestock Policy, 2013: In order to improve the productivity of the livestock sector in a sustainable manner, taking into account the provisions of the National Policy of Farmers, 2007 and the recommendations of the stakeholders, including the States, the National Livestock Policy was developed in 2013 (Department of National Animal Husbandry, Dairying & Fisheries, 2013). It aims at increasing livestock productivity and production in a sustainable manner, while protecting the environment, preserving animal biodiversity, ensuring bio-security and farmers' livelihood.

4.2.4.1.1 Kerala

Kerala Agricultural Development Policy, 2015: Kerala's Agricultural Development Policy (Government of Kerala, 2015) covers the primary production sectors such as Crop Husbandry, Animal Husbandry, Plantation sector, Dairy and Environment. The policy also includes to a limited extent, the Inland Fisheries sector. The document comprises 331 policy approaches which were drafted taking into account stakeholder views especially those of the farmer. The main focus of the policy like the National Policy is to ensure that farmers/those who are associated with farming are able to improve their net income earned. The policy's guiding principles are focussed around the judicious utilization of

available resources of land, water, rural manpower and technology. In a first across the country, the document introduces 'Actio Apportum' under which farmers have access to an assured income and the legal right to a share of the profit generated from trading farm produce.

Breeding policy in the State of Kerala, 2008: The breeding policy of Kerala (Kerala Livestock Development Board, 2008) promotes Jersey and Holstein Friesian to be used as exotic donor breeds and Jersey and its crossbred lines is used in larger proportions. It envisages cross breeding, limiting the exotic inheritance to around 50 percent followed by selection and inter se mating. In 2017, the government announced plans to review this policy.

Kerala State Organic Farming Policy, Strategy and Action Plan, 2010: Kerala aims at becoming an organic state through a target of converting a minimum of 10 percent of the cultivable land into entirely organic every year. The objectives of the policy (Government of Kerala, 2010) are to make farming sustainable, remunerative and respectable, to enhance natural soil fertility and productivity, to ensure soil, water conservation and agricultural bio-security, food and nutritional security, to create and ensure domestic market for organic products controlled by the farmers and to avoid the use of agrochemicals and other hazardous material and, ensure chemical - free water, soil, air and food, to ensure seed, food and sovereignty, to promote biodiversity based ecological farming, to ensure quality control in organic inputs and agricultural produce, to enable human health promotion by providing safe agricultural products and commodities and to conserve and extend traditional knowledge related to agriculture.

4.2.4.1.2 *Karnataka*

Karnataka's Agricultural Policy, 2006: The policy's (Government of Karnataka, 2006) focus is to double the state's agricultural output and improve agricultural investments by generating a growth rate of 4.5 percent annually. The "Farmer Centric" approach within the policy intends to bring back the focus to farmers rather than technology alone. It envisages a major role for the state to attain the stated objectives of the policy through budgetary support and macro-economic adjustments, production and technology sector, land issues, agro processing, trade and value addition to the farm products, removal of domestic market distortions and strengthen the linkages with other allied sector. It is a comprehensive policy considering several issues i.e. the need for dissemination of scientific knowledge by bridging the gap between the scientists and the land users, the need for land rights, the need for promotion of high value horticulture crops, provision of appropriate transportation and so on.

Karnataka State Policy on Organic Farming, 2004: With organic products gaining importance in the produce market, Karnataka state announced its Organic Farming Policy in 2004 (Commissionerate of Agriculture, 2004). The main objectives of this policy emphasise on aspects such as soil fertility and productivity by increasing life of soil, sourcing local natural resources to reduce the cost of cultivation, efficient use of water resources, improving farmer's income and food security by encouraging traditional crops and traditional food habits. It also seeks to set priorities which increase the rural employment opportunities to prevent urban migration, facilitate farmer's Self Help Groups (SHGs), improve environment safety and human and animal health, mitigate droughts and finally bring about suitable institutional changes in teaching and research on organic farming.

Karnataka Livestock Development Policy, 2010: The policy (Government of Karnataka, 2010) envisages achievement of an eight percent growth rate per annum of the livestock sector by addressing and providing infrastructure, institutions and incentives. It highlights the opportunities for public private partnership (PPP) for overall growth in the husbandry sector. Thrust areas include the development of backward areas and all species of livestock (cattle, buffalo, sheep, goat, pig and poultry). The policy addresses biodiversity conservation, emphasising on development of native breeds.

Integrated Agribusiness Development Policy, 2011: Karnataka through the policy (Government of Karnataka, 2011) intends to show initiative for developing sustainable agribusinesses. This policy includes agriculture and its allied sectors like horticulture, fisheries, animal husbandry, sericulture and food processing. It addresses issues related to production, processing, marketing and export. It also includes several interventions including that of infrastructure and industrial segments.

4.2.4.1.3 Goa

Goa Draft Agriculture Policy, 2017: Goa's draft agriculture policy has been awaiting approval from a committee which is yet to be formed for this purpose. The draft outlines strategies to develop agriculture, animal husbandry and dairy support services as well as measures to protect and improve available resources – land, water, biodiversity and genetic resources. Mechanisms for promoting agriculture in market-driven economy and encouraging horticulture and high-value crops so that farmers could get substantial return from agricultural land resources have been detailed (The Navhind Times, 2017).

Goa Breeding Policy for Cattle and Buffalo, 2010: The breeding policy's (Department of Animal Husbandry, 2010) main objectives are focused on milk production through the production of a large number of economically viable milch animals (cattle and buffalo) through their genetic improvement, conservation and improvement of local dairy animals, achievement of self-sufficiency in the state in terms of milk production and developing a homogeneous breeding policy for cattle and buffaloes across the state.

4.2.4.2 Fisheries

The governance of the fisheries sector is vested with the Ministry of Agriculture and the chief executive is the Secretary to the Government (Fisheries). However, it is the State Department of Fisheries that carries out all the development and management programs envisaged in the fisheries sector. The Director of Fisheries heads this department which is structurally stratified and organized under Executive Officers.

National Policy on Marine Fisheries, 2017: The National Policy on Marine Fisheries, 2017 (Department of Animal Husbandry, Dairying and Fisheries, 2013), aims to “ensure the health and ecological integrity of the marine living resources of India’s Exclusive Economic Zone (EEZ) through sustainable harvests for the benefit of present and future generations of the nation”. Sustainable development, socio-economic upliftment of fishers, principle of subsidiarity, partnership, inter-generational equity, gender justice and precautionary approach are the seven pillars in the policy that envisage guiding the actions of the various stakeholders. Although the policy talks about mainstreaming biodiversity conservation in production processes it places a lot of focus on auctioning quotas to the highest bidder and then allowing the free market to regulate the harvest, the trade and the sustainability of the resources. The policy also does not take into account the Coastal Zone Regulation Notification neither does it frame actions around traditional and small scale fishers. It proposes a rights-based approach which is commendable but limits itself to economic efficiency ignoring social justice.

4.2.4.2.1 Kerala

Kerala Fisheries Development and Management Policy, 2004: Kerala held the second position in India (2013-2014) in terms of fish production but dropped to fourth place (2016-2017) after West Bengal, Andhra Pradesh and Gujarat due to decline in fish catch. Since the late 1980s, Kerala State has been maintaining a ban on monsoon trawling to protect and sustain fish stocks. It was also the first coastal state to implement a fisheries management policy in 1994. The policy identified resource sustainability, economic viability, provision of decent living standards to the workers, and a good supply of fish for local consumption and export as its main tenets (Government of Kerala, 1994). Although the policy was developed in 1994, it was only implemented after 1997. The latest version of the policy is called the Kerala Fisheries Development and Management Policy, 2004 (Government of Kerala, 2004). The document includes guidelines for the general development and advancement of the fisheries sector, welfare of fishermen community and fisheries industry. A number of practices like mini-trawlers and pair trawlers along the coast, mechanised fishing inland are banned. Measures such as artificial reefs,

ecosystem and mangrove restoration are stressed on in the policy and the Pokkali farming² is promoted.

4.2.4.2.2 *Karnataka*

Karnataka Fisheries Policy, 2010: The policy (Government of Karnataka, 2010) looks to enhance the production of fish in the state. The policy aims at alleviating poverty through an improvement in the socio-economic conditions of the fishers, increasing fish exports and maintaining an ecological balance by conserving aquatic biodiversity.

4.2.4.3 *Water*

Water, like agriculture is a state subject under the Constitution of India. However, the Centre or the National Government has the power to regulate the development of inter-state rivers and settle inter-state water disputes, playing an important role in ensuring the sustainable management of river systems.

The National Water Policy, 2012: This policy of the Government of India was first enunciated in 1987 but it was not until the 2002 revision of the policy when the ecological and environmental aspects of water allocation were considered. The National Water Policy, 2012 (Ministry of Water Resources, 2012) incorporates an integrated perspective in the planning and management of water resources. It underlines that water management should be done in the context of a common pool community resource and its trusteeship, which is under the state, should be administered to ensure equitable and sustainable development for all. Water allocation prioritization is no longer included and the policy encourages viewing water as an economic good as a tool to promote its conservation and efficient use. This provision intended for the privatization of water-delivery services is being criticized from various quarters. Issues such as adapting to climate change, conservation of river corridors, water bodies, and infrastructure, management of floods and droughts, water supply and sanitation are detailed.

4.2.4.3.1 *Kerala*

Kerala Water Policy, 2008: Kerala was the first state in the country to bring out a state water policy in 1992 (Government of Kerala, 2014). This policy (Kerala Water Resources Department, 2008) was later modified in 2008. The 2008 policy operates through a multidisciplinary and holistic approach that recognises water as part of the ecosystem, for the benefit of all and not as commodity for profit of a few. It considers interventions in the varied aspects of climate change, micro-watersheds, water quality and wetland preservation. It includes the necessity of conservation, development and management of water resources based on the concept that watershed is inevitable for maintaining the ecosystem, integrity of rivers and river basin of Kerala. As the policy was

² Pokkali is an ancient farming practice which involves the alternation of a special saline tolerant variety of paddy with prawns.

developed before the 2012 national policy, it retains the prioritization of water use, however it bases this on the physical, environmental and social background of the state.

4.2.4.3.2 *Karnataka*

Karnataka Water Policy, 2002: Karnataka's Water Policy (Karnataka Water Resources Department, 2002) shifts its focus from yield per acre to yield per unit of water consumed. Highlighting the looming water crisis, the policy places a high priority on the sustainable and improved use and development of its water resources by taking an Integrated Water Resource Management (IWRM) approach. The policy sets out six explicit policy objectives which concern themselves more with drinking water, irrigation and hydropower than they do with environmental preservation.

4.2.4.3.3 *Goa*

Goa Water Policy, 2000: The Goa State Water Policy, 2000 (Goa Department of Water Resources, 2000), highlighted that the state should switch to a basin approach combining this with integrated development of water resources into a planning instrument. Addressing Goa's atypical water resource situation, some of the proposals that the policy includes are to regulate extraction of sand from river beds, check damage caused by mining activities, avoid pollution of drinking water, to bring in legislation and formulate plans for protection of *Khazan* lands and estuarine ecosystems, and take measures for shore protection. The policy makes no mention of flood or drought related issues but it does underline the need to take account of global warming and potential sea level rise while planning water resources development. The policy document also throws light on the long term adverse effects of global warming on the hydrology of the Western Ghats region. This makes Goa the first state to recognise and incorporate climate change aspects in its policy more than a decade before it received attention at the National level in 2012.

Goa Ground Water Policy, 2015: The state of Goa approved the Goa Ground Water Policy, 2015 in connection with a Public Interest Litigation (PIL) before the high court of Bombay at Goa which petitioned that measures be evolved through a policy to regulate use of groundwater. As per the policy, the government is trying to ensure that all existing wells and ones to be dug are registered mandatorily and proper records can be maintained. Tankers, supplying from groundwater sources, will have to avail passes issued by groundwater officers. The policy envisages installation of pumps in wells to prevent sourcing of water bypassing the use of meters, amidst allegations of excessive exploitation of water for commercial purposes, by mining companies and others. Rainwater harvesting and other means of water conservation such as *bhandaras*, percolation tanks, check dams are encouraged. Furthermore, the policy also advocates using abandoned mining pits for water harvesting.

4.2.4.4 Tourism

Tourism is a subject in the concurrent (national and state government) list. The tourism policy of 2002 was developed with the intent to promote tourism as a tool for economic growth and therefore strategies and proposals included development of tourism infrastructure, new tourism destinations, and integrated tourism circuits, capacity building in the hospitality sector and new marketing strategies (Dayananda and Leelavathi, 2016).

National Tourism Policy Draft, 2017: As of 2017, incorporating developments at the global level which have had a strong bearing on the Tourism sector, a new draft National Tourism Policy (Ministry of Tourism, 2017) has been formulated and is awaiting approval. Sustainability has been recommended as the guiding principle for the policy, along with terms such as- “smokeless industry, soft ecological footprint, no over-exploitation of natural resources and respectful of the carrying capacity of tourist sites”. There is an emphasis on ecotourism and going beyond nature based tourism with an overarching aim of poverty elimination, ending unemployment, improving overall environment, encouraging tribal and indigenous crafts, and encouraging the industry to adopt a code of ethics.

4.2.4.4.1 Eco-Tourism

National Ecotourism Policy and Guidelines, 1998: Acknowledging the significance of ecotourism, the Ministry of Tourism and the MoEF have issued policy and guidelines relating to the same. In 1998 the Ministry of Tourism released the National Ecotourism Policy and Guidelines where preservation, retention and enrichment of natural resources is outlined through seven cardinal principles. The policy was an instrument to ensure regulated growth of ecotourism with the main intention on positively impacting environmental protection and community development. The policy while it identified key stakeholders, did not actually detail the institutional set-up, fiscal incentives or community ownership within the country.

Draft Guidelines for Ecotourism in and around Protected Areas, 2011: The MoEFCC in 2011 drafted the Guidelines for Ecotourism in and around Protected Areas as a response to the recommendations set out in Tiger Task Force Report (2005) and the 2006 Amendment to the Wildlife (Protection) Act of 1972. A detailed set of framework guidelines on the selection, planning, development, implementation and monitoring of ecotourism in India is set out. The guidelines are broad, encouraging States to develop their own specific Ecotourism Strategies and Plans. The document also details the roles and responsibilities of different stakeholders with regard to tourism in these types of areas.

4.2.4.4.2 Kerala

Kerala Tourism Policy, 2012: In 1995, the Kerala government announced a comprehensive tourism policy which encouraged public-private partnership in order to bring about infrastructure development, focussed on tourism products and improvement of human resource capacities and marketing. The Tourism Vision 2025 released in 2001 aimed at developing Kerala as an “upmarket high-quality tourist destination” through optimal utilisation of resources. In 2007, the state adopted “Responsible Tourism” as the guiding tenet of its tourism policy, implementing this in four pilots (Kumarakom, Kovalam, Wayanad and Thekkady). Community engagement was the focus of the concept which was brought about through creation of micro enterprises, undertaking group farming, and setting up of ethnic restaurants run by women from below poverty line (BPL) families. The recent Tourism Policy, 2012 (Government of Kerala, 2012) reinforces the need to have a comprehensive sustainable development strategy to promote tourism. It has balanced economic dynamism with environmental, social and cultural considerations.

Ecotourism: Soon after the national government released its ecotourism policy, Kerala has announced an eco-drive to brand itself as an ‘environmental state’ with the purpose of augmenting its international appeal. Hoteliers were presented with eco-friendly guidelines. The State Tourism Department and the Forest Department worked in conjunction to promote the image of ‘Ever-green Kerala’ and coordinate ecotourism activities. The Thenmala Ecotourism Promotion Society was constituted in 1996 to develop a model for ecotourism. In 2004 the state introduced ‘Kerala Tourism Eco initiative’ which was an Eco-Certification Scheme designed to improve eco-friendly behaviours within the sub-sectors of tourism (Department of Tourism, 2004). In 2005, the forest department of the state introduced a participatory Ecotourism Programme to promote participation in Ecotourism through EDC/VSS institutions (Department of Tourism, 2005).

4.2.4.4.3 Karnataka

Karnataka Tourism Policy, 2015-2020: Karnataka was among the first states in India to bring out a forward-thinking Tourism Policy as early as June 1992. Since then, the state has prepared three policies. The present policy (2015-2020) (Government of Karnataka, 2015), focuses on improving the participation of private players in the sector to promote balanced regional development. It encourages a “positive shift in attitudes from regulation and control to decentralization and empowerment at local levels, from patronage to building partnerships and from linear government-led structures to alliances with diverse stakeholders in the sector”. Safe and sustainable tourism with an emphasis on providing a quality experience to tourists is reiterated through the policy. Eco-tourism has also been encouraged in close collaboration with the Karnataka Eco-tourism Development Board. From Coorg to Karwar, an eco-tourism zone will be identified and a chain of nature camps encouraged as Eco-trails. Unfortunately the policy does not detail how this will be done.

Wilderness Tourism Policy, 2003: Presently, the Karnataka Eco-tourism Development Board operates by the Wilderness Tourism Policy, 2003 (Karnataka Forest Department, 2003) in National Parks, Wildlife Sanctuaries, Reserves and other forests. It was the first policy in the country to opening up forest areas for ecotourism. The policy however, allows the public sector to monopolize access to these areas.

4.2.4.4.4 Goa

Draft Interim Tourism Policy, 2016: In an attempt to develop an implementable plan with tailored tourism products, the Government of Goa announced a Goa Tourism Master Plan for 25 years (Government of Goa, 2016). A tourism policy and institutional framework will also be developed. The tourism policy will include framework for resource allocation, investment, incentives and initiatives. The draft interim tourism policy, 2016 of Goa intends on repositioning the state as a multi-product destination through a number of strategies which include making the state a coastal tourism destination where culture and heritage will play a major role (India Infoline News Service, 2016). Although the government announced that special emphasis will be placed on eco-tourism amongst other things like hinterland, wellness, Meetings, Incentives, Conferences, and Exhibitions (MICE), wedding and adventure tourism, nature-based tourism (and not ecotourism) finds a place in the draft as a focus product. The intention is also to develop a plan which promote jobs, boost the economy and increase environmentally sustainable tourism.

4.2.4.5 Land Use

Several policies which relate to land use exist in India. Some of these are the National Water Policy (2012), National Forest Policy (1988 now being revised), Policy Statement for Abatement of Pollution (1992), National Livestock Policy (2013), National Agricultural Policy (2000), National Population Policy (2000), National Biodiversity Action Plan (2008) and Addendum (2014). Town or urban planning in India was done through economic plans in form of the Five Year Plans wherein there was sectoral allocation of money. Urban planning is carried out through a number of development plans such as Master Plans and the Town Planning Scheme. Master Plans govern the growth and land use development of urban areas. Land use planning as a spatial planning tool is followed for all development purposes (Planning Tank, 2016). Specific to planning and land use, the following policies exist:

Draft National Land Utilisation Policy, 2013: The draft policy (Department of Land Resources, 2013) was designed with the purpose of “ordering and regulating land use in an efficient and rational way, thus taking care of the needs of the community while safeguarding natural resources and minimising land use conflicts”. It divides the country into six land use zones (rural and agricultural, areas under transformation like semi-urban areas, urban areas, industrial areas, ecological areas and hazard-vulnerable areas) based on predominant land use. The land use pattern within each zone will have a corresponding type

of development plan with the intent of increasing the productivity of that land use. Within each zone, there will be further areas earmarked for targeted intervention. They are: protected, regulatory, reserved and guided development areas. The protected areas are the forest areas while regulatory areas include the agricultural and other hazard-prone areas.

The policy is not only a revival of an old attempt but it also suggests a mechanism to implement it that has failed in past. It suggests a state level land utilisation policy, followed by a two-year exercise to create land utilisation zones along with decision to how much land in each zone a state wants to use for what purpose. The policy has to evolve a long-term development plan for each zone.

Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines, 2015: In 1996, UDPFI Guidelines were introduced to provide a framework for plan preparation and implementation. New emerging aspects like regional development, inclusive planning, sustainable habitat, land use and transport integration at the planning stage, Service Level Benchmarks, disaster management concepts, and governance reforms have given a new dimension to the planning process. To address these, the guidelines were revised in 2015 (MoUD, 2015). These incorporate the provisions of the legal and policy guidelines of the line Ministries (nine ministries guide land use planning at the national level), best practices of the states and the current planning systems.

Policies at the state level are mostly absent as land use planning generally takes place at a regional level or local level. However Kerala State developed a draft land policy in 2009 details of which are presented below.

4.2.4.5.1 Kerala

Kerala State Land Policy, 2007: The policy's main objective is to formulate an integrated land information system and generate awareness on scientific land use to overcome the environmental impacts and disasters due to the uncontrolled and illegal land use. The policy also highlights that it will enable proper protection, management and sustainable use of the rivers, backwaters, wetland and other water sources in the state through the creation of a 'wetland information system' and a 'wetland management system'. It deals with regulations which prohibit reclamation of paddy fields, wetlands as well as protection of water bodies and marshlands. The policy advocates for the formation of land use advisory boards at state and district levels. It also states that strict laws will be enacted to prevent unauthorized sand mining, clay mining, quarrying, mining and encroachments in wetlands and paddy fields.

4.2.4.5.2 Goa

Transfer of Development Rights (TDR) policy, 2017: The Goa government has raised the concept of transfer of development rights (TDR) in a bid to protect and conserve eco-sensitive areas, salt pans, mangroves, and even heritage homes. The TDR is expected to curb increasing conversion of agricultural and orchard

lands for other activities, mainly construction of buildings by real estate developers. This policy will be incorporated into the Regional Development Plan 2030 (Outlook, The News Scroll, 2017).

4.3 Key legislation

4.3.1 Environmental and biodiversity law

India has well defined laws and policies on the environment and biodiversity (wild). Environmental protection is represented within the Constitution of India in Article 48A (Protection and improvement of environment and safeguarding of forests and wildlife) and Article 51(A)(g)3 (to protect and improve the natural environment including forests, lakes, rivers and wildlife, and to have compassion for living creatures). Important laws (Singh and Singh, 2016) relating to the environment, forests and biodiversity include The Indian Forest Act, 1927; The Forest (Conservation) Act, 1980; The Joint Forest Management (JFM) Circular, 1990; The Wildlife (Protection) Act, 1972; The Environment (Protection) Act, 1986; The Water (Prevention and Control of Pollution) Act, 1974; The Air (Prevention and Control of Pollution) Act, 1981, Biological Diversity Act, 2002. Some major initiatives take in the country to improve implementation mechanisms are Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights Act, 2006); setting up of the Wildlife Crime Control Bureau; Green India Mission; Mahatma Gandhi National Rural Employment Guarantee Act; and setting up the National Fisheries Development Board, 2006. Biodiversity has been mainstreamed in the agricultural sector through the following legal instruments Bio-safety Regulatory Framework in India; The Seeds Act, 1966 as amended up to 1972; The Insecticides Act, 1968, as amended up to 2000; The Protection of Plant Varieties and Farmers' Rights Act, 2001 (MoEF, 2002).

4.3.1.1 Forests and Wildlife

The Wildlife (Protection) Act (WPA), 1972, Amendment 1991: The Act provides for protection to listed species of flora and fauna and establishes a network of ecologically-important protected areas. The WPA empowers the central and state governments to declare any area a wildlife sanctuary, national park or closed area. There is a blanket ban on carrying out any industrial activity inside these protected areas. It provides for authorities to administer and implement the Act; regulate the hunting of wild animals; protect specified plants, sanctuaries, national parks and closed areas; restrict trade or commerce in wild animals or animal articles; and miscellaneous matters. The Act prohibits hunting of animals except with permission of authorized officer when an animal has become dangerous to human life or property or is so disabled or diseased as to be beyond recovery (WWF-India, 1999). The near-total prohibition on hunting was made more effective by the Amendment Act of 1991.

The Indian Forest Act, 1927: The Act consolidates the law relating to forests, the transit of forest-produce and the duty leviable on timber and other forest-produce. The act deals with reserved forest, village forest, protected forest, control over forests and lands not being property of government, the duty on timber and other forest produce, regulation transit of forest products, collection of timber, penalties and procedures, cattle – trespass, forest officers and other miscellaneous provisions.

The Forest (Conservation) Act, 1980: This Act was adopted to protect and conserve forests. The Act restricts the powers of the state in respect of de-reservation of forests and use of forestland for non-forest purposes (the term ‘non-forest purpose’ includes clearing any forestland for cultivation of cash crops, plantation crops, horticulture or any purpose other than re-forestation). The act was amended in 1988.

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006: The Act recognizes the rights of forest-dwelling Scheduled Tribes and other traditional forest dwellers over the forest areas inhabited by them and provides a framework for according the same. The Act aims to devolve powers over forest lands to local people. Under this Act, land titles totalling 1.8 million hectares (Krishnan *et al.*, 2012) have been granted to forest-dwelling communities (MoEFCC and MoTA, 2010).

4.3.1.2 Environment

Environment (Protection) Act (EPA), 1986: This Act is an umbrella legislation designed to provide a framework for the coordination of central and state authorities established under the Water (Prevention and Control) Act, 1974 and Air (Prevention and Control) Act, 1981. Under this Act, the national government is empowered to take measures necessary to protect and improve the quality of the environment by setting standards for emissions and discharges; regulating the location of industries; management of hazardous wastes, and protection of public health and welfare. From time to time the national government issues notifications under the EPA for the protection of ecologically-sensitive areas or issues guidelines for matters under the EPA. Some notifications under this Act can be found in Appendix 8. Two important measures introduced under the Act are the requirement to conduct Environmental Impact Assessment (EIA) for specified projects, and regulation of specified activities in the coastal zone.

Notification on Environmental Impact Assessment (EIA) of developmental projects, 1994, amended in 2006: To check the damage to the environment by developmental projects the mechanism of EIA was introduced. It was initially introduced in 1978 to evaluate river valley projects. Later in 1994, the EIA legislation was enhanced to include other developmental sections. The notification listed 30 projects that required environmental clearance from the Central Government. It also included - for the first time – public hearing as a pre-requisite for clearing large projects. The 2006 Amendment decentralized the environmental clearance projects by categorizing the developmental

projects in two categories, i.e., Category A (national level appraisal) and Category B (state level appraisal). The notification was further amended in 2016, to streamline the permissions for buildings and construction sector so that affordable housing can be provided to weaker sections in urban area under the scheme 'Housing for All by 2022' and to bring small-scale mining projects under its ambit. The amendment exempts buildings and construction projects with a built-up area measuring between 20,000 sq meters and 1,50,000 sq meters from the existing procedure of 'prior environmental clearance' from the state level environment impact assessment authority (SEIAA). It also exempts the operation of the Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974 for building and construction projects up to 1,50,000 sq meters. The Amended Notification has been brought under scrutiny before the NGT (December, 2017) petitioning that the above Notification be quashed as it is in contravention to the provisions of EIA notification, 2006 and The Environment Protection Act, 1986. The NGT bench has strictly asked the Ministries to refrain from acting under the new notification otherwise the notification would be stayed.

Coastal Regulation Zone Notification, 1991, amended in 2011: With this notification India became one of the first countries in the world to bring about legislation protecting its beaches from unplanned development and to demarcate specific areas for conservation. The notification binds states to prepare a Coastal Zone Management Plan (CZMP) classifying various beach areas in terms of four Coastal Regulatory Zones (CRZ I, II, III and IV). Over the years this notification itself has become extremely diluted and in April 2018, a new draft notification has been released by the MoEFCC. The latest draft considerably relaxes the guidelines within the 2011 notification allowing for ease of business for real estate development, ports, and tourism.

Wetlands (Conservation and Management) Rules, 2010: The rules were drafted to ensure better conservation and management and to prevent degradation of existing wetlands in India. In order to ensure there is no further degradation of wetlands, the Rules specify activities which are harmful to wetlands such as industrialization, construction, dumping of untreated waste, reclamation etc. and prohibit these activities in the wetlands. Other activities such as harvesting, dredging etc may be carried out in the wetlands but only with prior permission from the concerned authorities.

The National Environment Appellate Authority Act, 1997: This Act provided for the establishment of a National Environment Appellate Authority to hear appeals with respect to restriction of areas in which any industry operation or process or class of industries, operations or processes could not carry out or would be allowed to carry out subject to certain safeguards under the Environment (Protection) Act, 1986.

There are several legislations that directly or indirectly deal with hazardous waste. The relevant legislation includes the Factories Act, 1948, the Public Liability Insurance Act, 1991, the National Environment Tribunal Act, 1995 and some notifications under the Environmental Protection Act of 1986.

National Environment Tribunal Act, 1995: The Act provided strict liability for damages arising out of any accident occurring while handling any hazardous substance and for the establishment of a National Environment Tribunal for effective and expeditious disposal of cases arising from such accident, with a view to give relief and compensation for damages to persons, property and the environment and for the matters connected therewith or incidental thereto.

4.3.1.3 Biodiversity

Although all the above laws are important, the two most relevant, from the perspective of biodiversity governance, are the Wildlife (Protection) Act, 1972 and the Biological Diversity Act, 2002. While the Wildlife (Protection) Act focuses on conservation of biodiversity and establishment of protected area network, the Biological Diversity Act focuses on sustainable use and fair and equitable sharing of benefits arising out of the use of biological resources and related knowledge.

The Biological Diversity Act, 2002: This Act came out of India's attempt to realise the objectives enshrined in the United Nations Convention on Biological Diversity (CBD) 1992. The Act aims at the conservation of biological resources and associated knowledge as well as facilitating access to them in a sustainable manner and through a just process. It provides a framework for access to biological resources and sharing of the benefits arising out of such access and use. The Act requires the government to develop national strategies and plans for the conservation and sustainable use of biodiversity, carry out EIAs for projects that are likely to affect biodiversity, integrate biodiversity management into sectoral programmes, and protect traditional knowledge related to biodiversity.

Biological Diversity Rules, 2004: The rules outline the procedures to be followed for access to biological resources (wild plants and animals, crops, medicinal plants, livestock, etc), their commercial utilization, transfer of rights of research, and intellectual property rights related to biodiversity. Additionally, it also proposes the institutional structure for the implementation of the Act.

4.3.1.3.1 Kerala

The state of Kerala has forest coverage of 11,309 sq. km. (Forest Statistics, 2011) under three categories (Reserve Forest - 9,176.3 sq. km., Proposed Reserve - 295.37 sq km and Vested Forest - 1837.79 sq. km) which together represent 29.1 percent of the geographical area of the state (Government of Kerala, 2014). There are 22 protected areas including 17 Wildlife Sanctuaries and five

National Parks³. The management of forests in the state is regulated by the Indian Forests Act, 1927, the Wildlife (Protection) Act, 1972, the Kerala State Forest Act, 1961 and the Forest (Conservation) Act, 1980.

Kerala State Forest Act, 1961, amended in 2010: This Act provides for the protection and management of forests in Kerala. In 2010 the Act was amended in order to insert a new chapter on provisions relating to sandalwood and in particular on: restrictions on the cutting and sale of sandal trees; prohibition of possession and transport of sandalwood and sandalwood oil; declaration of the stock of sandalwood and sandalwood oil possessed; restrictions on the purchase, sale, of sandalwood and sandalwood oil; and penalties and seizure.

Kerala Private Forests (Vesting and Assignment) Act, 1971 and Kerala Private Forests (Vesting and Assignment) Rules, 1974: This Act put restraints on the rights of owners of private forest to sell, mortgage, lease or otherwise alienate the whole or any portion of the private forests. Permission of the District Collector was required for cultivation in private forest or cutting trees from it or doing any act adversely affecting its utility as a forest. The Government can also impose restraints on customary or prescriptive rights in such forests.

Kerala Forests (Vesting and Management of Ecologically Fragile Lands) Act, 2003, Amended in 2009: This Act aims at transferring to and vesting in the Government the ownership and possession of all ecologically fragile lands held by any person in order to minimize the degradation of these ecosystems and their biological diversity. The amendment in 2009 provides for dispute redressal in respect of lands having an extent of not more than two hectares and for the constitution of the Ecologically Fragile Land Claim Dispute Redressal Committee.

Kerala Preservation of Trees Act, 1986: The Act prevents felling of 10 species of trees viz; Sandalwood (*Santalum album*), Teak (*Tectona grandis*), Rosewood (*Dalbergia latifolia*), Irul (*Xylia xylocarpa*), Thempavu (*Terminalia tomentosa*), Kampakam (*Hopea parviflora*), Chempakam (*Michelia chempaca*), Chadachi (*Grewia tiliaefolia*), Chandana vempu (*Cedrela toona*), Cheeni (*Tetrameles nudiflora*) without the prior permission in writing of the authorized officer.

Kerala Forest Produce (Fixation of Selling Price) Act, 1978: The Act deals with the fixation of the selling price of certain important forest produce and for the prohibition of the sale of this produce at less than the price fixed.

Kerala Forest Produce Transit Rules, 1975: The rules list 59 species of tree which do not require a pass for the removal of timber.

³http://www.forest.kerala.gov.in/index.php?option=com_content&view=article&id=326&Itemid=280

Kerala Promotion of Tree Growth in Non-forest Areas Act, 2005 (Amended in 2007) and Rules, 2011: The Act permits the owner of non-forest land to cut and transport any tree unless notified under Kerala Preservation of Trees Act.

The Kerala Protection of River Banks and Regulation of Removal of Sand Act, 2001: This Act aims to protect river banks and river beds from large scale dredging of river sand and to protect their biophysical environment system and regulate the removal of river sand.

Kerala Biodiversity Rules, 2007: The Government of Kerala notified the Kerala Biological Diversity Rules, 2007 as per the Biodiversity Act, 2002. These Rules prescribe functions necessary to carry out provisions of the Biological Diversity Act. The Rules prescribe composition and membership of the State board as well as local BMCs.

4.3.1.3.2 *Karnataka*

The State of Karnataka has forest coverage of 43,356 sq km (Karnataka State Forest Department, 2015-2016) under five categories (Reserved Forests: 29,688.37 sq. km, Protected Forests: 3,540.07 sq. km, Unclassified Forests: 10,024.91 sq. km, Village Forests: 49.05 sq. km and Private Forests: 54.07 sq. km), which together represent 22.6 percent of the geographical area of the State. There are six National Parks, 23 Wildlife Sanctuaries and one Conservation Reserve in the state. The management of forests in the state is regulated by the Karnataka Forest Act, 1963, Karnataka Preservation of Trees Act, 1976 and Rules, Protection of Wildlife Act, 1972 and Rules, Forest (Conservation) Act, 1980 and Rules, Karnataka Forest Rules, 1969 and Environmental Protection Act, 1986.

Karnataka Forest Act 1963 and Rules, 1969: The Karnataka Forest Act defines the use and management of Reserved Forests, District Forests, Village Forests and Private Forests, the control of forest products – both timber and other forest products. It also defines ‘reserved trees’ or trees that cannot be cut without permission from the Forest Department and the cutting of ‘Government Trees’ from private lands. It is the main act which provides in-situ legal protection to natural ecosystems. The ‘Reserved Forests’ provide the highest degree of protection.

Karnataka Preservation of Trees Act, 1976, rules 1977: According to the Tree Act the felling of any tree; even on private lands, requires permission from the appropriate authority for the area, as specified in the legislation. The legislation also mentions that there is a need to plant trees of the same or different species in lieu of the felled trees, as directed by the Tree Officer.

Karnataka Biodiversity Rules, 2005: The Government of Karnataka notified the Karnataka Biological Diversity Rules, 2005 as per the Biodiversity Act, 2002. These Rules prescribe functions necessary to carry out provisions of the Biological Diversity Act. The Rules prescribe composition and membership of the State board as well as local BMCs.

4.3.1.3.3 Goa

The State of Goa has forest coverage of 1,224.46 sq. km. under three categories (Reserve Forest - 251.44 sq. km., Protected Forest - 711.44 sq. km. and Unclassed Forest - 261.58 sq. km.) apart from private forests of 200 sq km, which together represent 38 percent of the geographical area (3,702 sq km) of the State (Accountant General Goa, 2011). There is one National Park, six Wildlife Sanctuaries and one Zoo in the state, covering an area of 754.91 sq km. The management of forests in the state is regulated by the Indian Forests Act, 1927, the Wildlife (Protection) Act, 1972, the Goa, Daman and Diu Preservation of Trees Act, 1984 and the Forest (Conservation) Act, 1980.

The Goa, Daman and Diu Wild Animals and Wild Birds Protection Act, 1965: This Act imposes restrictions on hunting activities, regulates licenses and trade and commerce in wild animals and seeks to establish sanctuaries, national parks, game reserves and closed areas where wildlife can be protected and propagated in its natural environment.

Goa, Daman and Diu Forest Code, 1979: This Code is intended to define the administrative set up of the department and its working, the functions of the officers of the department and the initial accounts to be maintained by them.

The Goa, Daman and Diu Preservation of Trees Act, 1984: The Goa, Daman and Diu Preservation of Trees Act (GDDPTA), 1984 is an important legislation of the state for preservation of trees outside the forest. As per the GDDPTA, no person can fell or dispose of any tree in any land, whether in his ownership or occupancy or otherwise, except with the previous permission of the Tree Officer. Every person granted permission under the Act is bound to plant such number and kind of tree/trees in the area from which the tree/trees is/are felled or disposed of under such permission as may be directed by the Tree Officer. Further, as per the Goa, Daman and Diu Preservation of Trees Rules, (GDDPTR), 1983 a security deposit has to be collected for ensuring the replanting of the tree/trees, which is refunded on re-plantation of the trees stipulated by the Tree Officer.

Goa Biodiversity Rules, 2017: The Government of Goa notified the Goa Biological Diversity Rules, 2017 as per the Biodiversity Act, 2002. These Rules prescribe functions necessary to carry out provisions of the Biological Diversity Act. The Rules prescribe composition and membership of the State Board as well as local BMCs.

4.3.2 Land use and spatial planning law

Planning and Land Use is a state subject. Some states have comprehensive Town and Country Planning legislation which provides for urban planning and development from a regional perspective beyond the city limits and coordinated with the overall framework of economic development, priorities and resource availability. Some of these states are Goa, Gujarat, Himachal

Pradesh, Karnataka, Kerala, Nagaland, Orissa, Punjab, Rajasthan, Tripura and Uttar Pradesh.

Town and Country Planning Act: The Act provides for the constitution of a State Town Planning Board for advising the state government regarding planning and development and for determining principles and policies for achieving balanced development of the state as a whole. It provides for the state government to declare any area in the state to be a local planning area for the purpose of the Act.

Master plan: Master plan under the Act for any local planning area has to be prepared in two stages.

- a) Preparation of an outline development plan which for all practical purposes will be an interim master plan. The details are enumerated in the Act.
- b) Preparation of a comprehensive development plan for the area. This is a detailed and more exhaustive master plan.

Chapter V of the Act provides for town planning schemes for the purposes of implementing the proposals in the comprehensive development plan. The procedural details, powers and functions of the planning authority and the financial implications are detailed in the Act.

Land Acquisition, Resettlement & Rehabilitation Act, 2013: The Land Acquisition Act of 1894 was created with the purpose of facilitating acquisition of privately held land by the government for public purposes. Due to a number of issues with 1894 Act, such as the property valuation techniques, lack of redressal of relocation and rehabilitation of land owners displaced by the actions of the Act, a New Act - 'The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013' (effective from 1st January 2014) was introduced. The new Act regulates land acquisition and notifies rules for granting compensation, rehabilitation and resettlement to the affected persons. The Act has provisions to provide fair compensation to those whose land is acquired permanently or temporarily, brings transparency to the process of acquisition of land to set up factories or buildings, infrastructural projects and assures rehabilitation of those affected. The Act establishes regulations for land acquisition as a part of India's massive industrialization driven by public-private partnership.

Model Town and Country Planning and Development Law, 1985: The original law of 1960 was revised in 1985 to enact a comprehensive urban and regional planning legislation in all the States and UT's. It is in the form of guidelines which ensures better overseeing and coordination of planning with implementation, so that a single agency can undertake both these functions.

Model Municipal Law, 2003: The Model Municipal Law, 2003 is an initiative to implement the provisions of the 74th Constitutional Amendment Act (CAA) for empowerment of ULBs and provide legislative framework for implementation of the Urban Reform Agenda. The Law is expected to enhance the capacities of ULBs to leverage public funds for development of urban sector and provide an environment so that ULBs can play their role more effectively and ensure better service delivery.

Industries (Development and Regulation) Act, 1951: The Act provides for development and regulation of certain industries. The last amendment was in 1984. It provides for establishment of the Central Advisory Council and Development Councils; regulation of the industries through the processes of registration, licensing and investigation into industries liquidation or reconstruction of companies and miscellaneous provisions. The Act gives a list of industries which requires compulsory licensing.

Special Economic Zone (SEZ) Act, 2005: The SEZ Act, 2005 provides for the establishment, development and management of the Special Economic Zones for the promotion of exports. The Act gives tax benefits which will help to boost international trade.

4.3.2.1.1 Kerala

Land-use planning in Kerala is primarily carried out through town planning schemes which have been prepared under the provisions of the Town Planning Act (Government of Kerala, 2006). The Government of Kerala recently enacted the Kerala Town and Country Planning Act, 2016 which is based on former acts- Town Planning Act, 1933, Travancore Town and Country Planning Act, 1945 or the Madras Town Planning Act, 1920. Each of these Acts has comparable provisions with regard to content and processing of a town planning scheme. They envisage preparation of two levels of Plans (i) General Town Planning Scheme and (ii) Detailed Town Planning Scheme. The General Town Planning Scheme is referred to as the Master Plan or the Development Plan. This is prepared as an indicative plan for the development of a whole town/city, and the immediate surrounding areas (recognized as the planning region/area) or for the Urban Agglomeration area. The Detailed Town Planning Scheme is a Plan in much detail (considering individual land parcels) on a cadastral survey map and is prepared for a priority development area within a Development Plan area or for such an area not included in a Development Plan. Such a detailed Plan is generally prepared for an area of about 50 to 150 hectares of land.

Kerala Town and Country Planning Act, 2016: The Kerala Town and Country Planning Act was enacted in 2016 to provide for the promotion of planned development and regulation of growth of urban and rural areas in the state, focusing on scientific spatial planning. There are provisions within that act for the constitution of the State Town and Country Planning Board whose responsibility it is to prepare a state perspective plan. The Kerala Perspective

Plan 2030 was prepared as a strategy to enable the state to achieve economic and living standards equivalent to Nordic countries. The Plan targets leapfrogging the high middle income threshold in the next 15 years and seeks to position Kerala among the Nordic countries in terms of human capital and social and environmental indices. The area under the jurisdiction of a Kochi Municipal Corporation is deemed as a Local Planning Area (LPA) as per the Act. The responsibility and powers for developing a master plan and its execution for the LPA has also been given to respective councils or standing committee of the local self-government.

4.3.2.1.2 *Karnataka*

Karnataka Town and Country Planning Act, 1961: The Act forms the comprehensive legal framework for urban planning of the state and its statement of objectives specifies that “Physical planning with co-ordinated effort on a large scale is necessary if the people are to live in a better, healthier and happier environment”.

Karnataka Land Revenue Manual, Land Acquisition Act of Karnataka and Land Reforms Acts and Karnataka State Land Use Board are the major legal institutional instruments governing land use pattern in the State (Sawhney et al., 2003). Land reforms were legally enforced in Karnataka through Karnataka Land Reforms Act, 1961. The Karnataka Land Reforms Amendment Bill 1995 brought a major change in agrarian relationship in the following areas;

- 1) Made provision to lease in the agriculture land for aquaculture for a period of 20 years in the districts of Dakshina Kannada and Uttara Kannada up to 40 units (around 220 Acres)
- 2) Agricultural land can be bought or inherited by anyone whose income from non- agricultural source is below INR 0.2 million
- 3) Up to 108 acres of agricultural land can be bought for industrial development purpose
- 4) Up to 28 acres of agricultural land can be bought for establishment of educational institutions
- 5) Up to 54 acres of agricultural land can be bought for places of worship
- 6) Up to 54 acres of agricultural land can be bought for a housing project
- 7) For horticulture including floriculture and agro based industries up to 108 acres

4.3.2.1.3 *Goa*

The Goa (Regulation of Land Development and Building Construction) Act, 2008: This acts deals with regulation and control of all land development and building construction in the state.

Goa Town and Country Planning Act (2017): Land-use planning takes place under the principles laid down by the Goa, Daman and Diu Town and Country Planning Act, 1974, which was amended to the Goa Town and Country Planning Act in 2017. The 1974 Act constituted Planning and Development Authorities for

divisions known as “planning areas”. These authorities are mandated to provide and enforce Outline and Comprehensive Development Plans as well as the Town planning schemes. The amended Town and Country Planning Act, constitutes independent Chief Town Planners for land use, planning and administration purpose respectively.

4.3.3 Disaster management law

Disaster Management Act, 2005: The Act lays down institutional, legal, financial and coordination mechanisms at the National, State, District and Local levels. The National Disaster Management Authority is responsible for laying down policies and guidelines on disaster management. State Disaster Management Authorities also lay down policies and plans for disaster management in their respective states. District Disaster Management Authorities are the planning, coordinating and implementing bodies for disaster management in the district.

The Act also provides for a National Institute of Disaster Management for human resource development in the field of disaster management. Besides these, a National Disaster Response Force has been constituted.

4.3.3.1 Kerala

The State Government, in line with National Disaster Management Act, 2005, has notified Kerala State Disaster Management Rules, 2007.

4.3.3.2 Karnataka

In pursuant with section 14(1) of the National Disaster Management Act, 2005, the state has established Karnataka State Disaster Management Authority (KSDMA) and constituted District Disaster Management Authorities (DDMA) in all 30 districts of Karnataka.

4.3.3.3 Goa

The State Government, in line with National Disaster Management Act, 2005, has notified Goa State Disaster Management Rules, 2007. The rules were amended in 2011.

4.3.4 Applicable sector laws

4.3.4.1 Water

Water Legislation and Water Policy are closely linked due to their mutual feedback and interlock and together they form a comprehensive framework (Vijay Kumar and Bharat, 2014). Water, as stated before is a state subject but it is explicitly made subject to the provisions of Entry 56 in the Union List which enables the Union to deal with inter-state rivers if Parliament legislates for the purpose.

Water quality standards especially those for drinking water were set by the Indian Council of Medical Research (1975). The discharge of industrial effluents is regulated by the Indian Standard Codes and in 1998, water quality standards

for coastal water marine outfalls were also specified. In addition to the general standards, certain specific standards have been developed for effluent discharges from industries such as, iron and steel, aluminium, pulp and paper, oil refineries, petrochemicals and thermal power plants.

Panchayati Raj Act, 1992: Of the many National and State level legislations, from the point of view of institutionalization, this act is important (Vijay Kumar and Bharat, 2014). The Act devolves power to local bodies for subject under the Eleventh Schedule such as minor irrigation, water management, and watershed development if the State Government so notifies in terms of the state legislation. Similarly, water supply, public health, sanitation, and solid waste management are included in the list of subjects in the Twelfth Schedule which can be transferred to ULBs.

Water (Prevention and Control of Pollution) Act, 1974: This Act represented India's first attempts to comprehensively deal with environmental issues. The Act prohibits the discharge of pollutants into water bodies beyond a given standard, and lays down penalties for non-compliance. The Act was amended in 1988 to conform closely to the provisions of the EPA, 1986. It set up the Central Pollution Control Board (CPCB) which lays down standards for the prevention and control of water pollution. At the state level, the State Pollution Control Boards (SPCBs) function under the direction of the CPCB and the state government.

Water (Prevention and Control of Pollution) Cess Act, 1977: This Act provides for a levy and collection of a cess on water consumed by industries and local authorities. It aims at augmenting the resources of the central and state boards for prevention and control of water pollution. Following this Act, The Water (Prevention and Control of Pollution) Cess Rules were formulated in 1978 for defining standards and indications for the kind of and location of meters that every consumer of water is required to install.

4.3.4.1.1 Kerala

The Kerala Water Supply Sewerage Act, 1986: The Act lays down the guidelines for the formulation and powers of an autonomous authority (Kerala Water Authority) which will develop and regulate water supply and waste water collection and disposal.

Kerala Ground Water (Control and Regulation) Act, 2002: This Act contains provisions for the conservation of ground water and its regulation in the state of Kerala. The act also allows for the constitution of an authority called the State Ground Water Authority and its powers with regard to ground water regulation and control.

Kerala Irrigation and Water Conservation Act, 2003: The Act aims to consolidate and amend the laws relating to construction of irrigation works, conservation and distribution of water for the purpose of irrigation, levy of betterment

contribution and water cess on lands benefited by irrigation works and to provide for involvement of farmers in water utilization system. As per the Act, water courses (river, stream, springs, channel, lake or any natural collection) and the water in them are property of the state which entitles it to conserve and regulate use for the purposes of irrigation and the generation of electricity. The act also deals with regulation on construction of reservoirs/anicut, regulation on diversion of rivers, inter-basin transfer of water, and prohibition of quarrying of sand in water courses.

Kerala State Water Resources Regulatory Authority Bill, 2012: The Bill aims to formulate the 'Kerala State Water Resources Regulatory Authority' for the state to facilitate effective utilization of water resources within the state, to ensure its sustainable and scientific management for drinking, agriculture, industrial and other purposes.

4.3.4.1.2 *Karnataka*

Water resources management in Karnataka is governed by the State Water Policies and a plethora of legislations. There are in all 29 pieces of legislation that govern water resources in the State. Out of these 5 are directly administered by the Water Resources Department while the remaining are administered by such diverse departments as Forest, Environment and Ecology (3), Agriculture (6), Industries and Commerce (2), Rural Development and Panchayati Raj (3) and Urban Development (10) (Government of Karnataka and ADB, 2013)

Irrigation Act, 1965: Enacted in 1965, the Act provides among other things for the regulation of water from irrigation works, and gives certain powers to irrigation officers in regard to the survey, investigation, execution and maintenance of irrigation works. It provides for the performance of customary obligations in regard to maintenance of irrigation works by the beneficiaries. The Act was amended in 2000 to involve and empower farmers through Water Users Co-operative Societies and their Federations in irrigation water management to achieve better results in water management. The Act was amended in the year 2000 and 2002 to accommodate Water Users into main stream irrigation management through formation of WUCS at primary, distributary, project level and apex level. The WUCS are formed under the Karnataka Cooperative Societies Act of 1959.

Irrigation (Levy of Betterment Contribution and Water Rate) Act, 1957: The Act was enacted in 1957 to introduce the principle of levying betterment contribution and water rates in respect of lands benefiting from the irrigation work in the state. The Act provided for the levy and collection of betterment contribution from lands benefited by the construction, restoration, expansion or alteration by Government for any irrigation work and also for the levy of a water rate. In order to achieve better results in water management it was considered in 1995 to amend the Act to handover the responsibility of water management and collection of water charges to Water User's Cooperative Societies. The Act was further amended in 1995 and in 2002 to entrust the Krishna Bhagya Jala Nigam

and the Karnataka Neeravari Nigam Limited, respectively with the task of supply of water in any irrigation work under their jurisdiction and to empower them with the responsibility of fixing and collecting water rates.

The Karnataka Command Areas Development Act, 1980: Enacted in 1980, the Act provides for establishment of six Command Area Development Authorities (CADA) for the integrated development and ensuring rapid and optimum utilization of irrigation potential created under the major and medium irrigation projects in the state. The Act made the CADAs statutory bodies and empowered them to enforce land development on compulsory basis.

Karnataka Ground Water (Regulation and Control of Development and Management) Act, 2011: The Ministry of Water Resources, Government of India, had circulated a model Bill for regulation and control of development and management of ground water in 1992 and subsequently in the year 1996. Following this, the Government of Karnataka enacted the Karnataka Ground Water (Regulation for protection of sources of drinking water) Act, 1999 to give priority for drinking water and for protection of drinking water sources. The present Act, enacted in 2011 brings a general legislation to control indiscriminate exploitation of groundwater, especially in the notified areas in the state.

4.3.4.1.3 Goa

Goa has enacted two Acts namely, Goa Irrigation Act, 1973 for regulation of surface water resources and Goa Ground Water Regulation Act, 2002 for regulation of ground water resources.

Goa Irrigation Act, 1973: The Act makes provision for the construction, maintenance and regulations of canals, for the supply of water from these canals, obtaining labour in emergencies and for the levy of rates for water supplied and other matters pertaining to irrigation in the state of Goa.

Goa Ground Water Regulation Act, 2002: Goa was the first state to pass this type of legislation. It allows for the constitution of a ground water cell to implement the provisions of the Act. It also outlines the powers of the ground water cell and a Ground Water Officer. The Act gives the government the power to declare any area in the state as a scheduled area, water scarcity area and over exploited area depending on the availability of ground water and undertake protective and regulatory measures within these areas.

4.3.4.2 Air

Air (Prevention and Control of Pollution) Act, 1981: To counter the problems associated with air pollution, ambient air quality standards were established, under the 1981 Act. The Act provides means for the control and abatement of air pollution. The Act seeks to combat air pollution by prohibiting the use of polluting fuels and substances, as well as by regulating appliances that give rise to air pollution. Under the Act establishing or operating of any industrial plant

in the pollution control area requires consent from state boards. The boards are also expected to test the air in air pollution control areas, inspect pollution control equipment, and manufacturing processes.

To empower the central and state pollution boards to meet grave emergencies, the Air (Prevention and Control of Pollution) Amendment Act, 1987, was enacted. The boards were authorized to take immediate measures to tackle such emergencies and recover the expenses incurred from the offenders. The power to cancel consent for non-fulfilment of the conditions prescribed has also been emphasized in the Air Act Amendment. The Air (Prevention and Control of Pollution) Rules formulated in 1982, defined the procedures for conducting meetings of the boards, the powers of the presiding officers, decision-making, the quorum; manner in which the records of the meeting were to be set etc. They also prescribed the manner and the purpose of seeking assistance from specialists and the fee to be paid to them.

Complementing the above Acts is the **Atomic Energy Act of 1982**, which was introduced to deal with radioactive waste.

Motor Vehicles Act, 1988: In 1988, the Motor Vehicles Act was enacted to regulate vehicular traffic, besides ensuring proper packaging, labelling and transportation of the hazardous wastes. Various aspects of vehicular pollution have also been notified under the EPA of 1986. Mass emission standards were notified in 1990, which were made more stringent in 1996. In 2000 these standards were revised yet again and for the first time separate obligations for vehicle owners, manufacturers and enforcing agencies were stipulated. In addition, fairly stringent Euro I and II emission norms were notified by the Supreme Court on April 29, 1999 for the city of Delhi. The notification made it mandatory for car manufacturers to conform to the Euro I and Euro II norms by May 1999 and April 2000, respectively, for new non-commercial vehicles sold in Delhi.

Factories Act, 1948 and its Amendment, 1987: The Factories Act, 1948 was a post-independence statute that explicitly showed concern for the environment. The primary aim of the 1948 Act has been to ensure the welfare of workers not only in their working conditions in the factories but also their employment benefits. While ensuring the safety and health of the workers, the Act contributes to environmental protection. The Act contains a comprehensive list of 29 categories of industries involving hazardous processes, which are defined as a process or activity where unless special care is taken, raw materials used therein or the intermediate or the finished products, by-products, wastes or effluents would cause material impairment to health of the persons engaged and result in the pollution of the general environment.

Public Liability Insurance Act (PLIA), 1991: The Act covers accidents involving hazardous substances and insurance coverage for these. Where death or injury results from an accident, this Act makes the owner liable to provide relief as is

specified in the Schedule of the Act. The PLIA was amended in 1992, and the Central Government was authorized to establish the Environmental Relief Fund, for making relief payments.

4.3.4.3 *Agriculture and Fisheries*

The Protection of Plant Varieties and Farmers' Rights Act, 2001: The Act provides for the establishment of an effective system for protection of plant varieties, the rights of farmers and plant breeders and encourages development of new varieties of plants. The Act highlights the necessity of recognizing and protecting the rights of the farmers in respect of their contribution made at any time in conserving, improving and making available plant genetic resources for the development of new plant varieties. Further, the Act declares that for accelerated agricultural development in the country, it is necessary to protect plant breeders' rights to stimulate investment for research and development, both in the public and private sector, for the development of new plant varieties. Such protection will facilitate the growth of the seed industry in the country which will ensure the availability of high quality seeds and planting material to the farmers.

Indian Fisheries Act, 1897: The Act prohibited use of destructive methods of fishing such as dynamiting or poisoning of water with noxious materials in inland and coastal waters (up to one marine league). State governments were empowered to frame rules in selected waters for protection of fish which would include restricting the creation and use of fixed engines (dams, weirs, bar *pattas* etc.) for catching fish; to put a limit on mesh size, size of fish and catch, and to ban fishing in certain seasons and certain places for a period of two years (declaration of closed season and sanctuaries). Various state governments have issued regulations under the Indian Fisheries Act, 1897 for regulation and protection of fisheries. Kerala and Goa were the first to enact the Marine Fisheries Act in 1980.

4.3.4.3.1 *Kerala*

Kerala Conservation of Paddy Land and Wetland Act, 2008; Amended in 2016: This Act aims to regulate the conversion and development of paddy fields and protect wetland areas in order to promote agricultural growth, ensure food security and sustain the ecological system in the state of Kerala.

The Kerala Inland Fisheries and Aquaculture Act, 2010: The Act deals with legislation relating to the inland fishery sector and provides for the sustainable development, management, conservation, propagation, protection, exploitation and utilisation of the inland fishery sector in the state. It also deals with promoting social fisheries and regulation and control of responsible aquaculture activities and protection of livelihood and traditional rights of fishermen. Overall the act aims at ensuring the availability of nutritious fish with a focus on food security for the people.

Kerala Marine Fishing Regulation Act, 1980: Kerala was one of the first states to enact the Marine Fishing Regulation Act, 1980 for enforcing regulatory measures to restrict the number of fishing crafts and to ban the use of destructive nets. The state has been successfully implementing the Monsoon Trawl Ban for a number of years. The Act empowers the State Government to restrict or prohibit fishing within a specified area in the territorial waters of the sea using specified craft and gears, the number of fishing vessels, which may be used for fishing in any specified area in the territorial waters, the catching in any specified area of such species of fish and for such periods, fishing by unlicensed vessels and registration and licensing of fishing vessels and cancellation, suspension and amendment of license already issued.

In 2013 the Kerala marine fishing regulation bill was introduced. Later in 2017, the Act (1980) was amended. The amendment was introduced to regulate overfishing and netting of juvenile fishes in close-shore territories as a measure to conserve the fish population of the state. The Act regulates the engine capacity of fishing vessels to 200 HP for close-shore fishing up to 12 nautical miles and vessel size to a length of 20m. The amendment also mandates that boat building yards and units manufacturing fishing gears be registered with the Fisheries Department. Furthermore, it details the constitution of a three tier system of fisheries management council (Fishing Village Management Council, District Fisheries Management Council and State Fisheries Management Council) for the effective management and surveillance of marine fisheries through the act.

4.3.4.3.2 *Karnataka*

The Karnataka Marine Fishing Regulation Act, 1986 and Rule, 1987: Some of the provisions of the act include regulation of the operation of various sea crafts up to six km from the shore for traditional crafts, beyond six km for mechanized boats and deep-sea vessels are required to operate beyond 20 km. The Karnataka Marine Fishing Regulation Rules, 1987 incorporate provisions for protection of traditional fisherman and maintaining law and order. This legislation however, failed to provide for limited access, effective legal action against infringement and interstate vessel movements.

The Karnataka Inland Fisheries (Conservation Development and Regulation) Act, 1996: The Act provides for the conservation, development and regulation of inland fisheries in the state. It prohibits fishing without permits and fish breeding without registration. It allows the government to notify fish sanctuaries for the purpose of protection, propagation or development of fisheries. It also lays down provisions for the constitution of the Karnataka Inland Fisheries Advisory Board and details the powers of the Board.

4.3.4.3.3 *Goa*

The Goa Marine Fishing Regulation Act, 1980: The specifics of the Act include prohibition of mechanized fishing vessels within an area up to 5 km from the

coast-line, restrictions on mesh size of nets, i.e. 20mm for prawn and 24 mm for fish and banning mechanized fishing by means of trawl nets and purse seines during 5 June to 24 July every year.

4.3.4.4 Mining

The Mines and Minerals (Development and Regulation Act), 1957, and the Mines Act, 1952, together with the rules and regulations framed under them, constitute the basic laws governing the mining sector in India.

Oilfields (Regulation and Development) Act, 1948: The Act provides for the regulation of oilfields and for the development of mineral oil resources. The Act covers mineral oils which are defined as including natural gas and petroleum. It empowers central government to make rules with regard to mining leases and for the development of mineral oil.

The Mines Act, 1952: The Act contains provisions for measures relating to the health, safety and welfare of workers in the coal, metalliferous and oil mines. The Act is administered by the Ministry of Labour and Employment through the Directorate General of Mines Safety (DGMS).

The Coal Mines (Conservation and Development) Act, 1974: The Act provides for the conservation of coal during mining operations, development of coal mines and for other relevant matters.

For conservation and development of oil and natural gas resources a similar legislation was enacted in 1959.

The Mines and Minerals (Development and Regulation) Act, 2010: The 2010 Act repeals the previous 1957 Act and provides for the scientific development of mines and minerals under the control of the Union and the regulation of activities connected therewith.

The Oil Mines Regulations, 2011: The Oil Mines Regulations contain the necessary provisions relating to safety standards to be maintained in mines.

4.3.4.4.1 Kerala

Kerala Minor Mineral Concession Rules, 1967; Amendment, 2015: The rules deal with the granting of quarrying permits with respect to land owned by the government.

Prevention of Illegal Mining, Transportation and Storage of Minerals Rules, 2011: In order to check the spread of illegal mining in the state, the rules were issued by the state government in 2011. The compensatory afforestation and environment protection fee of Rs. 84,000 per hectare was extended to include all non-forest, patta and revenue land where mining leases were given out.

4.3.4.5 Electricity

Indian Electricity Act, 2003: Before the Electricity Act, 2003 the electricity sector was guided by The Indian Electricity Act, 1910 and The Electricity (Supply) Act, 1948. Generation, distribution and transmission were carried out mainly by the State Electricity Board. To distance the state government from tariff determination, the Electricity Regulatory Commissions Act, was enacted 1998 which was then changed in 2003 to the Electricity Act, in order to reform the electricity sector further by including the participation of the private sector and to bring in competition. The Act de-licenses power generation completely (except for hydro power projects over a certain size). As per the Act, 10 percent of the power supplied by suppliers and distributors to the consumers has to be generated using renewable and non-conventional sources of energy so that the energy is reliable. The Act was enacted to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity.

4.3.4.6 Other relevant laws

Food Safety And Standards Act, 2006: The Act consolidates the laws relating to food and to establish the Food Safety and Standards Authority of India for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import, to ensure availability of safe and wholesome food for human consumption and for matters connected therewith or incidental thereto.

Cultural Heritage Conservation Bill, 2010: The Bill seeks to enact a law for the purpose of implementing the decisions to take appropriate legal, scientific, technical, administrative and financial measures necessary for the identification, protection, conservation, presentation and rehabilitation of cultural and natural heritage.

PART C CITY-REGION SCOPING

5 CITY REGION CONTEXT

5.1 Policy frameworks at city-region level

City level policy frameworks are limited. Those that are easily available such as development plans have already been detailed in later sections and chapters. Nonetheless, brief summaries are presented below.

5.1.1 Kochi

City Development Plan (CDP), 2006- 2026: The CDP (Government of Kerala, 2006) comprises plans and urban reforms for a number of identified sectors of development in Kochi. The document outlines the policy framework and investment interventions to be conducted within the seven year period to achieve its vision. The CDP aims at achieving equitable development by addressing the issues of economic growth, infrastructure, poverty, good governance and service delivery to all, through a consultative process of strategizing and visioning. The action plan aims at improving urban governance and management, increasing investments to ensure employment potential and expand services including systematic and sustained urban poverty reduction.

Kochi Water Policy, 2015: In a first of its kind (developed by a local body for local level use), the Water Policy of Kochi (KMC, 2015) has a series of proposals for redressal of water problems like scarcity, low quality, disruption in supply and to conserve drinking water sources. The policy recommends the formation of a Kochi Water Information System to serve as a central repository for any water related data about the Corporation. It stresses on aspects like regular water audits, rainwater harvesting and well protection and sanitisation. The policy also recommends conservation of wetlands within and outside the city as well as delves into climate adaptation strategies. The policy sets a priority for water allocation putting drinking water at the highest and agricultural production/livestock/ fisheries at the lowest.

Travancore-Cochin Fisheries Act, 1950: The Travancore-Cochin Fisheries Act, 1950 resembles the Indian Fisheries Act, 1897. Both empower the government to make rules for regulating fishing in specified waters and for managing the fisheries therein. The rules notified under the act ensure protection of fish in selected waters. According to the Travancore-Cochin Fisheries act, nets with meshes having a cod end less than 20mm is prohibited mainly to protect the very young fishes.

City Sanitation Plan (CSP), 2011: This a comprehensive document (KMC, 2011) to detail short, medium and long term plans for governance, technical, financial, capacity building, awareness and pro-poor actions which will ensure 100 percent access to safe sanitation. The CSP framework forms the basis on which

the City Administration will work with stakeholders including other spheres of government, service providers and beneficiaries.

5.1.2 Mangaluru

CSP, 2010: The CSP identifies the areas in the city that are affected by various sanitary issues (viz. sewerage, solid waste management, storm water drainage and water supply). It provides a framework which details the problems, provides guidance and outlines strategies for the city of Mangaluru within the spheres of water supply and sanitation.

5.1.3 Panaji

CDP, 2015-2041: The CDP was prepared for Panaji in 2007, under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM). The document was revised in 2015 keeping in mind the objectives of the “Capacity Building of Urban Development” (CBUD) project, launched by Ministry of Urban Development (MoUD) and Ministry of Housing and Urban Poverty Alleviation (MoHUPA) (MoUD and World Bank, 2015). The document focuses on addressing the major constraints of urban development and specifically focuses on the capacity building requirements for successful urban management and poverty reduction. It also emphasises on the development of economic and social infrastructure, policies and programmes addressing the specific issues of urban poor, strengthening of municipal governments, and their financial management and accounting processes and promoting transparency in their functioning.

CSP, 2015: The CSP of Panaji city was prepared under the CBUD project as well (CCP, 2015). The document was developed in accordance with the framework formulated by Government of India in the National Urban Sanitation Policy (NUSP), 2008. The CSP was prepared with a vision to provide total sanitation for citizens and tourists at all times so that society is able to derive sustained benefits in terms of improved public health and thereby, better quality of life. The CSP identifies a set of interventions to improve the existing situation for continuous and sustained improvement in the city's infrastructure and services.

5.2 Socio-economic profile

5.2.1 Kochi

The city of Kochi is the largest urban agglomeration of Kerala and is situated in the district of Ernakulam, spread over an area of 107.13 km² (Government of Kerala, 2006). Being the only all-weather harbour on the west coast it has assumed a place of importance in the trade and commerce of the state. Kochi is also home to many large and medium scale industries and more than 60 percent of the tax revenue of the state comes from here. For these reasons it is known as the commercial capital of Kerala. According to the Development Plan for Kochi's City Region, 2010, the urban agglomeration consists of the Kochi

Municipal Corporation (KMC), adjoining Municipalities (Thrippunithura, Kalamassery, Eloor, Thrikkakara Maradu), and 11 contiguous Panchayats (Elamkunnappuzha, Njarakkal, Mulavukadu, Kadamakkudy, Cheranallur, Varappuzha, Thiruvankulam, Kumbalam, Kumbalangi, Chellanam and Vadavucode-Puthenkurisu) (Figure 13).

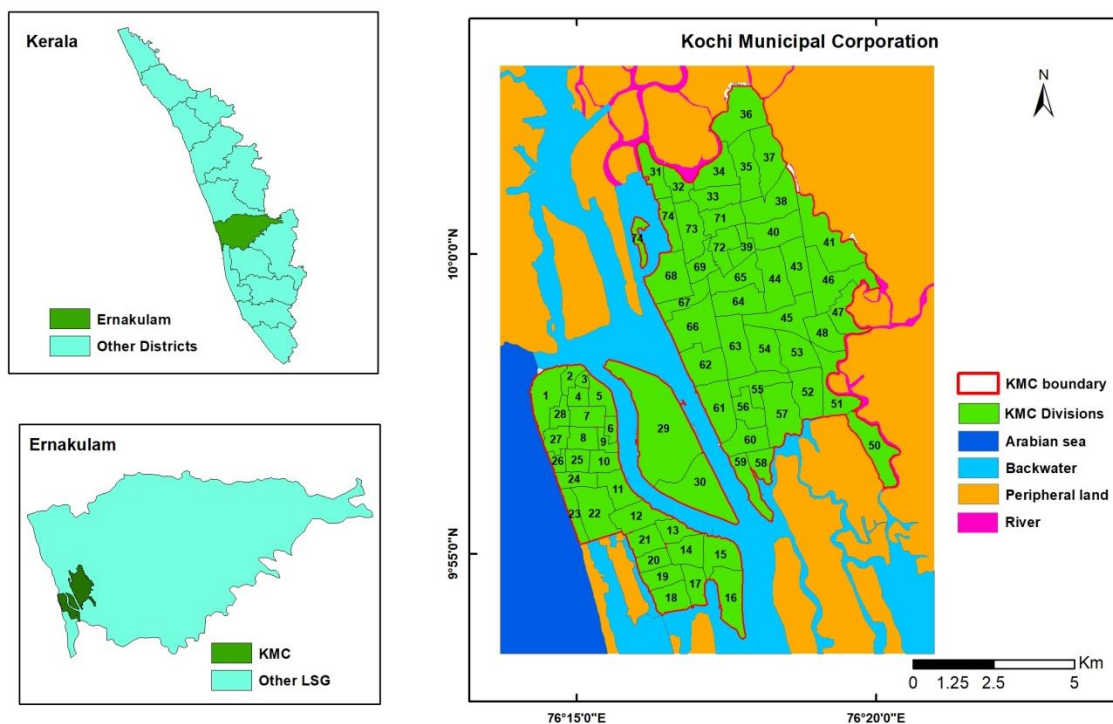


Figure 13: Location Map of KMC

5.2.1.1 Demographic details

KMC's population in 2001 (Census, 2001), was 596,473 which grew to 601,574 (296,668 males and 304,906 females) in 2011 (Census, 2011). According to the Development Plan, 2010, the projected population growth within the planning area is expected to be 1.37 million in 2021 and 1.43 million in 2026. The city being an industrial nucleus sees a daily influx of workers (0.25 million) who commute within a radius of about 100 km. Taking this into account, the total population is estimated to be 2.17 million in 2021 and 2.53 million in 2026 in the CDP area.

Kochi has significant Hindu, Christian, and Muslim populations. A sizable number of Tamil workers fill low-wage economic niches. The city's long history of international trade makes it unusually cosmopolitan, with many linkages to the Gulf States, Europe, and North America (MoUD and World Bank, 2010).

Kerala scores high on human resource indicators such as education levels and literacy. The city displays a literacy rate of 97.36 percent, which is one of the highest in the country (Census, 2011). The city area contains 60 schools, five colleges, a regional study centre of the Mahatma Gandhi University, the Law College and the Marine Campus of the Cochin University of Science and Technology.

5.2.1.2 Economy

Kochi, also known as the Queen of the Arabian Sea for its scenic beauty, is a trading port and was the spice trading centre of the world in the 14th century (Government of Kerala, 2006). To this day, the city is an important tourist site which attracts the maximum number of domestic and international tourists in Kerala, while also being a significant economic and trading hub within the state (ICLEI SA, unpubl.). The city is home to the only stock exchange in Kerala, and has also witnessed considerable investment for industrial growth. Its port provides round the year anchorage, operates as an international container trans-shipment terminal, houses oil refineries, and supports commercial maritime businesses. The Southern Naval Command of the Indian Navy is also based here. Other economically important nodes found here include the Cochin Special Economic Zone (SEZ) and Kerala Industrial Infrastructure Development Corporation (KINFRA)-Export Promotion Industrial Park (EPIP).

5.2.2 Mangaluru

Mangaluru, the administrative headquarters of the Dakshin Kannada district is a rapidly growing city and the fourth largest in the state (Census, 2011). Besides being a coastal city, it is also situated on the backwaters of two rivers – Gurupur and Nethravathi. The rivers merge at the peninsula of Tannir Bavi before emptying into the Arabian Sea, giving the city one of the longest and scenic riverfronts (Government of Karnataka, 2009) (Figure 14).

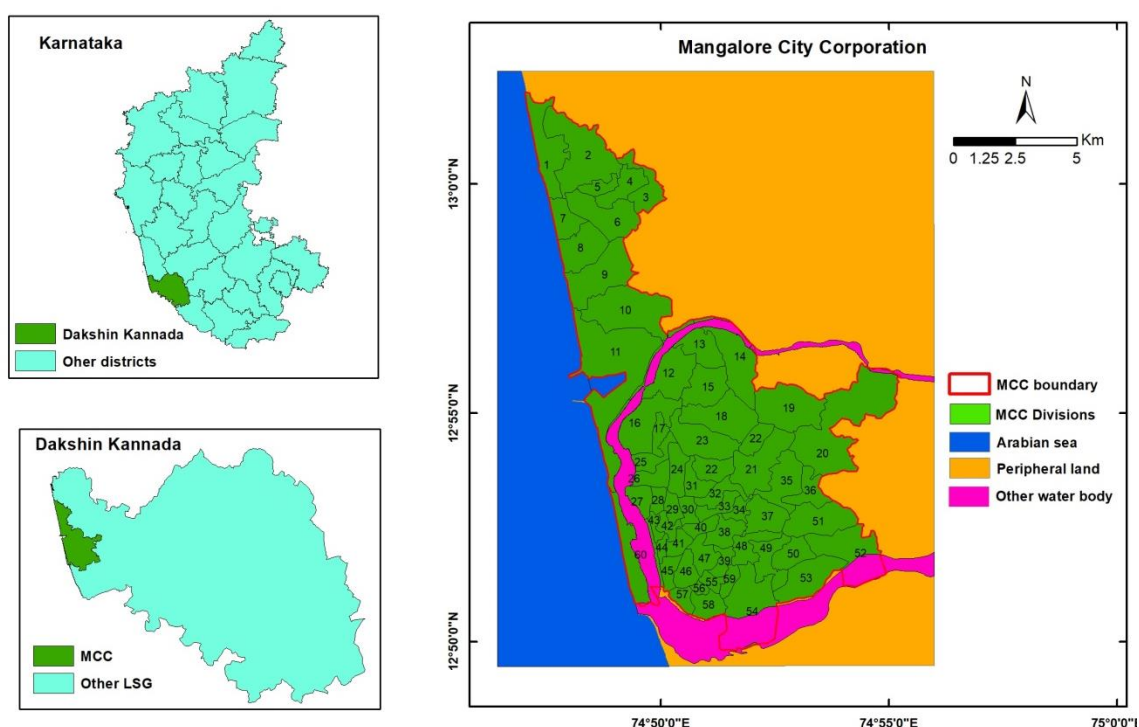


Figure 14: Location Map of Mangaluru

5.2.2.1 Demographic details

Mangaluru is the highest populated urban centre in Dakshin Kannada District with 22 percent of the total district population. The total population of Mangaluru and its outgrowth recorded as per Census 2011 is 499,487. The city is divided into 80 wards and is administered by the Mangaluru City Corporation (MCC). The total area of the municipality is 184.45 sq km, with a gross density of 2650 persons per sq km. Males constitute 50.2 per cent of the total population and females constitute 49.8 per cent. The sex ratio is 1016 (Census of India, 2011). The average literacy rate is 93.7 percent.

5.2.2.2 Economy

Mangaluru has a long tradition of business and entrepreneurship and ranks second in the state after Bengaluru in terms of growth and potential for development. Being the only major port in Karnataka, it evolved as a trading centre with links to western Asia and China since the 5th century AD. The city's economy is principally based on agricultural processing and port-related activities. However, over the years it has become a multi-functional city with business (trade and commerce), skilled jobs (industries) and administration emerging as important sources of employment. The contribution of the service sector (especially banking) has also increased over the recent years (Government of Karnataka, 2009). Major IT and outsourcing companies have started locating their facilities in Mangaluru. There are four SEZs operational presently in and around Mangaluru (*ibid.*).

The port handles 75 percent of India's coffee exports and the bulk of cashew nuts from the coastal districts. The Petrochemical industry forms the bulk of the industries in the city (Kumar, 2012). The major petrochemical industries are Badische Anilin- und Soda-Fabrik (BASF), Mangalore Refinery and Petrochemicals Ltd. (MRPL), Mangalore Chemicals and Fertilizers Ltd. (MCF), Kudremukh Iron Ore Company Ltd. (KIOCL), Hindustan Petroleum Corporation Ltd. (HPCL), Bharat Petroleum Corporation Ltd. (BPCL), JBF Petrochemicals and Total Oil India Limited.

5.2.3 Panaji

Panaji is a coastal city located along the West Coast of India in the northern part of the state of Goa. It falls under the Tiswadi *taluka* and is bound by the Arabian Sea along the South West, Mandovi River along the North and West and Zuari River towards the South East (Figure 15). Panaji is Goa's capital city and largest urban agglomeration. Panaji is also considered to be Goa's tourism, commercial and education centre (MoUD and World Bank, 2015).

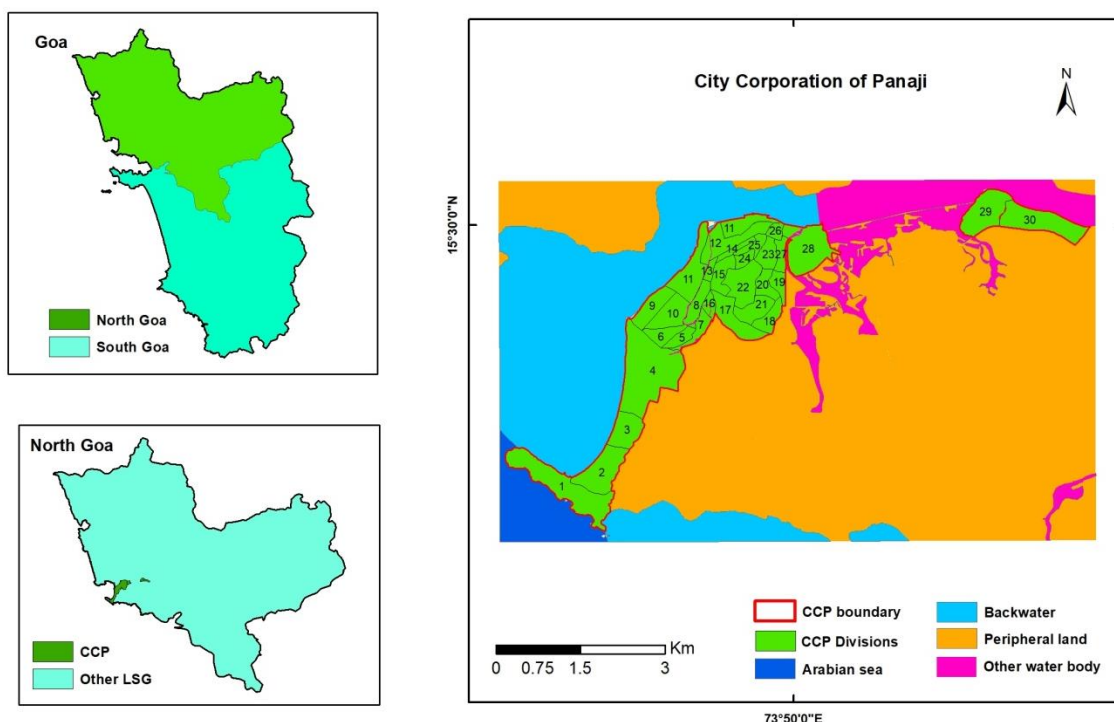


Figure 15: Location Map of CCP

5.2.3.1 Demographic details

The population of Panaji accounts for two percent of the total urban population of the state and 16 percent of the district's urban population (*ibid.*). The city population growth has been fluctuating over the past five decades mostly due to the changes in the area under jurisdiction of the Corporation of the City of Panaji (CCP). The total population that falls within the jurisdiction of CCP is 40,017 as per Census 2011 which shows decline of population from Census 2001 population of 59,066. This is due to exclusion of Taleigao and Durgawado, which were part of Panaji Municipal Council in Census 2001 and have been made outgrowths in Census 2011. The city also deals with a high influx of tourist population throughout the year. As per the tourist statistics for 2011, Tiswadi *taluka* received 1,136,861 tourists which comprised of 690,926 domestic tourists and 445,935 foreign tourists. Given that Panaji is the main tourist destination in the *taluk*, it can be assumed that the city receives a majority of the *taluk's* tourist arrivals throughout the year (Census, 2011).

The average sex ratio within the Corporation area has increased considerably from 882 in 1971 to 981 in 2011 (Census, 2011). The city region has an average sex ratio of 973 (Census, 2011) which is lower than the district average of 1,038 and *taluk* average of 1,035. The literacy rate in Panaji city was 87 percent in 2011. The city is the state's major educational centre and has a number of good quality educational facilities like pre-primary, primary, secondary, higher secondary schools and degree colleges.

5.2.3.2 Economy

Panaji city has a mixed economic base, agriculture and tourism being the more significant amongst them. The city's local and international popularity for coastal tourism has led to the growth of a number of industries such as the hospitality industry, transport industry, retail industry and unorganised sectors. With a large portion of the city under commercial activities, Panaji is also a commercial and administrative centre. According to the 2011 Census, about 98 percent of the city population was engaged in tertiary sector.

Commercial areas and markets are concentrated mostly in the northern and the core city areas. Out growth areas of the city at EDC (formerly known as Economic Development Corporation) Patto is emerging as the administrative hub with majority of government offices and departments located in this area (Directorate of Economics and Statistics, 2012-2013).

While there are no industries within the city due to it being an ecologically sensitive zone, they can be found at a range of 15 km outside the city. Corlim Industrial Estate which has around 58 industrial units is a key contributor to the economy of Panaji. Handicraft and cottage industries are well developed and support tourism (ICLEI SA, unpubl.).

5.3 Urbanisation and informality

5.3.1 Kochi

Kochi originated as a market harbour town. Over the years it has emerged as one of 12 major ports of the country and the nerve centre of commercial and industrial activities in the state. This transformation came about as a result of substantial industrialisation and urbanisation. As the city began to grow eastwards beyond its boundaries, its advanced canal system began to fall into disuse and disrepair, losing preference to road and rail facilities. Land-use pattern changes affected primary economic activities such as traditional farming and fishing. Economic activities were concentrated near the port and water front areas. Residential and spatial zoning were influenced by political, ethnic and religious elements. Overall, the local authorities and their jurisdictions shaped the location of major facilities such as wharfs, public buildings and industries (Government of Kerala, 2006; Department of TCP, 2010).



Figure 16: Thevara Canal which has been encroached upon

When the erstwhile rulers of Kochi shifted their capital from Mattancherry to Ernakulam in 1840, it brought about a significant change in the development of Kochi. The Corporation of Cochin was formed which combined the Municipal areas of Fort Kochi, Mattancherry and Ernakulam and a few settlements adjoining Ernakulam. This was a phase of rapid urbanisation which occurred between 1990 and 2000, where urban expansion outgrew the boundaries of the city. Eventually a diffusive urbanisation pattern took hold and the city grew along arterial corridors. Although growth was taking place, it did so along these traffic corridors, leaving small pockets of undeveloped land in between. These pockets were not large enough for major organised development and therefore the area retained Kerala's characteristic rural urban continuum pattern. As a result, Kochi began to be known as an urban agglomeration (*ibid.*).

Given Kochi's status as a metropolitan city and a commercial hub, there is a constant stream of developmental projects being implemented. As a result, a large floating population consisting of daily labourers from other states make up a significant proportion of the city. This has led to the formation of slums and informal settlements. The informal sector comprises of unorganized construction workers, pavement labourers, gardeners, domestic workers, and so on. The total slum population as per data taken from a project report of Kochi Corporation for the year 2012-13 and 2013-14 was 127,800 which comprise 21.25 percent of the urban population. There are 280 notified slums and 20 which are not notified, of which 70 percent are in west Kochi (KMC, 2012-2014). There are 27,861 households within these slums and the monthly income of these households can range between INR 3,000 to INR 20,000.

5.3.2 Mangaluru

Mangaluru is one of the fastest growing and urbanizing coastal cities of the Karnataka state. According to the 2011 census, the city's annual growth rate is 1.47 percent/year. Rural to urban migration is by far the major component of urbanization. In fact, urban development based on rapid urbanisation is manifesting itself along three important corridors of Karnataka, a) Bangalore-Belgaum, b) Mysore-Bangalore-Kolar, and c) Mangaluru-Udupi-Karwar (UDD, 2009).

Growth of the City has primarily been towards the north and eastern sides, along the Airport and National Highway 17 (towards Suratkal and Udupi). This is because the sea-face along the west and the administrative state boundary of state of Kerala in the south has restricted growth in these directions. A large number of redevelopment initiatives around Hampankatta and K.S Rao Road are also taking place. The development pattern of the port city has been in a manner that has resulted in the central areas in the city being congested and densely populated (Government of Karnataka, 2009; Kumar, 2012).

Mangaluru city has 32 recognized slums within the municipal corporation limit (Shetty, 2014). According to the 2011 census, 7,726 people reside in slums in Mangaluru city, which is 1.55 percent of the total population. The people residing in slum area are mostly migrant labourers from nearby villages who come to the city in search of economic opportunities. Jyothinagar is the largest slum in terms of population and CPC compound Kudroli has the maximum density/sq.km.

5.3.3 Panaji

Panaji has grown substantially from being a small fishing village to the most influential city in Goa. It was declared as the capital of Goa in 1843 after which it slowly developed as a city. The present limits of Panaji city occupies an area of 8.12 km² and consists of 30 administrative wards. The city area has been changing over the last four decades, acquiring importance as a major commercial and tourist hub as well as the administrative capital. Population density has been fluctuating with changes in the city area. In 1971 the density was 4,623 persons/km² which increased in 1981 to 5,786 person/km². In 1991 the city area increased drastically from 7.46 km² to 22.63 km² due to the inclusion of the urban agglomeration population and the development of new areas in the surrounding villages. In 2002, the CCP area was confined to 8.12 km² (Ministry of Urban Development and World Bank, 2015). Presently, the average density in the city is high at 4,928 person per sq.km² (Census, 2011).

Being the state capital, a major tourist destination and having the highest population among all the urban centres, Panaji has a high influx of floating and migratory population. This has resulted in a rapidly urbanizing costal belt of Goa. New towns have emerged from suburban pockets. Urban outgrowths of the city are spreading in the direction of old Goa and Bambolim.

In 1961 there were no slums in Panaji. With development of real estate, trade and commerce and educational institutions in the city, a steady stream of migrants from rural Goa and the neighbouring states of Karnataka and Maharashtra led to the formation of slum pockets in some areas. CCP estimates there are around 170 to 200 below poverty line (BPL) families (CCP, 2013), most of which comprise migrants. Figure 17 shows the location of slum pockets in Panaji city which has been taken from the DPR for basic services to the urban poor under the JNNURM project (CCP, 2013). Slum pockets are located in environmentally sensitive areas like the unbuildable slopes of Altinho, edges of St. Inez *nallah* and low lying areas of the city along water bodies.

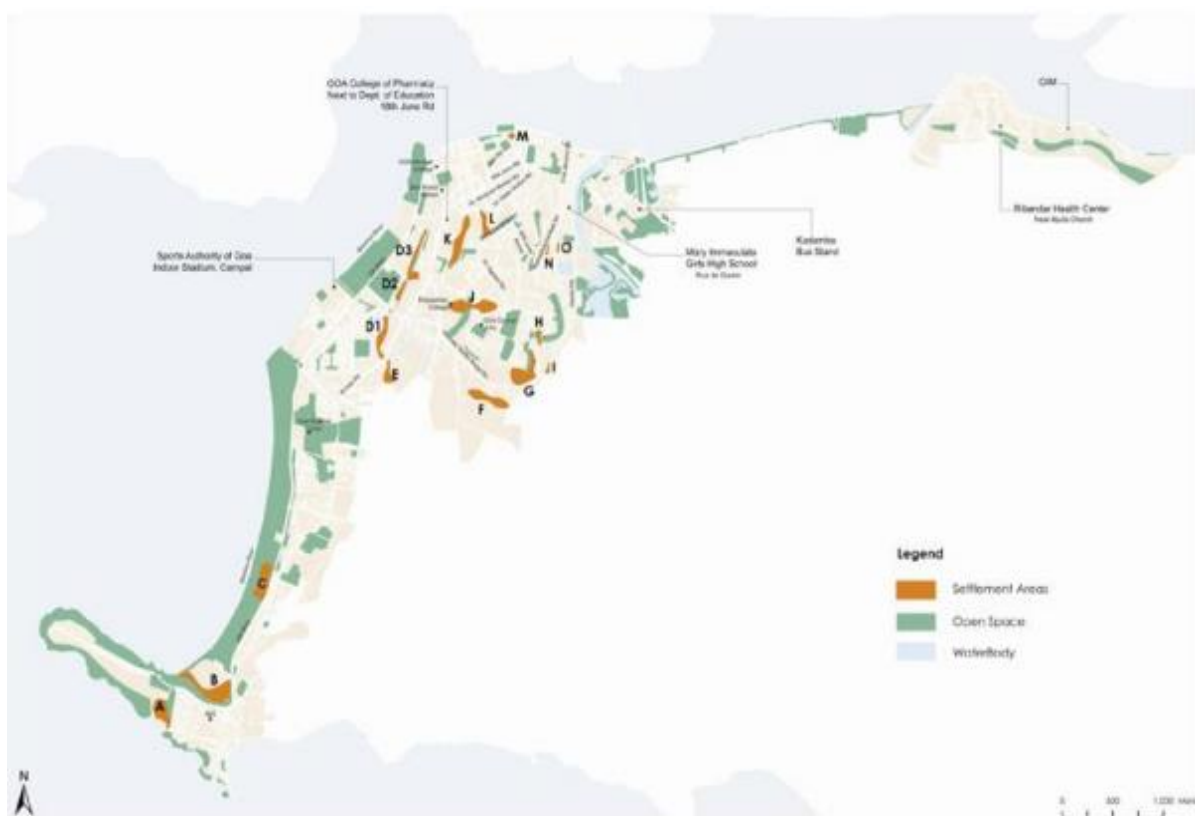


Figure 17: Locations of Slums in Panaji city with relation to the City's Open Spaces. (Source: CCP, 2013)

5.4 Climate Change Impacts and Challenges

5.4.1 Kochi

The Kerala SAPCC (Government of Kerala, 2014) reported climate scenarios for the summer monsoon rainfall and the annual average temperature for 1970s, 2020s, 2050s and 2080s for the state using PRECIS models. From the average rainfall calculated, it was observed that South-Central Kerala districts (Ernakulam- where Kochi is located, Alappuzha, Kottayam, Pathanamthitta and Idukki) show a positive deviation of 20 to 30 cm from the normal in the 2050s. The maximum temperature increase can be seen in these districts as well. Palghat, Ernakulam and Alappuzha will observe a change of 1.62°C to

1.66°C in the 2050s. The minimum temperature rise in the central districts other than Thrissur will be 1.59°C to 1.64°C. The report also presented the scenario of future sea level⁴. The projected Sea Level Rise (SLR) along Kerala coast on a conservative estimation is about 100 to 200 mm over the next 100 years.

According to the estimates predicted by the Inter-Governmental Panel for Climate Change (IPCC) in 1990, there will be a 31cm rise in sea level (lower scenario) induced by greenhouse gas warming by the year 2100. In that case the sea would move several meters inland, permanently flooding a large part of the highly urbanized coastal fringe of the city. This will only increase urban growth in the eastward direction.

A communication strategy developed by ICLEI South Asia in 2013, in collaboration with Indian Institute of Technology (IIT)- Delhi and Potsdam Institute for Climate Impact Research under the Asian Cities Adapt project, came out with the following predictions:

- Projected precipitation may show a net increase over the time duration of 2015-2044 with respect to the simulated rainfall of 1971-1999 by 0.5 mm/day over Kerala subdivision as well as over Kochi.
- Projected mean temperature may show a net increase over the time duration of 2015-2044 with respect to the mean temperatures of 1969-2000 by 0.67°C and 0.53°C over Kerala Subdivision and Kochi respectively.

Taking into account the various assessments, we have the following climate scenario statements (Table 4),

Table 4: Climate Scenario Statements for Kochi City

Changing Climate Conditions	Assessments	Climate Scenario Statements
Temperature change	Regional Assessment	The mean annual temperature is projected to increase from 26.8±0.4°C to 27.5±0.4°C in the 2030s. The net rise in temperature with respect to the 1970s will be between 1.7°C and 1.8°C.
	Supplementary Assessment	The average maximum temperature is projected to increase by 1.62°C to 1.66°C and the average minimum temperature by 1.59 to 1.64°C in the 2050s with respect to the 1950-2000 in the Ernakulam district.

⁴This was obtained by adding the projected values for a given year to the local trend of 0.02 cm per year times the number of years from present.

Changing Climate Conditions	Assessments	Climate Scenario Statements
	Local Assessment	Projected mean temperature may show a net increase of 0.53°C in 2015-2044 with respect to the mean temperature of 1969-2000 in Kochi city.
Precipitation change	Regional Assessment	The annual rainfall in the Western Coastal region is likely to vary between 935±185.33mm to 1,794±247mm, which is an increase of 6%–8% with respect to the 1970s an increase that is ranging from 69 to 109 mm.
	Supplementary Assessment	The average monsoon rainfall may show a deviation of 20 to 30 cm from the normal with respect to the 1950-2000 in the Ernakulam district.
	Local Assessment	Projected precipitation may show a moderate increase in 2015-2044 with respect to the rainfall of 1971-1999 by 0.5 mm/day in Kochi city.

The major impact concerns for Kochi are primarily related to possible changes in precipitation patterns and a rise in the sea level. Though these impacts may not be obvious in this half of the century, they may have long-term effects. ICLEI South Asia in their communication strategy produced under the Asian Cities Adapt project, identified the most impacted of the city's urban sectors, through a combination of secondary literature review and participatory shared learning dialogues. Given the state of the present infrastructure, resources available and capacities of local authorities, they found that the water supply system, solid waste management system, drainage and sewerage systems were most at risk to the identified climate change scenarios. A USAID funded study in 2003 also found that the most significant vulnerabilities are possible impacts on Kochi's water systems, especially drainage and waste disposal. The city already suffers from chronic water logging, and a combination of increased variability and intensity of rainfall and sea level rise will impacts land uses at the coastal margin, such as backwater islands. Other impacts of climate change could be on human health (increased incidences of dengue-related morbidity), on Kochi's fisheries industry, on its tourism, and possible impacts from climate changes in other regions, such as in-migration of environmental refugees from areas affected by drought or sea level rise.

5.4.2 Mangaluru

According to a study (Larour *et al.*, 2017) funded by NASA, Mangaluru is one of the 293 leading port cities which will be impacted most due to rise in sea level due to global warming. Over the next 100 years, glacial melt could increase Mangaluru sea levels by 15.98 cm compared to 15.26 cm for Mumbai and 10.65 cm for New York, according to the study. The findings are based on a forecasting tool, gradient fingerprint mapping (GFM), developed by the scientists at the US space agency's Jet Propulsion Laboratory. It allows planners to see exactly how

melting glaciers can impact sea levels for 293 major port cities, including three from India – Mangaluru, Mumbai in Maharashtra and Kakinada in Andhra Pradesh. Mangaluru is likely to see large parts of its areas go under water (D'Monte, 2017).

City-level temperature and precipitation projections were absent for Mangaluru and so regional projections from the Karnataka State Climate Change Action Plan (Government of Karnataka, 2011) were looked into. For climate change projections, the report used simulation data from the global climate model, HadCM3 from the Hadley Centre, UK (Collins et al., 2001) downscaled by the PRECIS model to yield a regional climate model (Kumar et al., 2006). The combination of HadCM3 and PRECIS models is known as the HadRM3 model. According to the report, the northern districts are projected to experience higher temperature rises (annual, maximum and minimum) when compared with the southern districts. Mangaluru falls in the southern part of Karnataka. Estimates for the Dakshin Kannada district predict an overall increase in average temperatures by 1.72°C, increase in minimum temperatures by 1.81°C and increase in maximum temperatures by 1.71°C. Annual rainfall is expected to generally decrease in the south-west part of the state, both monsoonal and post-monsoonal rainfall are predicted to decrease

The information above is presented in Table 5 below,

Table 5: Climate Scenario Statements for Mangaluru City

Changing Climate Conditions	Assessments	Climate Scenario Statements
Temperature	Regional Assessment	The mean annual temperature is projected to increase by 1.72°C in 2021-2050 compared to 1961-1990. There will be an increase of 1.81°C and 1.71°C in the minimum and maximum temperatures in 2021-2050 when compared with 1961-1990.
Precipitation	Regional Assessment	The annual rainfall in the southwest part of the state is expected to decrease.

5.4.3 Panaji

The Government of India's 'Climate Change and India: A 4x4 Assessment' report (INCAA, 2010) has detailed climate projections the Western Coast of India under which the state of Goa falls. The report makes the following projections for the year 2030,

- **Precipitation change:** There is a high probability of an increase in average annual rainfall in the range of 69 to 109 mm in the Western Coastal Region by the year 2030.

- **Temperature change:** There is a high probability of a rise in average annual temperatures by 1.5 to 2.2°C in the Western Coastal Region by the year 2030.

These can be visualised in the Table 6 below,

Table 6: Climate Scenario Statements for Panaji City

Changing Climate Conditions	Assessments	Climate Scenario Statements
Temperature	Regional Assessment	The mean annual temperature is projected to increase by 1.5°C to 2.2°C in the 2030s. The net increase in temperature ranges from 1.7°C to 1.8°C with respect to the 1970s. Temperatures also show a rise in all seasons.
Precipitation	Regional Assessment	The annual rainfall in the Western coastal region is likely to vary between 935± 185.33 mm to 1,794±247.1 mm. The projected precipitation is likely to increase by 6% to 8% in 2030s with respect to 1970s.

Sea level rise is not perceived as a threat to the city of Panaji so far. However, if one examines the projected impacts of a one meter SLR in the Panaji area in terms of 'percentage of GDP at risk', 'number of people at risk of migration' and 'potential land loss' these are found to be significant – as shown in the figures 18, 19 and 20⁵. The projections indicate that in the case of a one meter rise in sea level the GDP at risk in the Panaji area would vary in the range 4.58 percent - 12.47 percent, the number of people at risk of migration would range between approximately 19,000 and 64,000, and the hectares of potential land loss per administrative unit would be between 1,199 and 2,468 ha.

'Environmental Education and Sustainable Development in the New Millennium', a book by Deshbandhu (2009), released on the occasion of "VIII Global Conference on Environmental Education 2009" warns that Goa being a state with shortest coastline, is more prone to sea level rise due to global warming and climatic change.

5. Source: These projections have been accessed from the ci:grasp website which '...performs as a climate information service and provides sound knowledge on current and projected climate stimuli, climate impacts and adaptation options at the national, sub-national and regional level.' This is an interactive platform that has been developed by the Potsdam Institute for Climate Impact Research (PIK) and GIZ on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

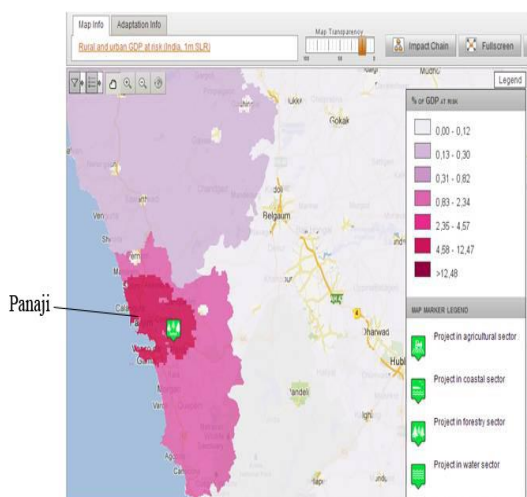


Figure 18: Percentage of GDP at Risk in the Panaji area due to 1m Sea-level Rise

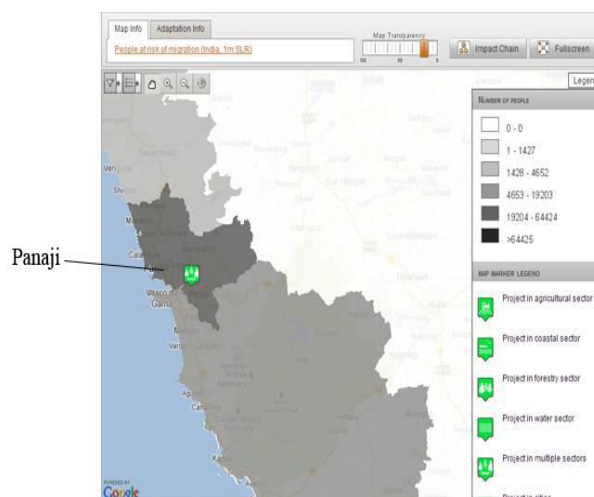


Figure 19: Number of people at Risk of migration in the Panaji area due to 1m Sea-level Rise

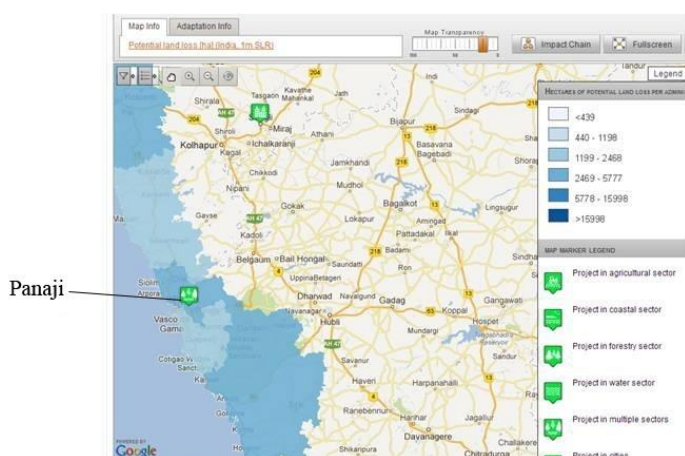


Figure 20⁶: Potential land loss (in ha.) in the Panaji area due to 1m Sea-level Rise

Rising sea level combined with other anthropogenic activities like over-extraction of ground water can increase the incidences of salt-water intrusion into Panaji's freshwater aquifers. According to TERI (2012), studies have estimated that under a one meter SLR, Goa could potentially lose as much as 4.34 percent of its total land area, impacting agriculture, land use patterns and cultivated land in the state. Increase in temperatures, changes in the overall amounts and timing of precipitation has started to impact agriculture. Pest and vector species life cycles can be favoured by the increases in temperature or changes to precipitation. These will have impacts not only on rural and peri-urban

⁶These projections have been accessed from the cigrasp website which '...performs as a climate information service and provides sound knowledge on current and projected climate stimuli, climate impacts and adaptation options at the national, sub-national and regional level.' This is an interactive platform that has been developed by the Potsdam Institute for Climate Impact Research (PIK) and GIZ on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. <http://cigrasp.pik-potsdam.de/worldmap>

agricultural systems but also on urban health and wellbeing. ICLEI South Asia in 2015 (ICLEI SA, unpubl.) identified the key fragile urban systems in the city already vulnerable due to infrastructural, governance, economic, social and political issues which may be aggravated by climate change. These urban systems which will be impacted and need to be strengthened are water supply, sanitation, drainage, health and transportation.

The IPCC (in TERI, 2012) projects that by 2080s, due to SLR, 33 percent of the coastal wetlands globally may be lost. This will impact the goods and services provided by these wetlands, especially in their ability to act as a regulator of the impacts of extreme events increasing the vulnerability of the city to flooding during storms. The vertical rise in the water column due to the predicted SLR, and the limitation of landward margins, may result in water logging and ultimately the death of mangroves as well as other dependent and associate biota. SLR can also alter the ocean currents and the food chains operating in the marine ecosystems, thereby affecting Goa's fisheries to varying levels.

5.5 Growth and development priorities and challenges

5.5.1 Kochi

Kochi's growth and development priorities according to its CDP (Government of Kerala, 2006) are to enhance its citizen's quality of life. To do this the Corporation has emphasized on the need to develop dependable urban services. Within the CDP itself, proposals mainly target the urban basic services sector, which includes Water Supply, Sewerage, Drainage, Solid waste disposal system, Traffic and Transportation with special emphasis to the urban poor, at the same time preserving the character and the heritage of the city. The overall vision, considering the city's natural assets, human resources, medical facilities available and cultural heritage, is to develop Kochi as a world health care centre, tourism destination and an IT and ITES centre.

Kochi has distinct advantages in terms of its moderate size and rate of growth, along with progressive management, high levels of human resources, and discouragement of heavy industrial development (attributed to Kerala's strong labour movement). However, like other cities in developing countries, Kochi too struggles with the effects of urban growth and rapid urbanisation. The city has to deal with its population of landless poor increasing, disproportionate increase in traffic versus infrastructure management and population spill-over outside its municipal boundaries. Kochi City (CDP area) is experiencing a population growth higher than the state average. To add to this, it also has a significant floating population which is expected to increase (Department of Town and Country Planning, 2010). The city's services and infrastructure such as transportation, sanitation, water, and electricity are constantly challenged by its population. Although Kerala was a water rich state, poor management of water resources has led to potable water scarcity and drought in several areas including Kochi. Jurisdiction boundaries complicate the matter as some urban

service such as water supply and electricity is a state responsibility. KMC handles solid waste management and sanitation, however the services are impacted due to limited financial, human and infrastructural resources.

Land-use planning is the biggest challenge that the city faces. With landforms consisting primarily of backwaters and wetlands the city historically had an excellent canal system which served the purpose of transportation, drainage, flood control and irrigation. This network now a victim of urban development lies encroached, silted, polluted, and blocked with solid waste, serves as informal sewage disposal channels. This decline of this crucial historic foundation, combined with the city's location in a flat, low-lying coastal area, contributes to the city's problems with drainage and water logging. The backwaters alone constitute almost 95 percent of the water sheet. Given that Kochi's growth is limited due to the large percentage of water around it, reclamation of land from backwaters has been a means to increase the supply of dry land for urban uses. However, while there are good examples of this such as Willingdon Island, most of reclamation is unplanned and affects the ecological balance. The CRZ rules explicitly restrict reclamation of water bodies except for Port related activity, however, encroachment continues unchecked, especially by those who have their properties adjoining the water bodies. Additionally, land which was used by paddy fields and prawn farms also tend to blur the boundaries between these areas and water bodies around them. Therefore with these areas getting converted to developed land, encroachment and illegal reclamation is common.

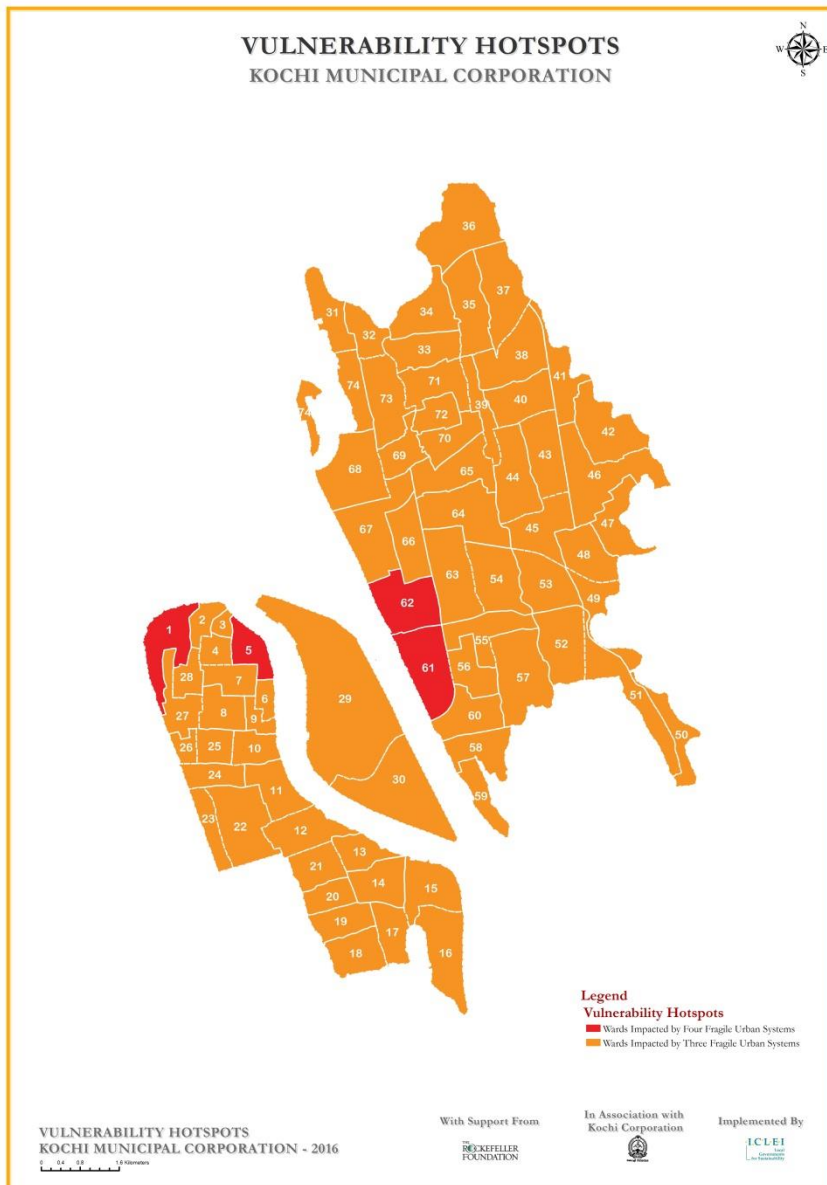


Figure 21: Vulnerability Hotspot Map, Kochi. Source: ICLEI SA, (unpubl)

According to the information gathered in 2013 by ICLEI South Asia under the Asian Cities Adapt (ACA) project and then in 2015 under the Asian Cities Climate Change Resilience Network (ACCCRN) project, Kochi's wards when overlaid with urban vulnerabilities in the context of climate risks, yielded the vulnerability hotspot map (Figure 21). More information on this exercise can be found in Appendix 9.

Kochi's Smart City Proposal (SCP) (KMC, 2016) aims at making the city connected and accessible, a city with vibrant identity, clean, green, safe and healthy and having inclusive smart governance. Key strategic focus areas include

- Urban transportation and mobility
- Solid waste, sewerage management

- Rejuvenation of water bodies especially canals
- Public spaces/open spaces
- Economic opportunity
- Intelligent government services

The proposal focuses its area based development on the transformation of seven sq. km of Fort Kochi-Mattancherry-Central City, linked by waterway. This will be done through multi-modal transport options, pedestrianisation and Non-Motorised Transport (NMT) friendly roads, rejuvenation of four canals and adjoining open spaces, inclusive essential services delivery to 100,000 citizens including 24x7 water supply, energy, storm water drainage, sewerage, housing, sanitation and solid waste management, restoring Fort Kochi as a Heritage area and re-configuring the City Centre as a commercial hub.

5.5.2 Mangaluru

Mangaluru's focus as detailed under the Smart Cities Mission proposal (2016) is to revive the City's role as a "place of confluence and exchange, re-orientated towards its core assets: the waters and its maritime-industrial strength, and updated to include efficient physical and digital networks for exchange". Mangaluru's status as an important port has built a cosmopolitan heritage with a diverse economy, characterised by fisheries, tile factories, boat-building, and a crucial connection with the Lakshadweep Archipelago. With the rise of typically service-based sectors such as Banking, IT, Healthcare and Education, the traditional primary and secondary industries declined. The Smart City proposal aims to revitalize these industries (Port, petro-chemicals, shipbuilding, manufacturing, food, fishing, traditional industries) balancing production and transportation with service and digital economies (IT, Education, Hospitality, Tourism, Healthcare). It also aims at crafting Mangaluru as a tourism gateway to the Malabar region.

Similar to other Smart Cities, the plan looks at how to balance policy with practicality in order to make the city liveable and sustainable. It identifies that encouraging collective civic development whilst simultaneously attracting investment in local industry, service sectors and tourism can address the demand resulting from increased growth. However, the plan only talks about scaling up infrastructure and economic development through improvements to certain sectors such as transportation, water supply and sanitation. It does not delineate plans or strategies to protect the city's natural ecosystems and resources or to scale up green spaces. Rather, it mentions that as part of tourism improvement, there will be some attempt to establish ecological protection standards for river, forest and beach areas. The detailed projects that are now being developed for implementation include development of water front gardens and green areas along the port.

5.5.3 Panaji

The Revised City Development Plan of Panaji, 2041 (MoUD and World Bank, 2015) marks the progression of Panaji's city administration towards a more sustainable development approach. The vision of the document is "To develop the city as clean, environment friendly and ecologically sustainable, with focus on improvement of the city urban infrastructure facilities, tourist infrastructure, conservation of the natural elements and heritage structures by adoption of eco-friendly alternatives and techniques". Sectors such as water supply, sewerage and sanitation, solid waste management, storm water drainage, traffic and transportation, urban poverty and slum improvement, local economic development, urban environment, social infrastructure, and heritage management are covered under the development goals to realize the CDP vision.

The Plan incorporated guidelines issued by the Ministry of Urban Development (MoUD) which include the following aspects:

- Formation of CDP Committees – Policy and Technical
- Inclusion of Heritage, Health and Education sector in the CDP
- Stress on infrastructure management aspects
- Outcome parameters of projects
- Revenue enhancement initiative, Expenditure management initiatives and Asset management initiatives
- Special emphasis on PPP projects
- Transit oriented development

Most of the area which falls under the CCP has already been urbanized and the city has been facing acute shortage of developable land at present with no scope for future expansion. Presently it has only 34 percent land under non developable land (CCP, 2016). Moreover there is no land available for the expansion of the present road network within the city. Traffic infrastructure is already overstressed due to lack of efficient and integrated public transport facilities, both within Panaji and connecting outgrowth areas. The city also struggles with meeting the needs of a significantly large daily floating population (nearly a third of its resident population). Like other Indian cities, there has been a poor devolution of powers to the city authorities. Jurisdictional boundaries and poor coordination between state and city authorities affects service delivery in Panaji. Most of Panaji's commercial activities are concentrated in its core area which leads to issues such as traffic congestion, problems due to on street parking, loss of pedestrian space, air and noise pollution. With the economy largely depending on tourism, the nature of the city and quality of life is changing accordingly, sidelining agriculture. As previously stated, due to unscientific planning and management of storm water drains, the city is extremely prone to flooding during monsoons, exacerbated during high tide

periods. Lack of an integrated approach to blue-green infrastructure planning increases vulnerabilities to climate change events and flooding.

According to the information gathered in 2015 by ICLEI South Asia under the UVA and ACCCRN project, Panaji's wards when overlaid with urban vulnerabilities in the context of climate risks yielded a vulnerability hotspot map (Figure 22). More information on this exercise can be found in Appendix 10.

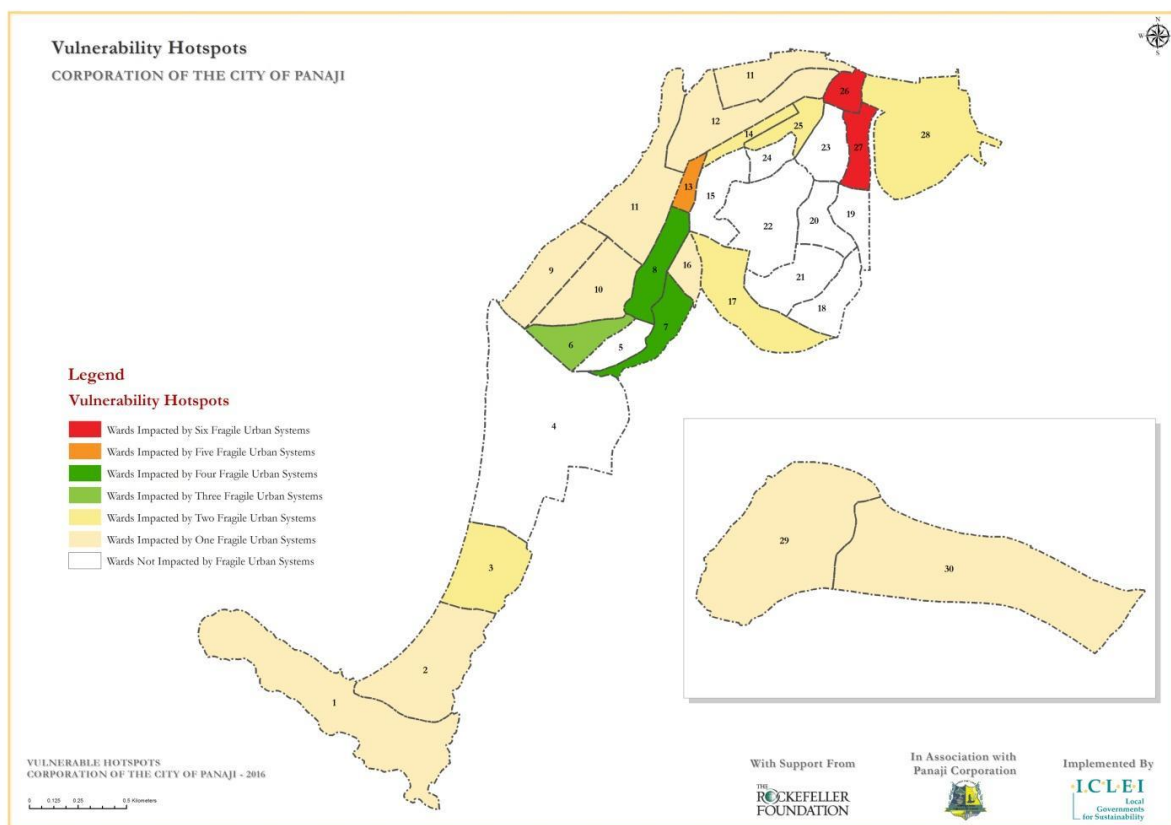


Figure 22: Vulnerability Hotspot Map, Panaji. Source: ICLEI SA, unpubl.

Under the Smart Cities Mission, Panaji's proposal (CCP, 2016) aims to identify pan city initiatives which will have city wide benefits as well as engineer specific solutions for area based development. The city has identified initiatives to address the following:

- Urban mobility including public transportation, waterways, pedestrianisation, walkability
- Solid waste management
- E governance and IT
- Economy and Employment
- Health and Education facilities

Some of the focus areas include smart parking with automated parking meters; part pedestrianisation-part cycle track provision for the Church Square roads, Patto

Cultural Zone for various cultural activities, improved quality of life for urban poor in the Mala heritage zone, and development of butterfly garden, bamboo corner, Mala Lake restoration, herbal garden and mangroves plantation in the city for biodiversity conservation. The SCP further addresses the aspect of inclusiveness, and basic services like roads, water, sewer lines, electricity, city transport and infrastructure.

6 STATUS OF BIODIVERSITY AND NATURAL ASSETS IN CITY-REGIONS AND ALIGNMENT WITH BIODIVERSITY PRIORITIES

6.1 City-region biodiversity profile

6.1.1 Kochi

Kochi has a tropical climate with abundant sun and precipitation. The annual variation of temperature in the Kochi region is between 22°C and 32°C. The maximum annual rainfall in the region is around 3,000 mm. Humidity is high round the year because of the nearness to the sea and due to the large area of backwaters in the region. The coastal tracts of Ernakulam district are prone to flooding. The KMC area falls within the coastal wetland zone and therefore water related disasters are encountered very often. KMC area being a flat land adjacent to the coast is subjected to floods during monsoon affecting normal life and disrupting traffic in the city.

The coastal region, Vembanad backwaters, estuary, mangroves, wetlands, fresh water ponds, Pokkali paddy field, other mixed cultivation, home gardens and public open spaces are the major biodiversity habitats of Kochi city. Kochi lacks a comprehensive biodiversity profile and a PBR has not yet been developed. The available data is limited to several study reports on Mangalavanam bird sanctuary, known as the lungs of Kochi city, which situated in the centre of the Kochi Corporation area (Jayson and Easa, 1999; Azeez and Bhupathy, 2006; Madhusudhanan and Jayesh, 2011). The other available references are the faunal diversity of the South Kochi (Thevara) by Abin and Samson (2014) and the Environmental Impact Assessment (EIA) report (2015) of the Multi-user Liquid Terminal (MULT) project of Cochin Port. Some of the information presented in the following section has been extrapolated from the district data.

Flora: An inventory of the flora of the Ernakulam district was prepared by Sunil *et al.* (2015) under a University Grants Commission (UGC) sponsored project. A total of 1,706 species belonging to 158 families and 866 genera were collected and documented during the study period 2012–2015. Poaceae is the largest family comprising 161 species followed by Papilionaceae (94 species), Euphorbiaceae (88 species), Cyperaceae (79 species), Rubiaceae (77 species), Acanthaceae (65 species), Asteraceae (54 species), Orchidaceae (47 species), Scrophulariaceae (41 species) and Convolvulaceae (34 species). Out of these 306 species are endemic to either the Western Ghats or Peninsular India and 108 species find a place on the Red List proposed by IUCN. 35 species of wild relatives of cultivated crops like piper, rice, ginger, nutmeg were collected and documented. A total of 56 invasive alien species belonging to 27 families and 48 genera are reported from the study area. Ernakulam district is also rich in wetland plant species including mangroves and coastal species. Out of the 16 true mangroves of Kerala, 14 are found in the district.

In Mangalavanam, the total number of plant species reported was 25 including four species of true mangroves. The vegetation of the Mangalavanam is dominated by *Avicennia officinalis* (IUCN status: Endangered), *Rhizophora mucronata* (IUCN status: Vulnerable) and *Acanthus ilicifolius*. True mangrove and mangrove associate species such as *Derris trifoliata* and *Acrostichus aureum* are also present here. Other plant species include *Alternanthera sp.*, *Azadirachta indica*, *Caryota urens*, *Ceiba pentandra*, *Coccinia grandis*, *Cuscuta reflexa*, *Enterolobium saman*, *Eucalyptus sp.*, *Ficus gibbosa*, *Hibiscus tiliaceus*, *Hydnocarpus alpina*, *Hygrophila sp.*, *Ipomoea sp.*, *Morinda tinctoria*, *Polyalthia longifolia*, *Pongamia pinnata*, *Tectona grandis*, *Terminalia catappa*, *Tinospora cordifolia* and *Woodina odiyari* (Jayson and Easa, 1999; Azeez and Bhupathy, 2006; Madhusudhanan and Jayesh; 2011).

A study of tree species in Subhash Bose Park, Kochi in 2017 by ICLEI South Asia (unpubl.) identified 66 species of trees in the park. From the EIA of the MULT project of Cochin port (2015) which surveyed a major part of the KMC, 91 tree species were reported.

Fauna: An invertebrate survey conducted in South Kochi (Thevara) reported 44 species of butterflies belonging to 36 genera and five families. Of these, 45 percent belongs to Nymphalidae family followed by Papilionidae (20 percent), Pieridae and Hesperiidae (14 percent), and Lycanidae (7 percent). The study also reported 10 dragonfly species belonging to nine genera and two families as well as five damselflies belonging to three genera of the Coenagrionidae family. A spider survey reported 49 species of spiders belonging to 39 genera and 13 families (Abin and Samson, 2015).

Sálim Ali Centre for Ornithology and Natural History (SACON) reported 17 species of butterflies in the Mangalavanam, of which 10 species belongs to the Nymphalidae family, four species to the Papilionidae family and three species belonging to the Pieridae family (Azeez and Bhupathy, 2006). A spider survey conducted in Mangalavanam during 2005 reported 16 families, 40 genera and 51 species from there. Araneidae was the dominant family constituting 12 species from eight genera. The Salticidae was represented by 11 species from 10 genera. At the species level, *Pisaura gita* was the dominant species (Sebastian *et al.*, 2005).

The vertebrate survey conducted in Thevara, south Kochi reported 44 species of fishes belonging to 40 genera of 35 families, four species of amphibians belonging to four genera of three families, 14 species of reptiles belonging to 13 genera of 10 families, 57 species of birds belonging to 46 genera of 29 families and 10 species of mammals belonging to 10 genera of seven families (Abin and Samson 2015). During the field survey in Mangalavanam during February 2002 by SACON, a total of 74 species of vertebrates were recorded. It included two species of amphibians (*Limnonectes limnocharis* and *Bufo melanostictus*), five species of reptiles (*Calotes versicolor*, *Hemidactylus frenatus*, *Mabuya carinata*, *Sphenomorphus sp.*, and *Xenochrophis piscator*), and five of mammals (*Pteropus*

giganteus, *Kerivoula picta*, *Lutra* sp., *Bandicota indica* and *Funambulus sublineatus*). The dominant vertebrate fauna observed was birds. A total of 398 birds belonging to 62 species were observed during the survey. Aquatic forms numbering 20 species contributed to a majority of the bird population. In earlier records of Mangalavanam (Jayson and Easa, 1999), the total number of bird species visiting the area was 72.

About 50 species of marine/estuary fish species, eight species of prawn, four species of crab and two species of clams were reported in the fish catch statistics of the region (EIA – MULT, 2015).

Vembanad Lake and its wetlands is the largest Ramsar site on the south west coast of India, and forms shallow estuarine network running parallel to the coastline of Kerala opening into the Arabian Sea, at Kochi and at Azhikode. Several economically important fish species are found in the lake such as cichilids (*Eetroplus suratensis*, *Eetroplus maculates*), cyprinids (*Labeo dussumieri*, *Puntius filamentosus*, *Amblypharyngadon microlepis*), mullets (*Mugil cephalus*, *Liza parsia* and *Liza macrolepis*), cat fish (*Arius maculatus*, *Arius subrostratus*, *Plicofollis platystomus*), crustaceans such as penaeids (*Metapenaeus dobsoni*, *Metapenaeus monoceros*, *Fenneropenaeus indicus*) and crabs (*Scylla serrata*, *Portunus pelagicus*). Eighty species of fin fishes, five species of penaeid shrimps, three species of palaemonid prawns and two species of crabs were reported (Asha *et al.*, 2014).



Figure 23: Pokkali Rice fields outside of Kochi city

The Pokkali system of rice cultivation (paddy and prawn culture) was carried out in the paddy fields in the city region but now the majority of these wetlands have been converted to other urban land-use, or some part is permanently used for prawn culture. Coconut is the commonly cultivated tree in the city region. Home gardens in the area also act as a good reservoir of biodiversity. One study in the nearby panchayats recorded 56 species of plant species in 168 surveyed home gardens (Sankar *et al.*, 2000).

6.1.2 Mangaluru

There is a lack of comprehensive studies on the biodiversity of Mangaluru. Isolated studies on invertebrates in neighbouring areas exist. A study by Vidya and Patil (2014) recorded the presence of 55 species of Foraminifera belonging to all the 32 genera 24 families in Chitrapu mangroves. A study (Ramachandra *et al.*, 2007) on the biodiversity of Tenka Yekkaru Grama Panchayat (in Mangaluru taluk) carried out over two days identified 187 plant species, 59 butterfly species of which two are endangered (Crimson Rose- *Pachliopta hector* and Daniad Eggfly-*Hypolimnys misippus*) and two are endemic (Malabar Raven-*Papilio dravidarum* and South Indian Blue Oak Leaf- *Kallima horsfieldii*) to the Western Ghats, 11 species of dragonflies and damselflies, six species of amphibians among which two are endemic to the Western Ghats (*Sylvirana aurantiaca* and *Philautus wynaadensis*) and one is endangered (*Philautus wynaadensis*), three species of reptiles, 55 bird species and seven mammal species. Data recorded on eBird (2018) reveals a total of 356 avifauna species from Dakshin Kannada district of which 80 percent of the observations belong to sightings in Mangaluru city. 56 percent of the species were sighted in Kenjar (in Mangaluru), an area which receives no protection.

An environment assessment report by Wilbur Smith Associates Private Limited (2006) listed some fish species found in Gurupur River-*Hyporhamphus limbatus*, *Puntius* spp., *Labeo* spp., *Valamugil* spp., *Leiza* spp. A number of estuarine species like *Gerrus filamentus* (Whiptail-silver -biddy), *Gerrusoblongus* (Silver -biddy), *Terapon puta* (Small Scale Terapon), *Stolephorus indicus* (Indian anchovy), *Horabagrus brachysoma* (Gunther's catfish) were identified in this assessment.

6.1.3 Panaji

Limited information is available for Panaji. The CDP (Ministry of Urban Development and World Bank, 2015) mentions a study conducted by the Goa State Biodiversity Board which recorded 404 species in Panaji city out of which 46 percent comprised of flora and 54 percent comprised of fauna. Out of the total species existing in Panaji, 14 species of fauna and 27 species of flora are accorded 'protected status' under the Wildlife Protection Act, 1972. The dominance ranking of third place for Ichthyofaunal diversity (fishes) is explained by the fact that the city has numerous aquatic species including lentic and lotic fresh water, back waters and marine waters. Herpeto-faunal diversity is moderate as these groups are affected by changes in microhabitat and microclimate, barring a few areas the city.

6.2 Ecosystem service appraisal

Stakeholder consultations on the present issues affecting the conservation of urban biodiversity in the city of Kochi have been carried out. Consultations were carried out in the form of workshops and interviews. Two critical ecosystems which were identified by stakeholders within and around Kochi City are mangroves and the city's backwaters which include a significant portion of

Vembanad Lake (called Kochi Lake). A workshop on understanding the ecosystem services provided by these critical ecosystems (backwaters and mangroves) was then carried out in the city. This section describes the outcomes from the workshop. For more information on the same, please refer to the workshop report prepared by Rhode and Balasubramanian, (2018) in Appendix 11.

Mangalavanam Bird Sanctuary, the biggest mangrove patch in the city and the Backwaters which comprise Vembanad Lake have already been described in detail in section 6.1.

Mangalavanam Bird Sanctuary is 2.74 ha. area comprising mangroves and a shallow tidal lake which connects to the backwaters by a canal, a symbolic relict of the original ecological set up of Kochi. The ecologically sensitive area contains biodiversity which is adapted to live in a tropical inter-tidal zone. The sanctuary is home to many native and migratory birds. A small population of butterflies and vertebrates is also found here. It serves as a main roosting site for flying foxes. Mangalavanam, also known as 'the green lungs of the city', is important in stabilizing the land along the coast and backwaters. The sanctuary is bordered by the Bharat Petroleum campus in the northeast, old Ernakulam railway station on the south and the National Institute for Oceanography (NIO) and the Central Marine Fisheries Research Institute (CMFRI) on the west. Significant threats to the site are dredging, filling, silt build-up, and waste dumping (mainly solid waste-plastics) clogging of the water body as well as continued construction around the core area.

The backwaters which primarily comprise Vembanad Lake which is a 900 km long intricate network of lagoons, lakes, canals, estuaries and deltas of several rivers that flow into the Arabian Sea. The lake forms the backwater network of several districts and cities including Kochi where it is called the Kochi Lake. The canals are used for navigation (as a national waterway) and they play a vital socio-economic and environmental role in the city. The backwater ecosystems help in controlling floods, preventing salt water intrusion, ground water recharge and serves as a breeding, feeding and nursing place of shrimps and fishes. It hosts about 100 native bird species, is an important site for migratory birds and supports over 20,000 waterfowl. Changes in land use, water and air pollution, improper disposal of waste and effluents, development of slums, and reduction of green spaces are the major causes of environmental degradation of the lake.

Based on the appraisal conducted by UFZ, Table 7 outlines the issues and role of ecosystem services within Mangalavanam as well as other mangrove patches and the backwaters comprising Kochi Lake (Vembanad Lake). Table 8 presents the relationship of human activities and actors with ecosystem services.

Table 7: Clarifying relevant issues and the role of ecosystem services (ES)

A. Clarifying relevant issues and the role of ecosystem services (ES) within Mangalavanam and other mangrove patches within Kochi's jurisdiction		
What are the important issues? Few mangrove patches remaining in and around Kochi, remaining ones tend to be degraded/polluted Mangalavanam a well-known piece of nature in city centre is increasingly polluted and disturbed	Which ecosystem services are relevant and connected to the issues? • Education (birds, biodiversity): nature interpretation center, education camps • Recreational use: nature walks (locals and tourists) • Aesthetic and inspiration for arts • Pollination through insects, birds and bats • Biological control of predator activities • Provision of food, raw material, fresh water and medicinal resources • Carbon sequestration • Prevention of erosion • Buffer against flood events • Prevent salt water intrusion • Local climate regulation and reduction of heat stress • Improve air quality • Water purification • Biodiversity habitat • Maintenance of genetic diversity	
	Where do trade-offs occur and how? Most trade-offs between polluting activities and ecosystem services	Where do synergies occur and how? Many synergies between the ecosystem services provided by healthy mangroves
A. Clarifying relevant issues and the role of ecosystem services (ES) within the backwaters (Vembanad Lake)		
What are the important issues? Pollution of the lake and canals (oil spills, waste, toxics from commercial activities and construction, sewage) harming biodiversity and human health Siltation from dredging / removal of silt by port harming backwater fisheries (access of fishers to the fishing ground) and aquatic ecosystem is	Which ecosystem services are relevant and connected to the issues? • Clean/fresh water provision (BUT drinking water for Kochi is coming from other source); • Provision of food: fish, grains, prawn, crabs, mollusks • Provision of raw materials: clam, sand, gravel, clay, calcium-carbonate, timber, fuel wood • Provision of medicinal resources, germ plasm, cosmetics and fertilizers • Water purification (reduced by too much pollution, close to tipping point) & phytoremediation of heavy metals • Mangroves as wind break protects local agriculture (paddy) • Mangroves prevent erosion and hold soil together • Mangroves provide storm and flood protection • Mangroves as breeding/spawning ground for fish • Carbon sequestration • Tourism: bird watching, boat tours, agricultural tourism picking	

distracted (microorganisms die) – no baits for fishing and as food source	up • Biodiversity habitat (incl. migratory species) and gene pool, RAMSAR site • Birds and insects as pollinators for paddy • Birds and frogs as pest control	
	Where do trade-offs occur and how? • Between polluting activities and ES • Between intensive agri-/aquacultural production and non-provisioning services • Between non-ecological aspects of tourism (e.g., oil spills, too high capacity) and habitat	Where do synergies occur and how? • Fishing and Pokkali benefits from water purification and healthy mangroves (windbreak, breeding and spawning ground) • Eco-tourism benefits from aesthetic value and habitat function

Table 8: Relationship of human activities and actors with ecosystem services

A. Understanding how human activities and actors relate to Mangalavanam's ecosystem services					
Which activities contribute to the provision of ES? (by conserving biodiversity or managing ecosystems) Who are the actors?		Which activities benefit from or rely on ES? Who are the actors that use or depend on ES and have an interest in their provision?		Which activities degrade or pollute ecosystems and/or deplete or harm the provision of ES? Who are the responsible actors?	
Activities	Actors	Activities	Actors	Activities	Actors
Mangrove management	- Coastal zone authority / Indian coast guard / Navy (national) - Protected areas managed by forest department	Fishing (mangrove for breeding and nursery)	- Fisherman and communities consuming fish - Fishing industry - Boat tour operators	- Cochin shipyard port activities - Kochi LNG (liquid natural gas) terminal construction for offshore storage and transport destroy mangroves	- Households with sewage - Constructors - Indian navy (dredging) - Indian coast guard (dredging) - Indian national railways (cut down mangroves)
Management and protection of Mangalavanam	- Kerala Forest Department - Kochi Municipal Corporation	Leisure trips, including boat tours (for pleasure, recreation, physical & Mental Health)	- Public visitors - Tourism operators - morning walkers	Incompatible land use in surrounding area (with high buildings)	- Corporation GCDA - Railway - Developers - High court - KMC - Govt. of Kerala - Private builders
Eco-friendly tourism	- DTPC - Private Agencies	Nature Camps and education activities	- Students - General public - Neighborhood - KFD	Light and noise pollution in surrounding area	- Local public and households - high court building - traffic
Research	- KFRI - CUSAT - SACON - Colleges	Climate protection efforts	- Agencies responsible for climate protection - Global community	Improper drainage system and destruction of natural drainage	- Govt. bodies - Local bodies
Buffer zone protection	Kerala State	Birdwatching	- bird watchers - tourism operators	Introduction of exotic plants and predators	- Forest Department - Natural invasion
Controlling pollution	- Kerala State Pollution Control Board - KMC			Waste disposal: toxic, solid and liquid	- General public - KMC - Businesses (for instance fishing net factory)
Regulations (CRZ/ RAMSAR agreement / Coastal zone management rule)	- Govt. of India - United Nations			Siltation of surrounding blocking tidal activities	- Public works Dept. - KMC
good railway stations (stopped)	Indian railways				

B. Understanding how human activities and actors relate to the backwaters (Vembanad Lake's) ecosystem services					
Which activities contribute to the provision of ES? (by conserving biodiversity or managing ecosystems) Who are the actors?		Which activities benefit from or rely on ES? Who are the actors that use or depend on ES and have an interest in their provision?		Which activities degrade or pollute ecosystems and/or deplete or harm the provision of ES? Who are the responsible actors?	
Activities	Actors	Activities	Actors	Activities	Actors
• Mangrove conservation, management (potentially also restoration, but not yet happening)	• Coastal zone authority • Indian coast guard • Navy (national) • Forest department • Private land owners • LLMC	• Tourism relies on attractive landscapes (boat tours), bird population (bird watching), clean water	• Boat tour operators • Bird watchers	• Crude oil transportation: oil spills from pumping and leakage	• Cochin shipyard port (port activities)
• Ecological agriculture (mainly traditional Pokkali)	• Farmers • Agriculture Dept. (via promotion and subsidies)	• Agriculture / food: production and consumption (local and export) • Paddy farming depends on pollinators	• Fishermen • Farmers • Local communities • Consumers • Government authorities responsible for fisheries	• Overfishing and destructive fishing (fishnet mesh size)	• Fishermen relying on the practices
• Community work on sustainable practices for clam and rejuvenated fish population	• Community-led enterprise-based conservation (ATREE)	• Eco-consumption	• Traditional Pokkali farmers	• (Overuse of) chemical fertilizer and pesticides	• Farmers relying on the practices
• Policies and legislation	• Government (at all levels)	• Fishing (subsistence, commercial, game fishing)	• Fishermen • Game fishing organizers	• Aquaculture monoculture (also with antibiotics)	• Fish farmers
• Social Forestry (Mangrove)	• Forest Department/ BMC/ local	• Germ plasm conservation		• Industrial discharge (incl. toxic waste)	• industries • New commercial activities at city outskirts
• Manual dredging	• KMC	• Industrial operations in the Kochi outskirts	• Industries	• Waste dumping and sewage disposal	• General population • Industries • Local authorities
• Waste Management	• KMC	• Biodiversity conservation efforts	• Environmental authorities and NGOs	• Shipping and dredging	• Port trust • Ship yard • Tourism boats
• Bank protection	• KMC	• Industrial extractive activities	• Cement and construction industry	• Legislation without scientific vision • Lack of clarity and violation of law	• Government • Policy makers • General public

• Wetland area monitoring	• Local level monitoring committee	• Recreation	• Local population and tourists	• Dredging	• Indian navy • Indian coast guard
• Legal monitoring of CRZ area	• KMC • District Collector	• Coir geo textile	• KMC	• Mangroves destruction	• Indian railways • Kochi liquid natural gas terminal
• Mangrove monitoring and research	• KUFOS • CUSAT • CWRDM	• Medicinal resources	• Pharmaceutical industry • Public health	• Oil spilling	• Tourism boat operators
• Water quality enhancement	• SPCB • CPCB • CUSAT • NIO • NGOs • Academic institutions			• Construction on the shores causing erosion ; conversion and filling	• Private companies • Private individuals • Constructors
				• Sand mining	• Local population
				• Un-authorized construction	• Govt. of India
				• Depletion of ground water	• Industries • Citizens • KMC

The following ideas (Table 9) were generated during the workshop and from expert consultations.

Table 9: Implementable framework of ideas to improve the ecosystem services of identified ecosystems

Idea	How to implement	Who could implement	Time frame
General			
Better waste management of solid, liquid, hazardous and biomedical waste	Decentralized management of organic waste at ward level; Insitu filtration effluent treatment plant at ward level; Amendment in Municipal Building rule, e.g. management system mandatory for shopping mall, buildings, hospital, industry	Govt of Kerala KMC SPCB Interact Bio Project	2 years
Monitoring & evaluation of wetland ecosystems and biodiversity hotspot (GIS based)	To identify ecologically fragile area and integrated to GIS platform; Regular monitoring surveillance using GIS mobile app or cloud; Establishment of a permanent monitoring station; Formation of task force	KMC Academic research platform, Cochin corporation, PCB state wetland authority, universities, fisherman communities	2 years – long-term
Policies to conserve and to restore green areas / trees in city	Mapping and monitoring of green spaces/trees inside Kochi; relate to heat stress and air pollution; awareness raising; find out which areas real estate are planning to buy and convert; discuss with builders the benefit of green spaces	KMC, NGOs, Research Institutes, Residents, Builders, Interact Bio Project	Long term
Increase environmental awareness / literacy creation from students to policy makers	Enhance capacity building, education & participation & awareness, including at all school levels, utilize ICT (effective) educational tools etc.	Govt India, Govt of Kerala, KMC, Community groups Local groups, NGOs, Research Institute, Interact Bio project	1 year – long-term

Idea	How to implement	Who could implement	Time frame
Zero waste disposal and discharge to the estuarine system	Proper implementation of waste collection and sewage treatment system	KMC, PCB	Long term
Ecosystem service assessment	Multi-disciplinary team conducted study	KMC lead (Support by ICLEI, etc)	2 – 3 years
Formulate and implement “green/sustainability” criteria for public buildings	Build on the “green audit” requirement for universities; check options to include criteria for all public buildings (schools etc.); check “green protocol” developed by KMC	KMC	1 year
Cleaning/desilting of canals and restoration of banks		INTERACT-Bio project, with KMC	1 year
Related to Backwaters (Vembanad Lake)			
Better support Pokkali paddy cultivation	Policy implementation and financial assistance for Pokkali farmers	Farmers, SHGs	Long-term
Management and action plan for policy formulation regarding Backwaters	Participatory process for shared vision, strategy, and action plan; Implementation through Acts, Rules, Notifications	KMC	1 year
Related to Mangroves			
Mapping of mangrove areas in and around Kochi, including ownership of land.		INTERACT-Bio project with KMC, KFRI, other research partners	3 months
Create network of mangrove landowners	Core group of mangrove stakeholders	KMC and other stakeholders	
Policies for protection of Mangroves	Bann cutting of mangroves through different legal and incentive measures	KMC, SHGs, Interact Bio Project	Long-term
Acquire private mangroves/ wetland area by state govt.	Implement GO (RT) 166/06/ forest dated 25 – 03 - 2006 Check exact content of legislation and amount of compensation ; contact Wildlife Trust of India on good practice experiences	Govt. of Kerala; KFRI	2 years
Specifically related to Mangalavanam			
Buffer zone and expansion of Mangalavanam protected area	Reclaim 7 hectares from housing corporation & add 10 h of marshy land	Legal notice Declaration	1 year
Stop Sewage flow into ecosystem	Sewage treatment plant at source; connect to other canals	KMC	Six months
Stop light and noise pollution	Antiglare windows and walls in all high rise buildings near to mangrove ; Establishing honking free zone	KMC	Three months

6.3 Approaches to land use and spatial planning, biodiversity mainstreaming and promoting ecosystem resilience

6.3.1 Land use and spatial planning

6.3.1.1 Kochi

Land-use planning in Kerala is primarily carried out through town planning schemes which have been prepared under the provisions of the Town Planning Act. The Government of Kerala recently enacted the Kerala Town and Country Planning Act, 2016 which is based on former acts- Town Planning Act 1933, Travancore Town and Country Planning Act 1945 or the Madras Town Planning Act, 1920. This has been discussed previously in section 4.3.2.

Development Plan for Kochi City region, 2011 – 2031: In 2005 under the Jawaharlal Nehru Urban Renewal Mission (JNNURM), Kochi prepared a CDP to be used as guidelines to prioritise the infrastructure development in the city region (Government of Kerala, 2006). Land-use planning, however, does not get prominence here. In 2011, KMC released its Development Plan for a plan period of 2011-2031. It was prepared under the old Town Planning Act and took into account some tenets laid out in the 2005 CDP (Department of Town and Country Planning, 2010). This Development Plan aims at planned development of the city and its surrounding region, promoting improvements and augmentation of infrastructure, compatible land utilization, and judicious use of the natural resources and conservation of natural and manmade heritage. The Plan aims at providing a framework to guide the development of the city region for the City Corporation, Municipalities and the Gram Panchayats included in the planning area.

The Plan proposes that the city region shall be comprised of Planning Divisions with Land Use/ Zoning Regulations suited to the divisions. Some mandates laid down in the Development Plan for each planning division includes the following:

- Ensuring effective housing and shelter options, focusing on the poor, marginalised and disadvantaged in the planning area by creation of adequate housing stock on either rental or ownership basis and delivery of serviced land, through Public Private Partnership.
- Conservation, development and management of natural resources and the related environmental infrastructure and services in a manner that would lead to optimization of use of natural resources and reduction/abatement of pollution and enhancement of their environmental value.
- Enforcement of strict land use control in and around environmentally sensitive areas

- Extending sewerage or a combination of sewerage and other sewage disposal systems to the whole of the planning area to reduce polluting of ground water and wetlands
- Implementation, maintenance of a comprehensive solid waste management system for the whole of the planning area and promote mass transport and pedestrian movements.

At present, the existing land use data for Kochi shows a dominance of the residential type (43.63 percent) followed by land occupied by agricultural activities and water sheets/marshy land (37.40 percent) (Department of Town and Country Planning, 2010). Recognising the importance of canals and backwaters, the CDP gives emphasis on the following:

- Water front development planning including rehabilitation of encroachers on public land
- Land use planning based on sound principles of planning
- Beautification of specific water front areas
- Water based recreational facility creation
- Creation of land and water based open space system and
- Enhancement of the use of waterways for tourism and inland navigation.

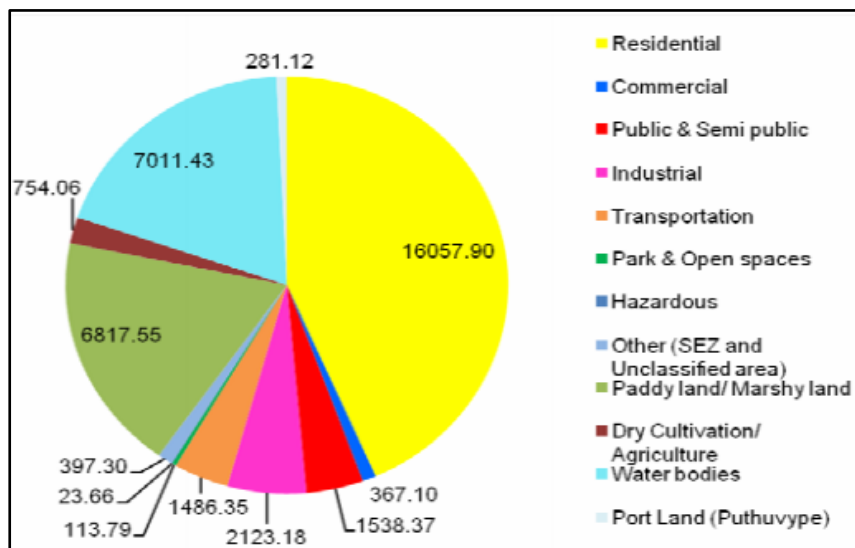


Figure 24: Land use of Kochi City Region (2009). (Source KMC, 2009)

Coastal Zone Management Plan (CZMP): A CZMP was developed specifically for Kochi in 2014 (National Centre for Earth Science Studies, 2014). However, other than a mention of the flouting of Coastal Zone Regulations in the Development Plan of the City region, the CZMP does not find much integration in the mainstream planning process.

6.3.1.2 *Mangaluru*

In Mangaluru, urban planning falls under the jurisdiction of the Town and Country Planning Department (TCPD) and Mangaluru Urban Development Authority (MUDA). Land-use planning takes place under the principles laid down by the Karnataka Town and Country Planning Act (1961) amended in 2015.

Guided by provisions under the Karnataka Town and Country Planning Act (1961), the Master Plan is a statutory document which guides urban planning for the LPA. It is considered an instrument to regulate the planned growth of land use and development. Earlier, the Act required the preparation of an Outline Development Plan (ODP) and then a Comprehensive Development Plan (CDP). The CDP included a Land Use Plan including zoning regulations and proposals for future development. The Act was amended in 2005 to provide for the preparation of a single Master Plan. However, the Master Plan has proved to be an inadequate instrument to fulfil the goals of planning for socio-economic development or regulating spatial development.

Master Plan (revision ii) 2011-2021: The Master Plan for Mangaluru (MUDA, 2011) is administered to a planning area which comprises the city corporation area, its outgrowths and two Municipal Councils (forming the Mangaluru urban agglomeration). According to the 2007 land use plan, a majority of the land-use in Mangaluru about 48.14 sq. km (37.5 percent) is residential. A sizable area of 20.55 sq. km (about 16 percent) has transport and communication infrastructure. Amongst the other prominent usages agriculture landholdings attribute to about 19.91 sq km (15.5 percent) (Land Use Plan, Mangalore Municipal Corporation, 2007). Over the years there has been a great deal of conversion of agricultural land into other uses at a rapid pace (Musthaf, 2011). The Master Plan focuses future development on industrial, transport and parks, play grounds and other open spaces land use. A large proportion of the open space areas fall under Coastal Regulatory Zones (CRZ –I,II&III) and Coastal Management Zones(CMZ) as required under the Environmental (protection) Act 1986.

CZMP: A CZMP was prepared for the state by the MoEFCC, Government of Karnataka State and the Coastal Zone Management Authority (CZMA) in 1996 like Goa. The new plan has been finalised but has not been approved by the Centre as yet (D'Silva, 2018).

6.3.1.3 *Panaji*

In Goa, urban planning falls under the jurisdiction of the Town and Country Planning Department (TCPD) and North Goa Planning and Development Authority (NGPDA). Land-use planning takes place under the principles laid down by the Goa Town and Country Planning Act (1974), amended in 2017. The Act constituted Planning and Development Authorities for divisions known as “planning areas”. These authorities are mandated to provide and enforce

Outline and Comprehensive Development Plans as well as the Town planning schemes.

The spatial planning of Panaji after the Portuguese colonial rule was carried out through zoning plans. However, it then followed the Outline Development Plan (ODP) which drafted by the NGPDA in 1989, revised later in 1997 and then in 2011. The ODP for the city governs land use of the city and had mapped the existing and proposed land use pattern in the city limits with all the amenities, road network, major natural features and building footprints. The ODP of 2011 had envisioned Miramar and Caranzalem as the main growth centres (NGPDA, 2011).

Holistic Development Plan, 2013: The Holistic Development Plan is a Master Plan (Goa State Infrastructure Development Corporation Ltd., 2013) which encompasses detailed plan proposals for the city in several identified geographical sectors of importance. The plan is a vision document for the year 2033 and has set out various proposals to manage and guide the future urbanization of the city. It has divided the city into six zones or sectors for purpose of detailed development. The major objectives are of the Master Plan are:

- To achieve a new mobility model in order to improve accessibility and everyday welfare for the city
- To provide more public and green spaces and improve the quality standards of the existing and the proposed spaces.
- To improve the standard of utilities and thereby ensure a sustainable and efficient city.
- To provide equipment network consistent with the city's main features and equivalent to current and future needs of the population.
- To provide a strategic plan for the conservation of cultural heritage and its promotion as a cultural resource for social and economic development.
- To provide a worldwide recognisable unique image through adequate city branding in order to attract quality tourism.
- To lay the foundations to achieve a long term habitable and sustainable Panaji City.

The local level land use planning and development control byelaws are controlled by the Outline Development Plan 2011 whereas the master plan will act as a revitalization plan and formulate recommendations on proposals that can serve as an instrument for transforming Panaji.

Panaji City Region is comprised of 66 percent developed area while 34 percent remains as undevelopable area. Residential areas form the main land use type (50.91 percent) with a high concentration of commercial land use within the core city area (15.45 percent). The undevelopable land comprises an eco-sensitive zone

consisting of four percent land under water shed, four percent land under conservation while 25 percent of the land comes under natural resources. The city lacks industrial set ups hence no land is under industrial land use.

Comparing land use in Panaji (CCP, 2006) with URDPFI guidelines (MoUD, 2015) in Table 10, we can see that in the case of residential, commercial and public and semi-public use the norms are exceeded while that of recreational and transportation land use is in adequate.

Table 10: Existing land use and comparison with URDPFI guidelines

Land use	URDPFI guidelines	Existing	Remarks
Residential	40-45%	50.91%	exceeds
Commercial	3-4%	15.45%	exceeds
Industrial	8-10%	0%	Nil
Public & Semi Public	10-12%	13.64%	exceeds
Recreational	18-20%	14.55%	no
Transportation	12-14%	5.45%	no

CZMP, 1996: A CZMP was developed by the Government of Goa in 1996 with the approval of the MoEFCC, however, its validity was up to January 2017. At present there is no CZMP in place as the draft plan is yet to be finalised (Shetye, 2017).

6.3.2 Biodiversity mainstreaming and promoting ecosystem resilience

6.3.2.1 Kochi

The biodiversity and promoting ecosystem resilience projects of KMC mainly focus on the promotion of integrated or organic farming, maintaining of public open green spaces like parks public ground, public pond conservation, tree planting and awareness programmes. Over the last three years, 1-2 percent of the Corporation budget is set aside for these activities (PFE Reports 2014-2017).

In November 2016, the Kerala Government launched Haritha Kerala (Green Kerala) mission which envisages pollution-free water sources, revival of water sources, water conservation, eco-friendly and sustainable waste management, and organic farming. In that vein, KMC started a programme (2016-2017) called 'Jaiva gramam' (organic village) promoting organic farming within neighbourhoods.

Within educational institutions, numerous clubs such as nature clubs, biodiversity clubs, agriculture clubs, environmental clubs, forestry clubs, Bhumitra Sena clubs, the National Service Scheme, National Cadet Corps have been constituted. Various activities organized by these clubs like afforestation and tree plantation drives,

bio waste management, organic farming and various awareness programmes tie up with the theme of biodiversity enhancement.

In Puthuvypeen, an upcoming major industrial area in Kochi, the State Government decided to set up a mega oceanarium project together with a Marine Biological Research Centre with the objective of imparting awareness on the marine resources of the Arabian Sea. The project so far has recorded 57 species of fin fishes, 19 species of crustaceans and 11 species of molluscs (Sahadevan, 2016).



Figure 25: Report in the local media regarding biodiversity mainstreaming activities of KMC (Source: The Hindu, 2018)

A major success of the INTERACT- Bio project is the mainstreaming of biodiversity management and conservation in urban planning in Kochi (Figure 25), which is exemplified through the incorporation of the following initiatives in the municipal budget for 2018-2019

- INR 1 million for biodiversity parks in 20 schools
- INR 0.6 million for mangrove park study
- INR 0.5 million will be invested in PBR development
- INR 0.5 million will be invested to develop a City Biodiversity Index

- INR 3 million for restoration of mangroves in Mangalavanam and development of a butterfly park in Subhash Bose park
- INR 1.5 million for high resolution mapping of natural assets and development of a GIS database
- INR 2 million for the development of an Ayurveda park in Fort Kochi
- INR 0.3 million toward tree plantation drives
- Awards for women farmer who adopt and develop good rooftop agriculture models
- INR 0.5 million for Resident Welfare Associations who work towards biodiversity protection and waste management
- INR 0.3 million for controlling invasive species
- INR 20 million towards restoration of Vembanad Lake (Kochi Lake)
- INR 200 million towards Chillavannur back water region protection

Kochi's SCP (KMC, 2016) has identified a number of initiatives which will receive funding within the city through the National Smart City Mission. One proposal which links with ecosystem resilience is the "Renewal of Open Spaces through rejuvenation of four canals and adjoining open spaces in their vicinity with green walkways". The proposal intends to rejuvenate existing canals and green spaces.

6.3.2.2 Mangaluru

Initiatives towards biodiversity mainstreaming as well as ecosystem resilience are limited in Mangaluru. The city's SCP (MCC, 2016) has identified the following initiatives towards greening the city

- 1) Development of waterfront gardens
- 2) Development of green areas along connector roads in the city

Pilikula Nisarga Dhama (Pilikula), an eco-education and tourism development project undertakes some activities which promotes biodiversity conservation such as the establishment of a Biological Park, an Arboretum, and a Science Centre. For more information in the centre, refer to Appendix 12. The centre also organises regular training and awareness programmes for teachers, students and members of the public, on the conservation of biodiversity, heritage and culture. Ecoclubs have been formed in schools and colleges in the city.



Figure 26: Aquarium facility in Pilikula Lake and Boating Centre

6.3.2.3 Panaji

Local authorities in Panaji have recognised that the city is located in a CRZ and an ecologically sensitive zone. In the CDP of Panaji (MoUD and World Bank, 2015), an action plan has been chalked out to strengthen ecosystem resilience. Some measures include mapping and preparation of GIS based database of ecological features and eco sensitive zones, eviction of encroachments along the water bodies, implementing pollution mitigation policies and strategies, energy conservation and diligent impact assessment and monitoring for infrastructure projects. Tree plantation drives are carried out on a regular basis by CCP.

Panaji's SCP (CCP, 2016) has identified several initiatives which promote mainstreaming of biodiversity and ecosystem and climate resilience. This will be done through the following approaches

- 1) **Blue-Green Sustainability:** Adopting a blue-green sustainability approach, CCP envisions an integration of existing blue-green infrastructure with the built heritage and tourist destinations, integrated water resource management, improving native biodiversity and preservation of mangroves.
- 2) **Climate Resilience:** To build climate resilience CCP aims to adopt climate adaptive strategies and low carbon/emissions development such as investing in renewable energy and energy efficient infrastructure.
- 3) **Biodiversity Conservation:** The SCP has specifically taken up initiatives for ecological restoration of Mala Lake, biodiversity enhancement in Jogger's Park (by creating a butterfly garden and bamboosetum), documentation of existing biodiversity, mangrove plantation in creek area and development of future conservation leaders through a school program.

- 4) **Enhanced Green-Cover:** The Corporation aims to increase green cover by planting 5000 fruit bearing trees in the two sq. km. area of Patto and mangrove plantations along the Rua de Ourem creek.

6.4 Alignment with international and national biodiversity policy frameworks (NBSAP)

6.4.1 Kochi

Although the state of Kerala was the first in the country to complete the formation of BMCs in 2012 as per the Kerala Biological Diversity Rules, 2007, their functionality and effectiveness remains to be seen. Poor understanding of their mandate and responsibilities is a major reason affecting the working of the BMCs (Nandakumar, 2015). While it is reported that Kochi city has formed a BMC, the members have not met in over 10 months and no steps have been taken as yet to prepare a PBR of the city.

6.4.2 Mangaluru

The city of Mangaluru is yet to constitute its BMC.

6.4.3 Panaji

Panaji city has formed a BMC as per the Goa Biological Diversity Rules, 2017, and had engaged TERI to map and benchmark its biodiversity and collate knowledge of local biological resources on behalf of the CCP and the Goa State Infrastructure Development Corporation (GSIDC). The outputs of the project are expected to be a PBR and City Biodiversity Index. However, the project is facing delays due to administrative and logistic issues (The Times of India, 2018).

7 DRIVERS OF CHANGE

7.1 Rapid urbanisation

7.1.1 Kochi

Kochi is in the most urbanized region of Kerala- Ernakulam District where the percentage of urban population (47.56 percent) is far beyond that of the state (25.96 percent). Kochi City Region which forms the core area of the district holds more than one third of the district population. It also continues to be the state's fastest growing region. As discussed previously, the urban sprawl of Kochi has extended beyond its city boundaries to adjacent areas of Thripunithura, Eloor, Kalamassery and Thrikkakkara, forming Kochi Urban Agglomeration.

The influence of the development in the city and the immediate surroundings extends much further than just the district. Studies on the developments that have taken place in the above wider region around Kochi, during the last two decades, show that the influence region around the city (depending on the activities in the area which have immediate dependence on the city and the activities that directly affect the development of the city and the area around) extends up to the towns of North Parur and Kodungallur in the north, Angamali town (transcending the towns of Kalamassery and Aluva) in the north-east, Muvattupuzha town (including Kothamangalam town situated close to Muvattupuzha) in the east and Cherthala town, in Alappuzha district, in the south.

As part of the preparation for a Development Plan for Kochi (Government of Kerala, 2006) in 2006, the Centre for Environment and Development (2006) found that land-use maps of 1967, 1988 and 2005 indicated a considerable increase in built up area by way of conversion of the natural vegetation in the land and low lying and cultivated areas. The city's low lands which were used for paddy cultivation are steadily being lost to reclamation. The iconic canal system which was used for navigation now functions as either as wastewater drains or has been encroached upon. All of these changes have exacerbated flooding and water logging within the city. The foremost environmental issue for most of the urbanised areas of the state is water pollution. Degradation of aquifers and rivers is due to release of effluents (agricultural, industrial and domestic), over-extraction of ground water and saline water ingress. Another urban issue is solid waste management. Most of the waste is either dumped in landfills or on the road sides, drains and canals. Slums mushrooming around narrow streets and canals combined with the lack of awareness on hygiene have created large scale environmental problems for the Corporation to deal with.

According to the Town and Country Planning Department, Kerala (2010), in order for the city to grow and develop sustainably it needs to address the following issues

- **Unplanned urban sprawl:** With Kochi's unplanned urban sprawl into surrounding environs come problems of infrastructure and services. This further increases dependence on the city putting pressure on traffic resources and other urban services as well as leads to unsustainable practices related to water and sanitation.
- **Traffic:** The city's road transport facilities are overstressed due to increasing traffic volume and poor traffic management. Public Mass Transport facility is not well organized and has a share of only 40 percent of all travels. Roads are not planned with drains or footpaths.
- **Infrastructure:** Water supply, sewerage, surface water drainage and solid waste management are services which are noted as highly deficient.
- **Water bodies:** Nearly a fourth of the city area is covered with water bodies. These are left out of planning and development processes which leads to their deterioration and encroachment.
- **Escalating Land Value:** Due to sky-rocketing land prices and a minimal level of Government interventions in the land market, a large number of people cannot afford land in the city. This contributes to the urban sprawl issue as more people buy property on the outskirts. It also impacts traffic volume into the city.
- **Environment:** Kochi's urban environment is declining at a fast rate. The total area of open/green space/park is only 0.65 sq. km which is less than one percent of the Corporation area. This is far lower than other Indian cities and what is required (the minimum requirement is at least 9 sq. m. per person according to the World Health Organisation). Regulating domestic (sanitation especially) and industrial activities and increasing healthy green spaces can strengthen environmental services and functions.
- **Informality:** see section 7.2.

7.1.2 Mangaluru

Mangaluru has always enjoyed an important position economically in the state with its prowess in banking, being at the helm of industrial growth and a port town. Urbanisation and industrial development have gone hand in hand and the city (including the Municipal Corporation area and outgrowths) has seen 12.66 percent of a growth rate in the last decade, the highest in the Dakshin Kannada district (Census, 2011). According to the Karnataka District Handbook (*ibid.*), a corresponding decline was seen in Mangaluru taluka's rural areas with a negative growth rate of about 25.46 percent.

While the city's fast paced growth, industrialization and modernization, has positively impacted its image as an attractive real estate destination in Karnataka it has

also resulted in a number of hazards within the surrounding urban environment (Musthaf, 2011). Urban sprawl is in the direction of the north and north eastern sides along the industrial growth corridors of the city. Commercial growth is predominantly towards the eastern side. The southern part of the city has various resorts exploring the water front potential. Unable to match up with increased growth and urbanisation, there has been greater pressure on the existing urban water supply and sanitation systems. In fact, Mangaluru with its rapid growth and associated urban environmental problems of industrial pollution, solid waste and sewerage disposal has been posing serious threat to the coastal ecology (Sastry, 2006). Moreover, rapid urbanization, industrialization, maritime transport, marine fishing, tourism, aquaculture and the setting up of special economic zones have led to a very significant increase in demand for infrastructure, resulting in over exploitation of coastal natural resources. Expanding infrastructure facilities is leading to agricultural land conversion into built-up areas. This is more pronounced in areas adjacent to industrial centres and fish landing centres (Government of Karnataka, 2003).

The increased volume of intra-city vehicular traffic in the past few years has caused severe stress on city's transportation systems especially since there is limited scope for further road widening of the narrow streets of the old city. There have been limited studies on the impacts of urbanisation especially on the ecology and ecosystems of surrounding environments.

A study (Thukaram *et al.*, 2014) on the land use land cover change detection for urban planning of Mangaluru attempted to analyse the contribution of urbanisation on temperature distribution in the city. It found that like most cities, Mangaluru was an urban heat island. This temperature increase will be further compounded by change in precipitation pattern and will impact liveability and municipal services especially water supply.

7.1.3 Panaji

Urbanization and a lack of developable land within the city have led to a commercial ribbon-development along the NH17. The CDP (2015) classifies this as an undesirable trend, which needs some measure of control. Another trend that is emerging due to unplanned urban growth is that of a conurbation between Panaji and Mapusa diminishing the rural-urban distinction. The residential character of the city has shifted to commercial and institutional since it is the state's administrative and economic hub. The popularity of Panaji as a tourist destination has resulted in a large floating population and a proportional increase in commercial establishments aimed at tourists. At the same time, slums have also sprung up. Residential areas have moved to the city's outgrowths due to the high real estate price, congestion and densification.

Population growth, coupled with growing industrialization and modernization is leading to rapid urbanization which has contributed to urban environmental hazards. Panaji is located in an eco-sensitive zone and due to high urbanisation and

land reclamation for development the city's ecosystem is extremely threatened. This in turn has lowered the city's resilience to various natural disasters whose frequencies are increasing as a result of climate change. Loss of green spaces due to illegal constructions, inefficient basic service provision, and growth of urban slums in an unplanned manner are by-products of urbanization. Large tracts of ecologically sensitive areas/ecosystems, i.e. mangroves, sand-dunes and *Khazan* lands mangroves and sand dunes are being lost due to encroachment and conversion of land.

The St. Inéz Creek is a significant part of Panaji's natural drainage system. It carries the city's storm water into the Mandovi River which ultimately opens into the sea at Miramar. The carrying capacity of this drain has been affected due to encroachment, siltation and pollution as it receives a large part of the city's untreated sewage and garbage (ICLEI SA, unpubl.). This leads to flooding in some parts of Panaji during heavy precipitation events in the monsoon. A large number of mega-projects coming up in the area will only heighten the problem. Urbanisation, tourism and construction are not only affecting the creek but also the sand dunes which exist in a stretch of about 4.5 km from Miramar, Caranzalem to Panaji and the mangrove forests and marshland around Santa-Cruz, Patto Plaza, and Mercês. All these areas are being reclaimed and transformed into housing complexes, private garages and commercial units.

7.2 Informality

7.2.1 Kochi

Economic opportunities in Kochi and its surrounding areas attract a large floating population in the form of daily wage earners, migrant workers and construction labourers. A majority of the urban poor work in unorganized informal sectors like fishing, scrap collection, construction work, cloth selling or work as vegetable vendors, coolies, and carpenters. These informal activities are mainly concentrated around the major road network in the city such as road margins, foot paths, spaces in small market areas especially in areas such as Shanmukham Road, Broadway, and M.G. Road. The percentage of population below poverty is higher in the coastal areas, where fishermen constitute a major share. This demography faces the problem of seasonal unemployment and threats to potential earnings due to changing technology, climate change and depletion of fish stocks in rivers and seas.

A lot of the informal activities take place on public land leading to unplanned development in these areas, a lack basic services and lead to insanitary conditions.

7.2.2 Mangaluru

Mangaluru is emerging as an industrial city and its commercial importance is increasing. A booming economy also supports large segments of informal sector activities.

Some of the big sectors providing informal employment are construction, beedi – making, incense sticks, brick kiln, garbage collection, shoe repairing, catering and vehicle repair workshops. The construction sector however employs the largest proportion of workers as it is a labour intensive industry (Bhat, 2011). The effects of informal settlements in the city on its natural resources have not been documented.

7.2.3 Panaji

Goa is the premier coastal tourist destination in the country and as a result, tourism has emerged as the primary contributor to the economy. This has also provided economic opportunities and occupational avenues for a large number of people in the informal sector. There are eight locations which have a proportion of the population living in slum like conditions- Santa Inez creek, Altinho, Caranzalem, around Mala Lake and Cabo Fort. With the absence of basic amenities, like sanitation, open defecation is common and waste water and solid waste is directly disposed off into the Patto nala, Fort tank and Mala Lake. Other impacts of informal settlements have not been quantified in Panaji.

7.3 Solid waste and effluent

7.3.1 Kochi

The city region of Kochi produces an estimated 670 tons of solid waste per day. The waste is primarily organic (around 48 percent) (Department of Town and Country Planning, 2010). There is a lack of a proper scientific management system for solid waste in the city region. Other than some small-scale efforts, most of the waste is dumped by households on the side of roads, in canals, vacant plots and estuarine fringes.

The area under KMC generates around 350 tons of solid waste daily (ICLEI SA, unpubl.). Households and small shops contribute about 67 percent, markets (vegetable, fruits, and meat) about 10 percent, hospitals and health care establishments another 10 percent, and hotels and restaurants the remaining 13 percent. Only 50 percent of waste is collected at secondary collection points and transported. The remainder is dumped on road sides, vacant plots and water bodies. Container lorries and trailers deposit the collected waste on municipal land at Willingdon Island, Cheranellur, and Brahmapuram (Government of Kerala, 2006). Dumping of waste at Cheranellur was discontinued due to protests from the locals.

Lack of designated waste disposal sites and an inadequate collection and disposal system pose chronic challenges for health, sanitation, and environmental degradation. The unscientific practice is leading to increased reports of air and water borne diseases. Even though Kochi has seen significant improvement in door-to-door collection efforts through the *Kudumbashree*, the cost recovery is limited as the user charges are retained within the collection agencies (GIZ,

2010). The challenges with respect to littering and in waste recovery/ safe disposal are also persistent.

In summary, the present situation (Department of Town and Country Planning, 2010) of the SWM system can be attributed to the following:

- Inadequate storage and segregation at source
- Open dumping/littering behaviours and lack of involvement of the community
- Bio-medical waste gets mixed with general waste
- Insufficient transportation resources
- Long term, secured disposal sites are not available

In the 1970s, a sewage scheme was commissioned which envisaged coverage of the entire city. Unfortunately, it could not be implemented and today, only three percent of the total area in the heart of the city i.e. General Hospital area (2.5 sq. km) and Gandhi Nagar (1.50 sq. km) is covered by the existing sewerage system (Department of Town and Country Planning, 2010). A Sewage Treatment Plant (STP) of 4.5 MLD capacity commissioned in 1955 which treats sludge, is located at Ernakulam. A high ground water table and flat terrain are major obstacles which impede the implementation of a centralised sewage system.

Sewerage service levels in Kochi have not kept pace with the growth of the city and fall below service level norms. The corporation therefore depends on on-site disposal of toilet waste and open surface drain disposal of sullage. In areas which do not suffer from water logging, have good soil permeability and low population density, onsite options like septic tanks with twin pits are good options (GIZ, 2010). This unfortunately cannot be applied to the western coastal parts of the Kochi City as the area is often flooded during monsoon. Service provision for the cleaning and ongoing maintenance of the septic tanks is done by private sector providers who have no scientific or technical knowledge of the management of sewage. These providers illegally release the sewage into water bodies and open spaces (ICLEI SA, unpubl.).

Effluents from toilets are commonly seen overflowing into drains, backwaters and rivers in the region. In the monsoon, sullage mixes with rainwater and contaminates drinking water. In summer, stagnating sewerage having high Biological Oxygen Demand (BOD) levels in open drains provide excellent areas for mosquito breeding. Besides, there is a prevalence of water /excreta related diseases like typhoid, gastroenteritis, diarrhoea, amoebic dysentery etc. (USAID, 2003). It is estimated that in Kochi City about 85,000 septic tanks discharge to open drains (Department of Town and Country Planning, 2010).

According to the Development Plan for Kochi City, (*ibid.*), the major issues emerging are:

- The ground water contamination from on-plot systems. The contamination leads to health issues in dense urban pockets in west Kochi.
- The contamination in open drains, canals, back waters and rivers caused by the combined flow of sullage and storm water. Combined drains are often difficult to maintain in a situation as in flat terrain areas of Kochi city region.

Coastal pollution around Kochi is mainly due to pollution owing to the population, discharge of industrial effluents, and indiscriminate use of agricultural chemicals. The lack of a sewerage system and improper management of septic tanks has led to freshwater, seawater and ground water pollution (GIZ, 2010). Kochi also faces seawater ingress due to the over-extraction of its aquifers. The sanitary system of Kochi, combined with the intrusion of salt water contributes to the degradation of the local water system.

Commercial waste is mostly directed to open surface drains. Industrial units located on the water fronts and river side release a load of effluents into the backwaters of the city. It is estimated that nearly 260 million litres of effluents reach the estuary daily from the industrial belt of Koch (Department of Town and Country Planning, 2010). The continued effects of all these factors result in the abuse of water courses, environmental deterioration and public health hazards.

7.3.2 Mangaluru

According to Mangaluru's City Sanitation Plan (CSP) (Government of Karnataka, 2010), the city generates about 260 TPD waste with a per capita waste generation of around 0.45 kg per day. Of the total waste generated per day, 90 percent collection takes place, according to the plan. A large proportion of the waste is organic in nature (approximately 60 percent). In some cases primary waste collection is done by private parties against certain fixed user charges while the other households manage their waste by dumping it at open spaces, community bins or secondary collection points. Door-to-door collection is practiced in about 30 areas through the support of *Nairmalya Samithi*. The total number of households serviced by the door-to-door collection in the MCC area is 26,186 (56.4 percent of 2011 population). In 2015, MCC introduced waste segregation in five wards (wards 26, 27, 28, 35 and 41). Collected waste is transferred to processing facilities of MCC i.e. aerobic composting and vermi-composting or scientific landsite for final disposal (Sequeira and Chandrashekar, 2015) which is about nine km away. The informal waste recycling sector in Mangaluru, like many other cities in Asia, has an extensive presence and plays a vital role in minimizing the quantity of waste requiring management by the formal sectors. Since a large percentage of the households of the city are not covered by appropriate collection infrastructure, waste

which is dumped in open spaces tends to accumulate in drains reducing their capacity and impacting health.

To reduce the burden on the centralized processing plant and sanitary landfill site, MCC constructed a bio-methanation plant in Urwa market as a pilot. It generates 150-160 m³/day of gas and 100 -120 Kg/day of manure. It is proposed to utilize the gas for generating power to illuminate the market (MCC, undated).

A majority of households in Mangaluru is still dependent on septic tanks. In 1961 a sewage scheme was introduced which resulted in the construction of the underground drainage system (Government of Karnataka, 2010). The underground system is 138 km in length and is divided into two major parts i.e. Mangaluru old town area and Surathkal area. Only 25 percent of the population is covered by this system. Grey water from most of the households passes directly into the public drains. MCC has three suction machines and three cleaning equipment which are used to clean the septic tank sludge from the households. The machines transport the sludge to the Kavor wet well from where it goes into the STP there. The city generates about 68 MLD sewerage from existing network out of which only 28 MLD reach the STPs.

Municipal and sewage waste has been identified as one of the major sources of delivering pollution load into the Arabian Sea through rivers and drains (Andrade *et al.*, 2011). The pollution load includes runoff of the sediment, waste from oil refineries, nutrients and pesticides, iron-ore residues from the nearby iron-ore industry and chemicals from the chemical factories. The beaches of the city are littered with plastic and other waste. According to Reddy (2010), in near shore and estuarine waters, pollution generally extends up to 5 km, sometimes 10 km from the shore. The nutrient content and coliform count has been found to be relatively high in estuarine waters. Additionally, bioaccumulation of pollutants in aquatic organisms, such as *Perna viridis*, and *Villorita cyprinoids* has been noticed.

7.3.3 Panaji

Panaji city generates around 72.2 TPD of waste which includes 37 percent biodegradable, 17 percent non-biodegradable, 34 percent construction and demolition waste and 11 percent garden waste (Kumar, 2016). The per capita waste generation is 619 gm which is quite high. This may be due to the high percentage of floating population in the city. Source segregation is a common practice followed by local households, commercial units and institutions. The waste is generally segregated into wet and dry which is further undertaken in various waste streams (such as plastic, paper, metal and glass bottle) at material recovery stations. Wet waste goes to decentralized composting stations. Door to door waste collection as well as collection from the community bins occurs every day. Only 60 percent (MoUD and World Bank, 2015) of the residential complexes are covered under four-way dry waste segregation. Construction waste is quite high and amounts to approximately 25 tons on an average per day.



Figure 27: Solid waste lies discarded by the river side

Insufficient composting units, insufficient land to set up new composting units, odour emanating from the units and difficulties in their management/monitoring are posing problems in the processing of organic waste within the city. The sorting centre currently used for non-biodegradable waste (dry waste) is not sufficient for the quantum of non-biodegradable waste received at the centre and not efficient, being completely manual in operation. The biggest issue however remains that residents, the floating and tourist population have poor civic sense (ICLEI SA, unpubl.).

The city's sewerage system dates back to 1967 and only covers the core city area. Ribandar, Taleigaon, Dona Paula, Caranzalem as well as the adjoining outgrowths lack any connections with the central sewerage system, although, some of the wards in the outer areas of the city are partially covered. The uncovered areas depend upon the system of individual soakpits/septic tanks, direct discharge into the major drains and also open defecation to some extent. 87 percent of households have individual toilets, seven percent use public/ community toilets while 0.6 percent resorts to open defecation. The households which have access to individual toilets are either connected to the existing sewerage system (42 percent) or have individual soak pits/ septic tanks (58 percent). The sewage from the sewerage network is collected in three outfall drains which carry the sewage to the Sewage Treatment Plant (STP) located at Tonca area for treatment (MoUD and World Bank, 2015).



Figure 28: Slum toilets along the St. Inez Creek

There are 29 public convenience systems with a total capacity of 171 seats located in various parts of the city (*ibid*). Out of these, 25 public toilets are connected to the underground drainage network while four are still connected to the septic tanks. With the increasing tourist influx in the city every year there is a need to provide adequate number of public toilets at major tourist destinations within the city as well as in the core city area. Apart from this, the existing public toilets need to be improved to meet international standards.



Figure 29: Sluice pipes choked with plastic

At present only 8.0 MLD (67 percent) of sewerage is being collected and treated in the existing STP at Tonca of 12.5 MLD. The major natural drains in the city receive solid and liquid waste water affecting the flow and discharging polluted water into the river. According to a gap analysis conducted by CRISIL (2015), the city requires an additional sewerage network of 31.43 km and 8.73 MLD additional capacity of sewerage treatment plant by the end of 2041.

In the past, leakages have led to contamination of piped as well as ground water. Water pollutants create a wide variety of problems when they enter the food chain, posing potential health hazards apart from foul taste or odour in drinking water (ICLEI SA, 2013). Open dumping of municipal solid waste also blocks sewers and drains resulting in flooding and insanitary conditions.

7.4 Extraction of water and water quality

7.4.1 Kochi

Ground water is a natural resource, which, if managed effectively, can address the drinking water problem in the state to a great extent. However, over-exploitation of the resource is leading to the depletion of the aquifers and subsequent threat of saline intrusion. Across Kochi, a majority of the ground and surface water sources are saline or polluted, beyond the potable limit as per the standards set by World Health Organisation (WHO) and Bureau of Indian Standards (BIS). This is mostly due to salt water ingress and poor septage management practices. Water is sourced from the Periyar River which is 20 km away. Rural and urban domestic consumers depend on this protected water source for their drinking water needs (ICLEI SA, unpubl.).

Kochi has the unique characteristic of being the industrial and commercial capital of Kerala, having the highest number of wards (74) and is densely populated. Due to a high standard of living the estimated water demand is 200 lpcd (Department of Town and Country Planning, 2010) which is 65 lpcd more than the national standard of 135 lpcd. The quantum of water supplied varies from 165 lpcd to 138 lpcd (ICLEI SA, unpubl.) as per different sources. The CDP also estimates a gap of 135 MLD in supply.

Some amount of ground water is extracted to overcome the shortage of water mainly for non-consumption purposes. Large households or apartment complexes with only one connection, buy water from tankers. The Corporation therefore depends on three sources of water: Kerala Water Authority (KWA), a state department, groundwater and tankers. Scarcity of potable water (due to pollution and inefficiencies in use) is one of the most “urgent and visible sources of political discontent in the city”. The huge demand/supply gap is likely to widen drastically in future (GIZ, 2010).

The coastal areas of Kochi are characterized by a high density of population and paucity of good drinking water sources. Most of the ground water sources are heavily degraded due to anthropogenic factors, and so this population depends mainly on piped water supply and supply through barges and lorries. Presently, alternate strategies in the form of desalinization plants, dual pumping systems and adopting proper treatment methods for the reuse of water are being explored (Department of Town and Country Planning, 2010).

7.4.2 Mangaluru

The parastatal agency, Karnataka Urban Water and Drainage Board, is the implementing body for water supply and drainage schemes in the city. Mangaluru receives its water from the Nethravathi River through two water supply schemes.

The major issues with regard to the water supply are that the existing distribution system has become old and water losses in this system are high, almost 40 percent. Almost 34 percent of households still lack coverage. While water quality is acceptable, this is primarily due to the fact that water is treated at Water Treatment Plants. However, the Nethravathi's major source of pollution is the discharge of domestic sewage and industrial waste which has impacted its water quality (Government of Karnataka, 2010).

Like the other coastal cities, salt-water intrusion is also increasing (Reddy, 2010). Wells located in a radius of up to a kilometre from coastline in sandy areas and up to 500 meters from the tidal tract of estuaries in alluvial areas are contaminated by saline water. During summer this really impacts drinking water availability. Furthermore, indiscriminate withdrawal of water from the ground/wells leads to salinity ingress as the coastal alluvial aquifers are highly permeable and are in hydraulic continuity with sea / estuarine water. Given that there are large industrial establishments and about 10,000 small-scale industries including about 200 ice factories, large quantities of water are extracted at a very rapid rate. This exacerbates the problem. Though rainfall in the coastal zone is heavy, about 88 percent of it is received during four months leading to disproportionate run off. This, in turn, reduces the flow in rivers during non-rainy periods, and hinders proper flushing. Excessive siltation consequently raises the riverbed. The reduced flow enhances the saline water intrusion to far upstream. Increased salinity in the river stretches affects wells in the vicinity and alluvial tracts (Government of Karnataka, 2010).

7.4.3 Panaji

In Goa, the State's Public Works Department (PWD) undertakes the functions of provision of water supply to the city. Panaji city's water supply source is River Khandepar which is a perennial source covered under the regional water supply scheme from Opa water works. The raw water capacity of River Khandepar is 123.0 MLD while the quantity drawn at present is 115.0 MLD. Further augmentation from this source is not feasible in future (CCP, 2015). The present gross water supply to the city region is 308 litres per capita per day (lpcd). However these estimates cannot be considered as accurate as the substantial portion of the water supplied to the region caters to the floating as well as the tourist population.

Considering the population of Panaji as per Census 2011, the daily water supplied is substantially high when compared with the service level benchmark of 135 lpcd as prescribed by the CPHEEO. The existing water distribution lines in the city

are old, and comprise of asbestos cement or corroded galvanized iron (GI) pipes which are prone to leakage during other utility works in the vicinity. This leads to high water losses under Unaccounted for Water (UFW) (*ibid.*).

Groundwater in Goa is available at 5-10m in the Tiswadi Taluk (Central Ground Water Board, 2010) but in Panaji City, groundwater availability has been reported at 1 to 1.5m below ground level. Salt water intrusion has impacted the quality of groundwater available. Parts of Tiswadi taluk are also impacted by this problem, especially along the coast, along Mandovi River and along Zuari River.

Real estate development in Panaji uses pumps to extract large volumes of groundwater for construction purposes. This has further caused salt water ingress into the city and increased levels of salinity in groundwater. Salt water ingress due to groundwater exploitation is affecting the availability of drinking water in the city as well (ICLEI SA, 2013).

Given the current state of the system where there is already over extraction of water and supply is greater than demand, unsustainable management will lead to acute water scarcity in the future especially in the light of the increased temperature projections (ICLEI SA, unpubl.).

7.5 Extraction / over exploitation of natural resources

7.5.1 Kochi

As discussed previously, Kochi's back water and canal system, which have been providing the city with critical socio-economic and environmental services, have been suffering from inattention and apathy, land reclamation and encroachment, poor sanitation management and pollution. Mangalavanam, Kerala's smallest bird sanctuary, is surrounded on all sides by built up area. It faces issues of pollution, diversion of land and sedimentation. The lowlands of Kochi, were at one point used for paddy cultivation, specifically for Pokkali paddy. This form of cultivation was environmentally friendly, an important provider of livelihoods and played an important role in maintaining environmental quality. The practice has now been discontinued and the land converted for residential and commercial purposes (Joy, 2013).

7.5.1.1 Coastal Ecosystem

Backwaters: The first major anthropogenic activities on the Vembanad backwater system took place when the area was dredged and reclaimed for a major natural harbour and locating port activities. Willingdon Island was artificially created through reclamation in order to house the berths and wharves and other facilities. Further reclamation occurred to expand residential and commercial areas. Effluents from industries and households are released from Kochi daily. The total dissolved solid content of water in the lake ranges from as high as 53,750 mg/l during summer to 16 mg/l during the rainy season. Faecal coliform counts of up to 1,800/100 ml have been recorded in past studies (MoUD and World Bank, 2015).

Mangrove areas: The city has a number of mangrove patches but Mangalavanam, which is located behind the High Court premises, is considered as the city's lungs. It provides refuge in the form of roosting and breeding sites for avifauna in a crowded city like Kochi (Jayson and Easa, 1999). Mangalavanam is under threat due to urbanisation as well as development activities such as proposals for low-cost housing, a new dry dock, and revival of an old railway station around it. Sedimentation is the biggest threat to the area which has occurred due to developmental and construction activities. This as well as pollution due to effluents and solid waste from households and industries has affected the water holding area of the sanctuary and impacted the aquatic biodiversity (Karunakaran et al., 2015).

Canal System: Kochi's canal system has fallen into disrepair and some parts are nothing more than waste water drains carrying sewage and solid waste (ICLEI SA, unpubl.). Encroachment over the canals increases the frequency and intensity of flooding/water logging during the monsoons (Government of Kerala, 2006). Breeding of mosquitoes in the canals has led to the spread of dengue, malaria and other vector borne and water borne diseases in the city (Department of Town and Country Planning, 2010).

Lowlands and Paddy Fields: The lowlands of Kochi were originally under paddy cultivation. The practice of Pokkali which was common in these areas, has been in decline since the 1990s. Parts of the lowlands which are not under real estate are either uncultivated or have aquaculture ponds such as in Kannamkode and Chakkanattukari. The Pokkali cultivations in lowlands supplement wetland function by acting as storm water receptacle. It is also an extremely sustainable practice which supplements livelihoods in the area and is environmentally friendly. In its absence, the land in the area suffers from water logging.

7.5.1.2 Fisheries

Cochin Port Trust maintains the Cochin Fisheries Harbour which can accommodate around 60 deep sea fishing trawlers, 900 smaller fishing vehicles and country crafts. According to Ammini and Augustine (2003) this harbour contributed a total of 6-11 percent of the state's annual marine fish landings in 2002-2003. According to the Government of India, this figure was at 10 percent in 2004-05 (GOI, 2005). A large proportion of these landings were contributed by pelagic species followed by demersal groups and shrimp and other shellfishes. Figure 30 highlights the quantity of marine fish in tonnes which was caught between the period of 1971-2000. There has been a steady rise in fish landing until it peaked in 1992. The figures can be attributed to an increase in the number of trawlers and an introduction of seines, purse seines and an expansion of fishing area. There was a large crash in 1999 possibly because species were not able to recover from the destructive fishing practices. The major species caught were panaeid prawns, perches, oil sardines, cephalopods, mackerel and carangids (Ammini and Augustine, 2003).

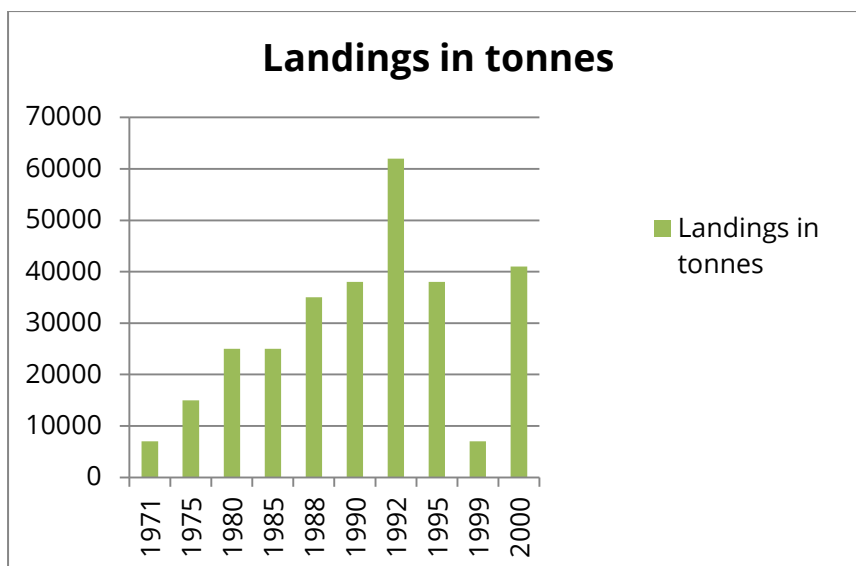


Figure 30: Fish Landings in Kochi Harbour 1971-2000

Nandakumar (2008) published annual landing data for major fishery species for the years 2000-2002 which shows the growth fluctuations among various species (Table 11).

Table 11: Total Annual Landings of the different fish groups at Cochin Harbour (2000-2002) (Source: Nandakumar, 2008)

Species	2000	2001	2002
Oil sardine	6,963	6,200	7,215
Mackerel	887	618	1,218
Penaeid prawn	11,203	5,920	9,255
Cephalopods	6,413	4,003	4,240
Threadfin breams	4,442	4,105	7,118
Ribbon fishes	3,640	3,963	3,235
Whitebaits	1,466	1,757	2,888
Lizard fishes	1,852	1,464	1,218

Vembanad Lake and its wetlands is the largest Ramsar site on the South West Coast of India, and forms shallow estuarine network running parallel to the coastline of Kerala opening into the Arabian Sea, at Kochi and Azhikode. Alterations in natural hydrologic regime of the wetland started with the commissioning of Thanneermukkom barrage across the backwater system in 1976, to prevent saline water intrusion, which adversely affected the eco-biology of the water body. Reclamation of estuarine areas for agriculture and other interventions has led to drastic decline in water holding capacity (2.4 to 0.6 km³) and depth (av. 4.02 m) of the estuary over the years. Padmakumar *et al.* (2002) documented the fishery decline in Vembanad wetlands. The annual landing of

finfish and shell fish (4387.31 t) in the Vembanad estuary during 2012–2013 period constituted 60.92 percent of the catch observed by Kurup *et al.* (1993) during 1988–1989. Analysing the fishery of both sectors of the estuary, the southern stations noted a radical decline in annual landings from 500 t in 1988–1989 (KWBS, 1989) to 486 t from 1995–1999 (Anon, 2001), to a slight increase up to 507 t during 2000–2001 (Padmakumar *et al.*, 2003) and further decline to 480.98 t during 2012–2013 (Asha *et al.*, 2014). In the southern zone of Vembanad estuary, 67 species of finfishes and 14 species of shell fishes were recorded during 2008–2010 (ATREE, 2012). The declining fish stocks in the estuary could be attributed to the lack of efficient fishery resource management. This said, there have been an increasing number of initiatives where the community with support from researchers has commenced setting up ‘fish sanctuaries’ that are ecological shelters for fish (Rajendran, 2018).

7.5.2 Mangaluru

Mangaluru city lies at the confluence of the two rivers Nethravathi and Gurupur. It also shares 22km of Malabar coastline with the Arabian Sea. Like Panaji and Kochi, parts of the city comprise estuarine, backwater, forest and coastal ecosystems.

7.5.2.1 Coastal ecosystem

Mangaluru is the industrial capital of Karnataka and as per its SCP, it intends on capitalising on this tag. In 2009, a study conducted by the Central Pollution Control Board (CPCB) brought out in their report, statistics which ranked Mangaluru among 43 of the most polluted industrial centres in the country. A lack of due diligence and poor regulation sees major industries and factories indiscriminately releasing pollutants into the sea either directly or through the Nethravathi and Gurupura rivers. The pollution load includes runoff of the sediment, waste from oil refineries, nutrients and pesticides, iron-ore residues, and chemicals.

In a study (Abdade *et al.*, 2011) of the coastal water pollution of Mangaluru, the pollutants encountered included both the biodegradable and non-biodegradable. The majority of the biodegradable waste included vegetable waste and dead fish/fish parts (due to fishing activity in the area). The non-biodegradable waste comprised plastic bags, cans, metal materials. Improper solid waste disposal and inadequate treatment of sewage contribute to the water pollution in urban areas. The Netravathi and Gurpur estuarine rivers are considerably affected by the discharge of sewage from Mangaluru city. The excessive input of nutrients is leading to eutrophication in certain arms of the estuaries.

In 2003, the Karnataka Coastal Management report (Government of Karnataka, 2003) documented that there was removal of clay from riverbanks and alluvial plains amounting to 3.2 million tons/year and laterite and hard rocks to 2.4 million tons/year adversely affect the carrying capacity of the State. Similarly silica and sand were being mined at 0.15 million tons/annum. In 2013, information from

the Department of Mines and Geology suggested that over 500 truckloads of sand are extracted in Dakshina Kannada every day (Belgaumkar, 2013). In 2015-2016 it was over 0.8 million tonnes of sand excavated. Conversion and reclamation of wetlands is affecting estuarine biodiversity.

7.5.2.2 Fisheries

The fisheries sector occupies major place in the growth and expansion of the city providing (direct and indirect) employment to a significant percentage of the population. Mangalore Fishing Harbour is one of the five major marine harbours of Karnataka state and contributes 35-40 percent of the total marine fish landings of the state. Mackerel, Sardine, Shrimp, Seerfish, Pomfret, Squid, Cuttle fish, Pink Perch, Crab and Ribbon fish are the important varieties traded here with a daily output of about 160 tonnes (Prasad, 2011). In terms of production within the state, Mangaluru is the highest. Figure 31 shows the annual fish landings per year from 2001-2010 made at Mangalore Fishing Harbour (take from Dineshbabu *et al.*, 2012).

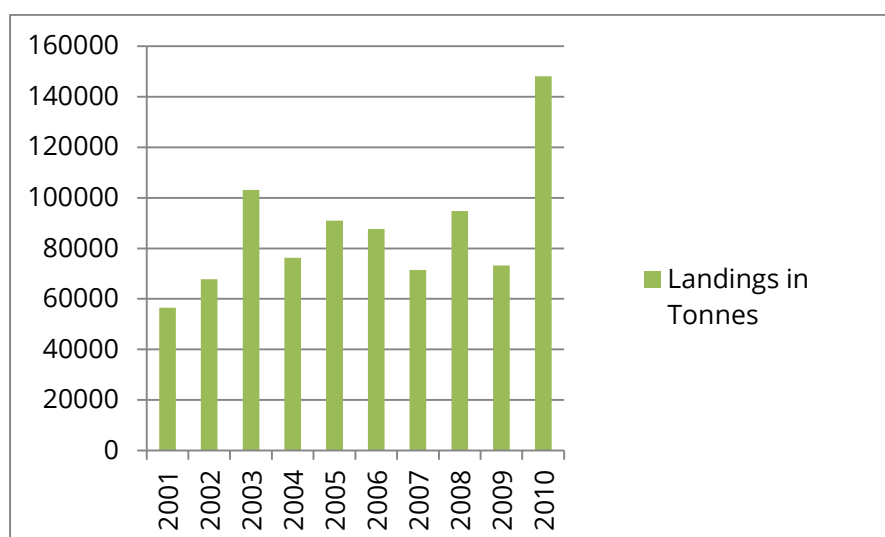


Figure 31: Marine Fish landings at Mangalore Fishing Harbour (2001-2010)

The trend is an increasing one. Of the amount, between the years of 2008-2011, it was estimated that the annual average catch by trawlers operating from Mangaluru Fisheries Harbour (southwest coast of India) was 124,105 tonnes. As current data for the harbour is unavailable, we cannot draw conclusions as to whether there is no impact of fishing and trawling along the coast from this trend. In a study by Dineshbabu *et al.* (2012) in 2008-2010, it was estimated that, in 2008-2009, single day operating trawlers (SDT) landed 3,515 tonnes of fishes, out of which only 64 percent were landed for edible purpose and the rest was rated as low value by-catch (LVB) used for miscellaneous purposes. Multiday trawlers (MDT) landed an estimated 220,678 tonnes of which 183,145 tonnes was retained for commercial purpose and 17 percent was discarded. From the discarded catch, 116 species of finfishes, 31 species of gastropods, four species of bivalves, seven species of cephalopods, 13 species of shrimps, three species

of stomatopods, 21 species of crabs, three species of lobsters and juveniles of unidentified sharks and rays were recorded. Juveniles of commercially important species formed 34 percent of the trawl discards by weight (44 percent by number) really impacting the coastal biodiversity. Another study by Sagar *et al.* (2014) found that the quantity of low value by-catch (trash fish) generated by trawlers of Mangaluru 32,426 tonnes (19 percent of the total trawl catch). According to the Karnataka Coastal Zone Management Authority, the marine fish production progressively increased up to 1996-97 (222,779 tons) and thereafter, showed a declining trend (152,500 tons in 2005-06) which remained more or less constant until 2010 when there was a sudden rise. Marine and estuarine populations are affected, including commercially important fish like the catfish (Reddy, 2010).

The stress on marine fisheries is mainly due to the confinement of fishing activity to the near shore zone upto a water depth of 50 meters. Trawlers further accentuate degradation of fishery. It results in the disproportionate destruction of non-target groups along with juveniles and sub adults of desirable fishes and other benthic organism. Most of the by- catches are of low economic value, but are vital for the food web consisting of marine shellfishes and fin fish (Government of Karnataka, 2003).

7.5.3 Panaji

Panaji city lies on bank of Mandovi River and, is surrounded with Zuari estuary, Mala Lake, Qurem creek and St. Inez drain. Salim Ali Bird Sanctuary, located in the village of Chorão, near Panaji, has rare and endangered bird species—both migratory and resident. The most prominent and extensive backwaters with mangroves are located along the east of the city.

7.5.3.1 Khazan lands

Akin to Pokkali fields, the *khazan* lands are saline flood plains in Goa's tidal estuaries (below sea level at high tide) which have been reclaimed over centuries with an intricate system of bunds and sluice gates. These areas lands are ecologically, economically and socially very important for both agriculture and pisciculture. Unplanned urbanization and poor regulation has given rise to uncontrolled construction and growth in and around these ecologically sensitive areas (ICLEI SA, 2013). Intensive agriculture and mining is also compromising the capacity of these wetlands to contain floods and excess storm water (ICLEI SA, unpubl.).

7.5.3.2 Coastal Ecosystem

The Mandovi and Zuari are two important estuaries in Goa, which are considered as lifelines of Goa's economy. The main channels of these estuaries span about 50 km long with a narrow channel, the Cumbarjua canal, interconnecting them. This demarcates the island of Panaji. A number of rivers/rivulets join these two estuaries. Throughout the course of these rivers an intricate system of wetlands, tidal marshes and cultivated paddy fields are found which are interconnected by canals, inland lakes, bays, lagoons and creeks governed by

regular tides. A luxuriant growth of mangroves is found bordering the estuaries thereby playing a major role in protecting the coast from heavy wave action and winds (GSCST, undated). The Mandovi River runs into the sea near Panaji. The river is getting silted at an alarming rate which can be seen from the large amounts of silt deposited near the Patto Bridge, requiring regular dredging. St. Inez creek which receives a lot of solid and liquid waste empties into the Mandovi River, polluting it further.

Panaji city had abundant lakes /marshy lands which acted as a buffer against floods in past years. However, these natural barriers have been shrinking in number and area over the years due to rapid urbanisation and increasing demand for developable land. The Ourém creek is located in the East of Panaji in an area called Fontainhas extending up to Mala and St. Cruz. The creek is dominated by mangroves on both its banks. Urbanization and construction in the vicinity of the creek is exposing it to increasing pollution (MoUD and World Bank, 2015). Garbage and sewage disposal is impacting the depth of creek and its biodiversity, impeding its functioning, and leading to flooding some parts of the city. The same can be said of the St. Inez creek which has become the receptacle of solid waste and sewerage leading to high levels of pollution and silt. Mala Lake has reduced in area from 70,000 m² to 15,000 m² due to reclamation of marshes and development in surrounding areas (*ibid.*). This has compromised its carrying capacity to retain water from the surplus flows of Altinho, causing floods in the area. The excess runoff from Altinho hills also causes water logging in low lying areas of the city. Further, the high tide line, springs in core area and backwater areas causes flooding of Mala Lake as the catchment area has been encroached upon.



Figure 32: State of St. Inez Creek in 2015

Low lying areas, the water balancing ponds at Portais, the mangrove marshlands at Mercês, Santa-Cruz and around Patto Bridge served a dual purpose, to receive and collect the river waters during high tide, as well as rain waters during

heavy monsoon showers. Several of these areas are being reclaimed. In Panaji, there are a large number of cases where coastal stretches have been subjected to the forces of erosion due to cutting down of mangroves for land reclamation (TERI, 2014).

7.5.3.3 Dunes

A stretch of about 4.5 km of sandy shore exists from Miramar, Caranzalem to Panaji city. Dona Paula - Caranzalem - Miramar (Mandovi estuary), and Dona Paula - Agassaim (Zuari estuary) are the main sand dune areas in the city. Due to urbanization and tourism, most of the dunes are rapidly being destroyed (TERI, 2014). At Campal, due to severe erosion, only a small portion of the otherwise quite extensive beach now exists. Taken over by developers, heavy construction activity is common along the coastal hill slopes. According to a report on the sand dunes of Goa by the National Institute of Oceanography (Mascarenhas, 1998), it has been observed that (i) construction of resorts and buildings, (ii) dune sand mining and (iii) roads in sandy strips are the major factors responsible for the large scale degradation and consequent elimination of sand dunes.

Some of the sectors in Goa that have had adverse impacts on the environment and natural resources are listed below.

7.5.3.4 Mining

While Goa was well known for mining, contributing nearly half of India's iron-ore exports, its impact did not receive too much attention due to the fact that it took place in rural part of the state. Mining operations took place mostly in the Western Ghats and forested areas. As a result Goan watersheds, groundwater aquifers, paddy fields and biodiversity have sustained terrible damage and degradation. The total forest area affected by mining during 1988-97 has been estimated at about 2,500 ha (TERI, 2012). The high overburden to ore ratio in the region makes waste disposal a problem and coupled with scarcity of land this becomes a major problem. As a result, the state accumulated 764 million tonnes of waste dump mountains, many over 30 metres high, in the mining taluks of Sanguem, Bicholim, Quepem and Sattari. The annual generation of waste is 123 MT which makes its way to the agricultural lands nearby through run off. Pollution of water resources is mainly due to dewatering of the mining pit water (to enable mining below the ground water level). Panaji's Opa Water Works have become silted from runoffs of these mining dumps (*ibid.*).

Mining areas have always been linked with very high levels of dust generated during mining and ore transportation activities. The level of particulate matter in mining areas has been found to be exceeding air quality standards with estimates of almost 38 percent contribution by the sector. Other than these, the sector also exhibits other concerns such as illegal mining, mine closure plans, and boundary issues with eco-sensitive zones. While mining might not be taking place within the city of Panaji, it has far reaching consequences. In

early 2018 the Supreme Court in a landmark decision quashed the 88 mining leases renewed by the Goa Government in 2015 to evade an amendment to mining legislation. The Mines and Minerals Regulation and Development Amendment Act (MMRDA Act of 2015), makes auctions mandatory for commercial mining of minerals like iron ore. While the decision brought some respite from environmental damage, there are many uncertainties which will only be resolved based on action taken by the government and other stakeholders (D'Mello, 2018).

7.5.3.5 Tourism

Mining and industries have had an impact on the environmental quality through generation of wastes and air pollutant emissions, however, tourism has had impacts on the coastal ecology and demand for natural resources not just in Panaji, but across Goa. Although significant to the state's GDP, the sheer influx of tourists within the state generates tremendous pressure on its resources. A promotion of coastal tourism has resulted in development of tourist infrastructure (legal and illegal) along the coast. As a result sand dunes, *khazans* and mangrove ecosystems have been severely affected (TERI, 2012). Development of shacks, lawns, and recreational activities on the beach itself is a major cause for the destruction of sand dunes and vegetation along the coast. The destruction of nature's first line of defence against the action of the tide, waves, and wind makes coastal areas susceptible to threats from sea level rise. Tourism-related infrastructure is also an important source of pollution, in terms of solid waste and waste water. Increasing waste generation in tourist regions and inefficient waste collection, transportation, and disposal facilities is contributing to poor waste management. Water consumption in hotels is quite high. The mismatch in infrastructure services too has contributed to poor management of waste and water resources. Reclamation of mangrove and *khazan* lands near the estuaries has impacted the food chain and breeding cycles of fish and shellfish.

Panaji is one of the prime tourist attractions in the state, being the administrative centre, having tourist infrastructure and good accessibility to other tourist destinations. The city's economy thrives on various economic activities supporting tourism sector. As per the data from Department of Tourism for 2011 the city of Panaji received 0.69 million domestic tourists and 0.45 million foreign tourists (Das, 2016). Here too there are significant impacts of tourism ranging from, unplanned high-rise constructions, construction along the riverside, encroachment onto eco-sensitive areas, destruction of mangroves and sand-dunes are common in the city. For instance, haphazard development of building along the river Mandovi at Panaji is a matter of great concern, which has affected the natural beauty of the river and caused water pollution. Insufficient waste facilities have impacted drainage in the city due to indiscriminate dumping in creeks and backwaters.

7.5.3.6 Fisheries

Fish is an integral part of Goan life, economically and socially. With booming tourism, migration, a shift to mechanization and climate change, the analysis of data suggests that catches have exceeded maximum sustainable yield, resulting in negative growth in subsequent years. The rich fish diversity of the Goan coast is boosted by high landing of penacid prawns. The estuaries of Goa are a rich source of different species of prawns (13 species) (Ansari *et al.*, 2006). High demand coupled with the fact that too many people are dependent on these resources has led to overexploitation.

Although statistics were unavailable for Panaji, the Marine Products Export Development Authority (MPEDA) statistics show a worrisome trend in marine exports from Goa, where seafood worth USD 93.38 million was exported in 2014-15. This figure decreased to USD 75.09 million in 2015-16. Overkill of fish for exports and to cater to the hospitality industry as well as rising sea temperatures has resulted in a fish famine of sorts in the waters off Goa, driving prices of locally consumed staple fish through the roof. According to fisheries department statistics, while 80,849 tonnes of sardines were caught in 2014, the catch dropped to 57,270 tonnes in 2015 and to a mere 6,481 tonnes in 2016. The same is the case with another staple, mackerel. In 2013, 12,994 tonnes were caught; the figure dropped to 10,308 tonnes in 2014 and further slipped to 10,876 tonnes in 2015. In 2016, just 3,908 tonnes were harvested. Other species like the cuttle fish or the silver belly have also shown a sharp drop in haul. Several marine experts have been warning the Goa government about how pollution near Goa's river mouths and in the waters off the state's coastline as well as over-fishing could create a fish famine in the state. Added to this is the fact that natural fishery habitats are getting destroyed due to anthropogenic causes such as trawling and irresponsible tourism (Sreekanth *et al.*, 2015).

PART D PROJECT INTERVENTIONS

8 RECOMMENDATIONS FOR CONCEPT PROJECT INTERVENTIONS

8.1 Policy instruments

For effective mainstreaming of biodiversity conservation and nature based solutions, inclusion of the same in city level planning is imperative. One of the most effective tools for this is the annual budget of the city municipal corporation. The project should aim to be able to steer such initiatives in all the cities (model and satellite). In the city of Kochi, the project has attained success in this regard. As a result of the interactions that we have had in the city in the previous year, the city authorities are now better able to understand the need for biodiversity conservation. This is reflected from the fact that the city has earmarked funds for several activities (see section 6.3) on conservation of urban biodiversity and sustainable utilization of the same in the budget for the financial year of 2018-19.

A road map on building green and sustainable cities through nature based solutions for each project city needs to be developed. This road map will consist of a basket of initiatives and interventions (short term implementation as well as long term implementation) that the city government can prioritize and take steps for implementation of the same. To support the cities in developing effective plans and implementing the same it is essential to create natural asset maps. These are non-existent in all the three project cities. These maps will give the city authorities an overview of the blue-green asset that the city has (in the form of a map, as well as in terms of percentage area of each). These will serve as baseline guidance tools for the city to base future planning on.

8.2 Vertical and horizontal integration

Vertical and horizontal integration is a major focus of the project. In the absence of effective vertical and horizontal integration, mainstreaming biodiversity conservation will remain a distant dream. This component of the project thus needs to be focused on in detail. In order to promote effective vertical integration, a project steering committee has been formed. The committee is headed by the Additional Secretary, MoEFCC, Government of India. Members of the committee include Chairperson of the NBA, representation from the three concerned SBBs and the three city municipal corporations, along with ICLEI South Asia. The member secretary of this project steering committee is the secretary of the NBA. This committee will meet at bi-annual frequency and discuss the project progress and issues and challenges.

Various stakeholder workshops and events are being undertaken in the model city in order to promote horizontal integration. Participation of members from various departments of the city local authority, NGOs, scientists and city councillors is ensured in all these events. More such events need to be organised at regular frequency during the course of the project.

8.3 Capacity building interventions

Extensive capacity building initiatives need to be undertaken in the cities. The city authorities and stakeholders in all the three project cities are not very well aware of the concept of ecosystem services and steps that can be taken to promote integration of nature based solutions into urban planning. Regular consultation and interaction with stakeholders on one to one basis as well as in workshop mode has been a major area of focus in the model city. Stakeholder consultation on the present issues with regard to conservation of urban biodiversity in the city of Kochi has been carried out. On the basis of the same, stakeholders supported the identification of critical ecosystems in and around the city of Kochi. A workshop on understanding the ecosystem services provided by these critical ecosystems (backwaters and mangroves) has been carried out in the model city. These need to be conducted in the satellite cities as well.



Figure 33 Workshop on ecosystems services evaluation in Kochi

As part of the capacity building initiatives, a national workshop on development of Local Biodiversity Strategy and Action Plan (LBSAP) has also been carried out in the model city. This workshop was attended by participants from 18 cities (including one of the satellite cities) and three SBBs and the NBA.



Figure 34: National workshop on development of LBSAP in Kochi

In the model city, capacity building and awareness generation activities on the significance of urban biodiversity and need to conserve the same is also being carried out in the schools through a series of activities like lecture series, painting competitions, quiz competitions etc.



Figure 35: Awareness training for school children in Kochi

Extensive capacity building activities (including site visits to some cities in the county) need to be carried out in all the project cities in order to ensure deeper impacts of project in the long run.

8.4 Pilot implementation projects

For mainstreaming interventions to succeed they need to be packaged in a way that resonates with local priorities and does not come across as being anti-development. Secondly, the identification and design of mainstreaming interventions and pilot demonstration projects must take the short life span of politicians and spending priorities, which is linked to election cycles, into account. To facilitate ongoing buy-in and commitment to mainstreaming,

interventions and projects must deliver visible and concrete results sooner rather than later (within the current financial year). However, to ensure that mainstreaming is sustained, embedded institutionally and scaled up, it is necessary to balance short term quick wins with policy and paradigm shifting interventions that have a longer term impact horizon and incentivize decision-making and behaviour change.

Some pilot project ideas have been identified through primary and secondary information collected and discussions carried out with the stakeholders and city authorities on the same. These will now be discussed with the city council and then finalized for implementation. The interventions that have been shortlisted can be categorized into the following:

- A. Policy instrument interventions
- B. Capacity building interventions
- C. Ecosystem-based pilot projects

A) Policy instrument interventions

- 1) *Development of an action plan for Vembanad Lake:* The Vembanad Lake is known as the Kochi Lake in the city. Several groups of small islands including Vypin, Mulavukad, Vallarpadam, Willingdon Island are located in this portion. Kochi Port is built around the Willingdon Island, and the Vallarpadam Island. KMC has set aside some finances for the lake. However, an action plan for the lake, including restoration, rejuvenation and sustainable livelihood options for the fishermen folk living around the lake needs to be developed. This will involve discussions and coordination with an array of stakeholders including the city municipal authority, state and national water authorities, NGOs, academicians and the community members. The action plan thus developed can be taken by the city municipal corporation for implementation.
- 2) *Development of a policy brief to make the case for mainstreaming ecosystems (mangroves in particular) into city planning and decision making:* This is a longer term intervention and focuses on changing mind sets, the way in which the city provides services and officials go about performing their duties and functions, and on strengthening and improving vertical-horizontal integration.
- 3) *Well rejuvenation:* This intervention involves mapping all the wells in the city of Kochi, along with their ownership. The map will also detail the wells that need to be rejuvenated. The overall intervention will focus on development of a plan for rejuvenating the wells and maintaining the public wells as a source of drinking water for the city. Currently the drinking water for the city of Kochi is sourced from Periyar River, which is approximately 22 km away from the city and also faces high levels of pollution due to discharge of sewage and waste.
- 4) *Development of a city resilience plan based on nature based solutions:* This is a long term intervention and will focus on the development of a city resilience

plan for Kochi, with focus on nature based solutions and the integration of the same into urban planning. The action plan will comprise of action points that the city government can take and improve urban services and overall quality of life in the city, through use of nature based solutions.

B) Capacity building interventions

- 1) *Development of butterfly gardens in schools:* The city municipal corporation has earmarked some finances in the annual budget for development of butterfly gardens in 20 schools in Kochi. Technical assistance will be provided to the corporation for the development of these gardens. These butterfly gardens will support the propagation of indigenous species of plants and insects, which will on one hand, enhance the urban biodiversity of the city and on the other hand will also serve as demonstration sites for students. Students will be able to better appreciate the importance and role of biodiversity.

C) Ecosystem-based pilot projects

- 1) *Restoration of the Thevara Canal:* Thevara Canal is one of the back water canals in the city of Kochi. The canal is presently heavily silted and polluted due to discharge of waste and sewerage. In addition the government fish market that is located on the banks of the canal dumps the waste directly into the canal, thereby polluting it further. A composting plant can be established near the fish market to address the same. In addition the banks of the canal will also be restored with native vegetation. Awareness generation activities will also be carried out in order to address the issue of waste disposal into the canal.
- 2) *Mangroves:* A study on the site specific ecosystem services provided by the mangroves will be carried out. This will help to build the case for the protection of the presently unprotected mangrove patches around Mangalavanam and other areas like Edakochi. In addition, the mangrove patches existing in the city will be mapped along with ownership pattern. Awareness generation workshops will be carried out with the owners and stakeholders in order to communicate the significance of mangrove conservation.
- 3) *Mangalavanam Bird Sanctuary:* A pipeline from the city discharges sewage into the sanctuary. The city has laid an alternate pipeline. However, a small connection between the two is missing. If the same is done through the project, then it will help to address the issue of water pollution in the sanctuary.
- 4) *City heat island:* The heat islands in the city will be mapped. Rooftop gardens and plantation will be encouraged in those areas. Nature based solutions like use of permeable surfaces instead of pavement tiles will be promoted. These will on one hand improve ground water recharge and on the other hand reduce the heat island effect. The project of roof top gardening offers a good opportunity to involve the households and can also be linked to the initiative of the KMC to award the best woman roof top gardener.

9 CONCLUSIONS AND ACTION PLAN FOR WAY FORWARD

9.1 Key findings

9.1.1 National Level

The inventory of policy and legislative frameworks in India throws up interesting narratives. Legislation such as the Indian Forest Act (1927), the Wildlife Act (1972), the Environment (Protection) Act (1986) and the National Forest Policy (1988) have enabled a strong network of protected areas and have helped to shift the discourse from revenue to that of conservation. The Biological Diversity Act (2002) and Rules (2004) deal with conservation of biodiversity, sustainable use of components of biodiversity and fair and equitable sharing of benefits coming out of use of biodiversity.

Nationally, the portfolio is extensive. This is not to say that gaps do not exist, but to point out that the country has been proactive in the past in trying to reconcile its development with that of ecological balance and environmental stability.

In recent times however, policy frameworks favouring PPP and ease of doing business need to be rethought especially when it comes to natural resource assets and common pool resources. The recent draft of the 1988 forest policy is an example wherein a policy can undo the progress made in the last five decades by shifting conservation priorities to focus solely on revenue generation. The same can be said of the draft CRZ 2018 notification and EIA notification of 2016. While biodiversity is an important source of revenue, policies favouring this should enable safe-guards which prioritise conservation in the long-run.

Overall, the biggest challenge is the lack of coordination between ministries as well as within ministries. This impacts implementation and regulation of the various policies and legislation. Related schemes and programmes need to dovetail into each other which will enable greater coordination between ministries. A robust monitoring and evaluation framework is essential to measure the progress of a programme which is often missing from work/action plans.

9.1.2 State Level

At the state level, there have been efforts as well to align with national policies whilst focussing on growth and developmental priorities. Again, there are gaps and issues which do not lead to implementation at the ground. State progress on updating biodiversity frameworks (SBSAPs) in line with the NBAP is slow. In most states, these need revision and realignment. The impetus of the BSAPs will only be felt once they are modified within the regional context into actionable plans.

Coordination at the state level needs to also be improved and vertical integration should be strengthened. Enacting the Panchayati Raj Act at state level will bring about better crafted policies and action plans at the local level.

9.1.3 Local Level

The primary responsibility of local bodies is to provide basic civic amenities which broadly relate to public health, welfare, regulatory functions, public safety, public infrastructure works and developmental activities. However, in relation to the public services these bodies are mandated to deliver, the size of the municipal fiscal sector is very small (Sahasranaman and Prasad, 2014). Furthermore, in addition to a poor revenue base, these local bodies are also constrained by limited resources (manpower, financial), staff capacity, and jurisdictional grey areas (Ahmed, 2014; Chakrabarti, 2014; Sahasranaman and Prasad, 2014). These limitations restrict the active and effective discharge of ULBs' responsibilities to improve service levels.

Although through the 73rd and 74th Constitutional Amendment, local bodies were given control of certain subjects such as Water supply, Sanitation, Agriculture, Land use and so on, there has not been a complete devolution of powers and often there is the issue of jurisdictions overlapping with parastatal bodies or a lack of clarity and awareness as to what the distribution of powers are. The fact also remains that although "mainstreaming of biodiversity" is a commonly used term, it is not properly understood with local bodies equating it to greening activities (tree plantation).

It is clear from the scoping exercise, that policy frameworks addressing biodiversity are inadequate at the city level. Furthermore, with the limited powers that local authorities hold, biodiversity conservation is not a top priority on their list. While two of the project's cities- Kochi and Panaji were making the effort to address their city's liveability through an improvement to their blue green infrastructure, Mangaluru's focus was to strengthen its economic and trade position within the state.

Within the three cities it is clear that there is no integrated approach towards development. The focus of the cities is to improve their contribution to the GDP and improve the provision of basic services within their jurisdictions. There is a lack of knowledge about the significance of biodiversity and ecosystem services. This is clear from the fact that development is siloed from environment conservation and an imbalance between macro-economic policies and biodiversity conservation objectives. There is poor coordination within and between government departments which impacts developmental activities. Furthermore, an absence of communication with academia leads to unscientific and uninformed decision making. The biggest issue however, is the misunderstanding that the incorporation of biodiversity concerns into planning is in fact anti-development and retards the progress of a city.

Land use which is inextricably linked with biodiversity conservation and its sustainable use is presently market driven, which impacts equity and sustainability. There appears to be no enforcement of existing land use policies (or most policies for that matter) at the local level. Furthermore, the absence of up-to-date and accurate land use data, lack of ward-wise planning is leading to poor

implementation of Master Plans. Developments that take place outside of the Master Plan zone are uncontrolled either due to the fact that there is no regional plan or because there is little harmonization between the Master Plan, Regional Plan and CDP.

Poor capacities of local authorities especially with regard to biodiversity and ecosystem services see these matters being left out of planning and decision making. It is worth noting that none of the three project city corporations have a division dedicatedly working on urban biodiversity nor an ecologist as a staff member. Building awareness about biodiversity, the Act and Rules, amongst the main actors/stakeholders involved in the city's development is imperative as is the fact that mainstreaming biodiversity concerns into planning will have far reaching positive outcomes on the city's socio-economic status.

Given the limited avenues for funding, absence of earmarked funds for biodiversity and the focus on improving the coverage of basic services, there is little space for a city to dedicate resources to biodiversity conservation. It is important here that mainstreaming biodiversity is not seen as a financial burden, but rather a form of insurance for the city to improve the lives of its citizens (especially the most vulnerable), protect against the hazards of climate change and maintain a steady rate of economic growth and build overall city resilience.

9.2 Way forward action plan

Based on the interventions identified in the scoping report, a mix of hard and soft measures will be implemented within the city of Kochi in order to promote mainstreaming of biodiversity conservation into city planning. The activities planned in the coming year include:

- 1) Well rejuvenation: This intervention aims at developing a plan and database on the network of wells within the city in order to augment drinking water security. The activities that will be carried out will include mapping of public wells in the city of Kochi, along with their ownership. Through this exercise, wells requiring rejuvenation will be identified followed by on ground activities to rejuvenate the wells.
- 2) Identifying and Managing Urban Heat Islands: This intervention aims at ameliorating the heat island effect within the city through an increase in the vegetative cover. The heat islands in the city will be mapped along with the present density of trees. Once intervention areas are identified, the Resident Welfare Associations of those areas will be contacted and trained on developing community and rooftop gardens. To sustain the initiative, through the Municipal Corporation, rewards will be given to those communities who have been proactive and established their gardens as well as encouraged residents to participate.
- 3) Restoration of Thevara Canal: Thevara Canal which runs through the heart of the city is presently silted and blocked by waste and encroachments. The project will intervene by identifying a workable

stretch of the canal after which a series of awareness activities with the locals will be run. Awareness activities will be aimed at effecting behavioural changes in terms of waste disposal. A compost unit will be constructed near the fish market to divert fish waste from the canal and a plantation drive will be carried out along the canal boundary. Parallel de-siltation activities will be carried out by the Municipal Corporation.

- 4) Capacity building and awareness generation activities: The outreach of the project will be through the engagement of a number of stakeholders. Activities, workshops and seminars will be carried out in schools and colleges using the concept of citizen science to report on and monitor biodiversity and ecosystem services within these areas. Some of these activities will be done in partnership with KMC. The project will provide technical support and guidance to dissertations on urban biodiversity and ecosystem services of a select group of students, support the conceptualisation and establishment of a butterfly and bee garden in Subhash Bose Park and assist the city in the development of its People's Biodiversity Register (PBR) and City Biodiversity Index (CBI). Councillors who are elected representatives of wards of the city will also be given the relevant training on how they can contribute to and mobilise knowledge for incorporation into the PBR and CBI.
- 5) Mangrove conservation: Under this intervention a number of activities like establishing a comprehensive database of mangrove patches in the city which will help the forest department in the implementation of the Ecologically Fragile Lands Act, a study assessing the site specific benefits rendered by these ecosystems within the city, awareness generation activities highlighting the importance of mangroves along with signage developed for mangrove rich areas will be undertaken.
- 6) Vertical and Horizontal Integration: A national level steering committee meeting has been planned with representation from the MoEFCC, NBA, SBBs and Cities. Additionally a number of workshops at the city region level will also be conducted.
- 7) Investment case development: One investment case that profiles the value of both the socio-economic and ecological benefits (e.g. creating jobs) and supports the implementation of the projects, mentioned will be developed and promoted.

10 APPENDICES

APPENDIX 1: CITY COMPARISON MATRIX

City	Accessibility	Political Stability	Proximity to area of high biodiversity value	ICLEI in the city	Additional Information	Population	Area	City aware of project
Chennai	City has airport and railway station	State is presently unstable. In normal conditions, state elections are due in 2021. Municipal elections are due within May 2017	1. Situated close to Eastern Ghats 2. Has Guindy National Park 3. Has wetlands that need conservation	Not working presently	1. National Biodiversity Authority is situated there 2. Recent floods showed strong links of ecosystems and urbanisation with climate change 3. Very strong civil society 4. A 100 RC city 5. A Smart City	8,917,749	1,189 sq km	No. EOI not signed
Pune	City has airport and railway station	State elections due in 2019; municipal elections just got over	1. Situated close to Western Ghats- a global biodiversity hotspot 2. Bhimashankar Wildlife Sanctuary and Mayureshar wildlife sanctuary are situated in Pune district 3. Has wetlands that need conservation	ICLEI is working with Pune Municipal Corporation	1. Strong civil society 2. Many research organisations there are working on biodiversity 3. A Smart City	5,057,709	7,000 sq km	Yes. EOI signed

City	Accessibility	Political Stability	Proximity to area of high biodiversity value	ICLEI in the city	Additional Information	Population	Area	City aware of project
Siliguri	City is about 20 kms away from Bagdogra airport; City is also accessible by train through New Jalpaiguri Junction	State elections due in 2021; Municipal elections due in 2019; political instability as state and city are with different political parties and chances of change in ruling party in city cannot be ruled out	1. Situated close to Eastern Himalayas- a global biodiversity hotspot 2. City is dependent on natural resources 3. Have rivers which need conservation	ICLEI is working with Siliguri Municipal Corporation	1. Smaller city size makes it easier to handle	513,264	41.9 sq km	Yes. EOI signed
Panaji	City is about 29 kms away from Dabolim airport	State has just gone through elections, municipal elections due in 2020.	1. Situated close to Western Ghats- a global biodiversity hotspot 2. Have water bodies and mangroves which need conservation 3. Salim Ali Bird Sanctuary is situated along Mandovi River	Not working presently but ICLEI has long term relations with the city	1. ICLEI has worked previously 2. Strong civil society 3. A Smart City	114,759	76.3 sq km	Yes. EOI signed.

City	Accessibility	Political Stability	Proximity to area of high biodiversity value	ICLEI in the city	Additional Information	Population	Area	City aware of project
Kochi	City has airport and railway station	State and municipal elections are due in 2021.	1. Situated close to Western Ghats- a global biodiversity hotspot 2. Have a bird sanctuary (Mangalavanam) in the city 3. Vembanad Lake is a Ramsar site 4. Have water bodies and mangroves which need conservation	ICLEI is not working presently but has long term relations with the city	1. ICLEI has worked previously 2. Strong civil society 3. A Smart City 4. Many research organisations there are working on biodiversity	2,117,990	730 sq km	Yes
Mangaluru	City has airport and railway station	State elections are due in 2018 and municipal elections are due in 2021	1. Situated close to Western Ghats- a global biodiversity hotspot 2. Have water bodies and natural resources in vicinity which need protection	ICLEI has not worked	1. A Smart city 2. Many research organisations working on biodiversity	499,487	132 sq km	No. EOI not signed

APPENDIX 2: FOUR BIODIVERSITY HOTSPOTS IN INDIA

EASTERN HIMALAYAS

Spanning parts of India, Nepal, Bhutan and China, the Eastern Himalayas landscape is considered an important centre of speciation of several plant families. The Indian landscape has around 5,800 plant species, of which over a third are endemic. Some families show a high level of endemism. Among the endemic flowering plants, 55 are considered to be rare. The landscape also contains a number of wild relatives of many economically important species such as rice, banana, tea, citrus plants, chilli, jute and sugarcane. Around 63 percent of genera of terrestrial mammals and over 60 percent of the bird species found in India have been reported from this landscape. At least 68 out of 240 amphibian species in India occur here. Four Endemic Bird Areas (EBAs) overlap in some way with this hotspot. The biodiversity list is not comprehensive and is still being explored. Even for a relatively well-studied class like mammalia, new species – Namdapha flying squirrel (*Biswamoyopterus biswasi*), White cheeked macaque (*Macaca leucogenys*) and a sub-species of Hoolock Gibbon- the Mishmi Hills Hoolock (*Hoolock hoolock mishmiensis*) – have been reported from this landscape in the last decade (MoEF 2009; Krishnan *et al.*, 2012; Choudhury, 2013).

WESTERN GHATS

The Western Ghats, also called the Sahyadri, is a mountain range that runs parallel to the western coast of India. It hosts a diversity of forest ecosystems including the tropical wet evergreen, montane evergreen and moist deciduous forests. The Shola grasslands found in the higher reaches are unique to this landscape. Like the Eastern Himalayas, the Western Ghats landscape is an important centre of speciation and endemism. Nearly a third of all flowering plant species of India are found here. Around 1,500 endemic species of dicotyledons have been reported from the area. Of the 490 arborescent taxa reported from the landscape, as many as 308 are endemic. Around 245 orchid species are found here, of which 112 are endemic. Overall, it is estimated that 38 percent of India's flowering plants and 63 percent of evergreen woody plants are endemic to this region. Many species are considered threatened, including 235 species of endemic flowering plants. The landscape is rich in faunal species as well. As many as 116 species of fish, 97 reptiles, 94 amphibians, 37 butterflies, 19 birds and 14 mammals are considered endemic to this landscape. The level of endemism is particularly high among amphibians, reptiles and fish. The mammalian fauna is dominated by bats, insectivores and rodents (MoEF 2009; Krishnan *et al.*, 2012). The year 2017 alone threw up several new species discoveries including a new species of a burrowing water snake, four new species of burrowing frog (genus: *Fejervarya*), seven species of night frogs (genus: *Nyctibatrachus*), a purple pig-nose frog (*Nasikabatrachus bhupathi*), two species of earthworm (*Drawida polydiverticulata* and *Drawida thomasi*), one species of ant (*Tyrannomyrmex alii*).

INDO BURMA

The Indo-Burma biodiversity hotspot comprises the Indo-Chinese peninsula including parts of North-east India which do not fall under the Himalayan region, Southern China, eastern Bangladesh and the countries of Cambodia, the Lao People's Democratic Republic, Myanmar, Thailand, and Vietnam. Encompassing 33 terrestrial ecoregions and a large part of tropical Asia east of the Gangetic-Brahmaputra lowlands, the plant diversity of the entire hotspot is estimated to comprise about 13,500 vascular plant species, of which about 7000 (52 percent) are endemic. Of the 1,277 bird species found in Indo-Burma, 74 are endemic (van Dijk *et al.*, 2004). Similarly, 71 of the 430 mammal species in the hotspot are endemic. Other vertebrate groups show much higher levels of endemism, with 189 of the 519 non-marine reptile species and 139 of the 323 amphibian species being endemic to the hotspot. The region probably supports the highest diversity of freshwater turtle in the world and has a remarkable freshwater fish fauna, with 1,262 documented species, accounting for about 10percent of the world total, including 566 endemics (Tordoff *et. al.*, 2012; MoEF, 2014).

SUNDALAND

Forming part of the Sundaland hotspot which includes a small portion of Southern Thailand; nearly all of Malaysia; Singapore, at the tip of the Malay Peninsula; all of Brunei Darussalam; and the entire western half of the megadiverse country of Indonesia, including Kalimantan, the Nicobar Islands consist of some of the most pristine island ecosystems in the world. Also classified as one the 10 biogeographical zones of India (Rodgers *et al.*, 2002), the Andaman and Nicobar islands form a distinct ecoregion and are considered to be globally significant. These islands are fringed by one of the most spectacular reefs of the Indian Ocean region and abound in mangrove forests. Mangrove species including *Rhizophora mucronata*, *Bruguiera gymnorrhiza*, *Excoecaria agallocha*, *Carallia brachiata*, *Sonneratia acida*, *Timonius jambosella* and *Nypa fruticans* are found here (Krishnan *et al.*, 2012). Of the 3,500 plant species that have been reported from the Andaman and Nicobar group of islands, 422 floral genera and 648 species (13.11 percent endemic) have been reported from Great Nicobar Island. These belong to 142 families, of which 14 percent are endemic. The islands are reported to have 120 pteridophyte species and of the 110 wild orchids found here, 19 genera, with 25 species, are endemic. A remarkable feature, characteristic of the Nicobar Islands is absence of large mammals and the presence of a significant number of endemics, such as Nicobar tree shrew (*Tupaia nicobarica*). The only primate, the Nicobar Crab-eating macaque (*Macaca fascicularis umbrosa*), occurs in the Southern group of the Nicobar Islands. The mega herpetofauna include the Malayan box turtle (*Cuora amboinensis*), found on Great and Little Nicobar, the Sunbeam snake (*Xenopeltis unicolor*), the Saltwater crocodile (*Crocodylus porosus*) and the Reticulated python (*Python reticulatus*), found in the Southern Nicobar group, besides several species of Pit viper in the central Nicobars. Fifteen reptile species are

reported to be endemic to the Nicobars. Four species of marine turtle, the Leatherback turtle (*Dermochelys coriacea*), Hawksbill turtle (*Eretmochelys imbricata*), Green sea turtle (*Chelonia mydas*) and the Olive ridley turtle (*Lepidochelys olivacea*) also feed and nest around the Andaman and Nicobars. The nesting population of Leatherbacks in the Nicobars is one of the last four colonies that exceed 1000 individuals in the Indo-Pacific and hence has global significance (MoEF, 2014).

APPENDIX 3: DIFFERENT ECOSYSTEMS IN INDIA

- a) **Forests:** India is ranked among the top 10 forested countries in the world. The actual forest cover (as determined through remote sensing in 2017 is about 70.83 million hectares or 21.54 percent of the geographical area (FSI, 2017). In addition, estimates suggest the tree cover outside forests (patches of trees that are less than one hectare in area) to be 9.3 million hectares. Thus, total forest and tree cover in the country is over 79 million hectares, or 24.36 percent of the country's geographical area (*ibid.*). In FSI's (2017) analysis, Andhra Pradesh, Kerala and Karnataka were found to have contributed the most to the country's increase in forest cover since 2015. India's forest types comprise tropical evergreen, tropical deciduous, mangroves, swamps, sub-tropical, montane, scrub, sub- alpine and alpine. They are home to a number of megafauna, avifauna and herpetofauna such as the country's national animal Royal Bengal tiger (*Panthera tigris tigris*), Asian elephant (*Elephas maximus*), Wild water buffalo (*Bubalus arnee*), Indian grey hornbill (*Ocyrceros birostris*), Indian cobra (*Naja naja*), Indian cricket frog (*Fejervarya limnocharis*) (Krishnan *et al.*, 2012).
- b) **Grasslands:** A mosaic of grasslands can be found across the country such as semi-arid pastures in the west; Banni grasslands in the Kutch salt desert; humid, semi-waterlogged tall grasslands in the Terai (plains just south of the Himalayas); rolling Shola grasslands on the Western Ghats hilltops; and high altitude alpine pastures in the Himalayas (Bugiyals). The most widespread grassland in India is *Imperata* grasslands (8 million ha.). The grass flora is quite diverse, composed of about 1,256 species in 245 genera. The majority of the grass species found in India belong to the tribes Andropogoneae (30 percent), Paniceae (15 percent), and Eragrosteae (9percent). Grasslands support a number of rare faunal species such as Bengal florican (*Houbaropsis bengalensis*), Great Indian bustard (*Ardeotis nigriceps*), One-horned rhinoceros (*Rhinoceros unicornis*), Nilgiri tahr (*Nilgiritragus hylocrius*), Nilgiri burrowing snake (*Plectrurus perroteti*). The grasslands of India remain not as well studied as the forests. The estimates of grasslands and shrub lands in India vary from 3.7 percent to as much as 12 percent of the area (UNEP, 2001; IC Net, 2011).
- c) **Wetlands:** Available estimates regarding the area-based extent of wetlands in India vary widely from a lowest of 1percent to a highest of 5percent of geographical area, but they report that wetlands do support nearly fifth of the known biodiversity (Space Applications Centre, 2011). These wetlands are distributed in different geographical regions ranging from the Himalayas to Deccan plateau. Around 150 amphibian and 320 bird species (UNEP, 2001) have been documented in wetlands. Furthermore, many serve as important wintering sites for migratory birds. Internationally, 26 of the country's wetlands have been notified as Ramsar sites while national programs such the National Wetland Conservation Programme and the National Lake Conservation Plan cover 115 and 61 wetlands respectively (MoEF, 2012).

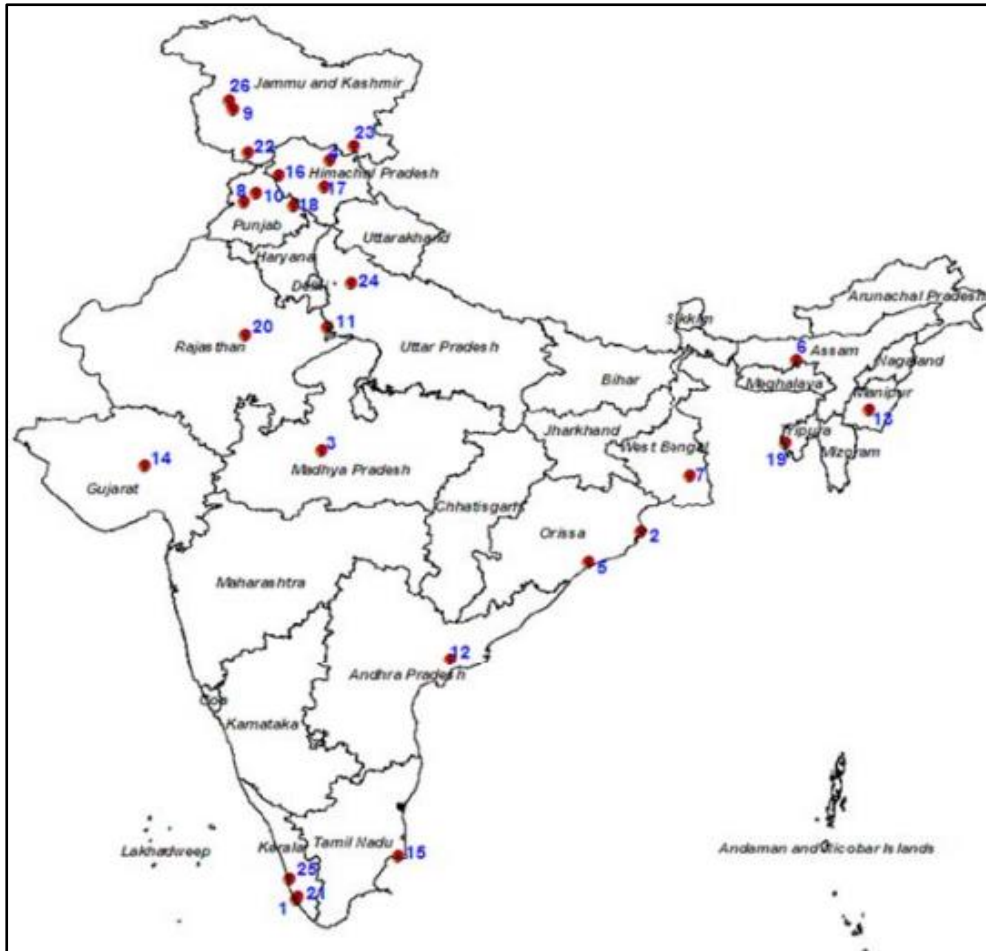


Figure 36: Wetland Map of India

- d) **Coral reefs:** In India, all the three major reef types (atoll, fringing and barrier) occur. The Indian reef area was initially estimated to contain about 218 coral species belonging to 71 genera spread around 0.24 million hectares. However, successive surveys between 2008-2013 revealed at least 519 species (Venkataraman, 2017). The four major reefs in the country include Andaman and Nicobar Islands, Gulf of Kutch, Gulf of Mannar and Lakshadweep Islands. Andaman and Nicobar Islands are the most species rich with at least 464 species of hard coral belonging to 86 genera and 19 families (De *et al.*, 2017).
- e) **Mangroves:** India has some of the most superior mangrove vegetation in the world, nestled in the alluvial deltas of the Ganga, Mahanadi, Godavari, Krishna, and Kaveri rivers and on the Andaman and Nicobar Islands. Three types of mangrove formations can be seen in the country- deltaic, backwater-estuarine and insular (Geography and You, 2017). Mangrove vegetation is spread over 0.47 million hectares or 0.14 percent of the geographical area. India accounts for around three percent of the world's mangrove vegetation and almost half of it is located in Sundarbans in West Bengal (FSI, 2011) followed by Gujarat and the Andaman and Nicobar islands. A total of 39 species of true mangroves and 86 species of associates have been identified. The major mangrove species are *Avicennia officinalis*, *Excoecaria agallocha*, *Heritiera fomes*, *Bruguiera*

parviflora, *Ceriops decandra*, *Rhizophora mucronata* and *Xylocarpus granatum*. Mangroves support over 3,100 of the country's animal species (Krishnan *et al*, 2012).

- f) **Deserts:** India has both hot (sand and salt) and cold deserts. The cold desert stretches from Ladakh (Jammu and Kashmir) to Kinnaur (Himachal Pradesh) while the hot desert is spread over the north-western states. The Thar Desert is the main hot sand desert and the seventh largest in the world (Krishnan *et al*, 2012). The flora found here comprises 682 species (including 63 introduced species) belonging to 352 genera and 87 families. Compared to the Sahara, the Thar Desert exhibits a higher level of plant endemism with 6.4 percent. The faunal diversity is also rich, with 755 invertebrate and 440 vertebrate species, including 140 bird and 41 mammalian species and the only known population of the Asiatic wild ass (*Equus hemionus khur*). The cold deserts cover 5.62 percent of the country's geographical area where the temperature plummets to as low as -50°C during the winter. The flora has high level of endemism and these cold deserts are also home to many endangered animal species such as Asiatic ibex (*Capra sibirica*), Tibetan argali (*Ovis ammon hodgsoni*), Wild yak (*Bos mutus*) and Snow leopard (*Uncia uncia*) (NFC, 2006, MoEF, 2009).

APPENDIX 4: NATIONAL BIODIVERSITY ACTION PLAN 2008 AND ADDENDUM 2014

The MoEFCC is India's nodal agency for implementing the provisions of Convention on Biological Diversity (CBD). As previously stated, the NBAP was adopted by the MoEF in 2008 as required by the CBD (Article 6a). The plan (MoEF, 2008) bases its framework around the principles set out in the NEP, 2006, and draws from the technical report of 2004. Overall it integrates the objectives of biodiversity conservation, sustainable use, and the equitable sharing of benefits resulting from the use of biodiversity. Although there is a push towards ecosystem based conservation, the NBAP seeks a steady expansion of the Protected Area network and establishment of more species-focused Protected Areas. In line with the Biological Diversity Act, the plan promotes the improvement of the natural resource base and its sustainable use (MoEF, 2009). It also seeks to control the introduction of invasive alien species and attempts to balance like the NEP, the integration of biodiversity concerns in economic development. It lays out ways to strengthen the institutional mechanism for biodiversity management, promotes capacity building, and provides for the valuation of the economic benefits of the goods and services provided by biodiversity (*ibid.*).

The objectives of the NBAP are broad-based and relate to current perceptions of key threats and constraints to biodiversity conservation as follows.

- 1) Strengthening and integration of in situ, on-farm and ex situ conservation
- 2) Augmentation of natural resource base and its sustainable utilization; ensuring inter and intra-generational equity
- 3) Regulation of introduction of invasive alien species and their management
- 4) Assessment of vulnerability, and adaptation to climate change and desertification
- 5) Integration of biodiversity concerns in economic and social development
- 6) To prevent, minimize and abate impacts of pollution
- 7) Development and integration of biodiversity databases
- 8) Strengthening implementation of policy, legislative and administrative measures for biodiversity conservation and management
- 9) Building of national capacities for biodiversity conservation and appropriate use of new technologies
- 10) Valuation of goods and services provided by biodiversity and use of economic instruments in the decision-making processes
- 11) International cooperation to consolidate and strengthen bilateral, regional and multilateral cooperation on issues related to biodiversity

The NBAP Addendum 2014 (MoEFCC, 2014), was annexed to the NBAP in order to synergise with the Strategic Plan for Biodiversity 2011-2020. The principle output of the addendum is 12 NBTs (Box 4), each of which consists of a number of composite indicators and correspond to Aichi targets.

Box 4: National Biodiversity Targets	
	Target 1: By 2020, a significant proportion of the country's population, especially the youth, is aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.
	Target 2: By 2020, values of biodiversity are integrated in National and State planning processes, Development programmes and poverty alleviation strategies.
	Target 3: Strategies for reducing rate of degradation, fragmentation and loss of all natural habitats are finalized and actions put in place by 2020 for environmental amelioration and human well-being.
	Target 4: By 2020, invasive alien species and pathways are identified and strategies to manage them developed so that populations of prioritized invasive alien species are managed.
	Target 5: By 2020, measures are adopted for Sustainable management of agriculture, forestry and fisheries.

	Target 6: Ecologically representative areas on land and in inland waters, as well as coastal and marine zones, especially those of particular importance for species, biodiversity and ecosystem services, are conserved effectively and equitably, on the basis of PA designation and management and other area-based conservation measures and are integrated into the wider landscapes and seascapes, covering over 20% of the geographic area of the country, by 2020.
	Target 7: By 2020, genetic diversity of cultivated plants, farm livestock and their wild relatives, including other socioeconomically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.
	Target 8: By 2020, ecosystem services, especially those relating to water human health, livelihoods and wellbeing, are enumerated and measures to safeguard them are identified, taking into account the needs of women and local communities, particularly the poor and vulnerable sections.
	Target 9: By 2015, Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization as per the Nagoya Protocol are operational, consistent with national legislation.
	Target 10: By 2020, an effective, participatory and updated national biodiversity action plan is made operational at different levels of governance.
	Target 11: By 2020, national initiatives using communities' traditional knowledge relating to biodiversity are strengthened, with a view to protecting this knowledge in accordance with national legislations and international obligations.

	Target 12: By 2020, opportunities to increase the availability of financial, human and technical resources to facilitate effective implementation of the Strategic Plan for Biodiversity 2011– 2020 and the national targets are identified and the Strategy for Resource Mobilization is adopted.

A road map for implementation at the central level has been laid out within these documents especially within the context of achieving and monitoring the NBTs. The key enforcers identified are the MoEFCC and 23 Union Ministries/Departments, the National Biodiversity Authority (NBA), the State Biodiversity Boards (SBB), State Forest Departments (SFDs), State Planning Boards and relevant departments of State Governments such as fisheries, forests, agriculture, livestock and animal husbandry, mining and education. Local-level institutions, including Biodiversity Management Committees (BMC), Forest Rights Committees (FRCs), Village Eco-development Committees (VEDCs), Joint Forest Management Committees (JFMCs) and Gram Sabhas (village assemblies) are critical elements for implementation of the NBAP (Figure 37).

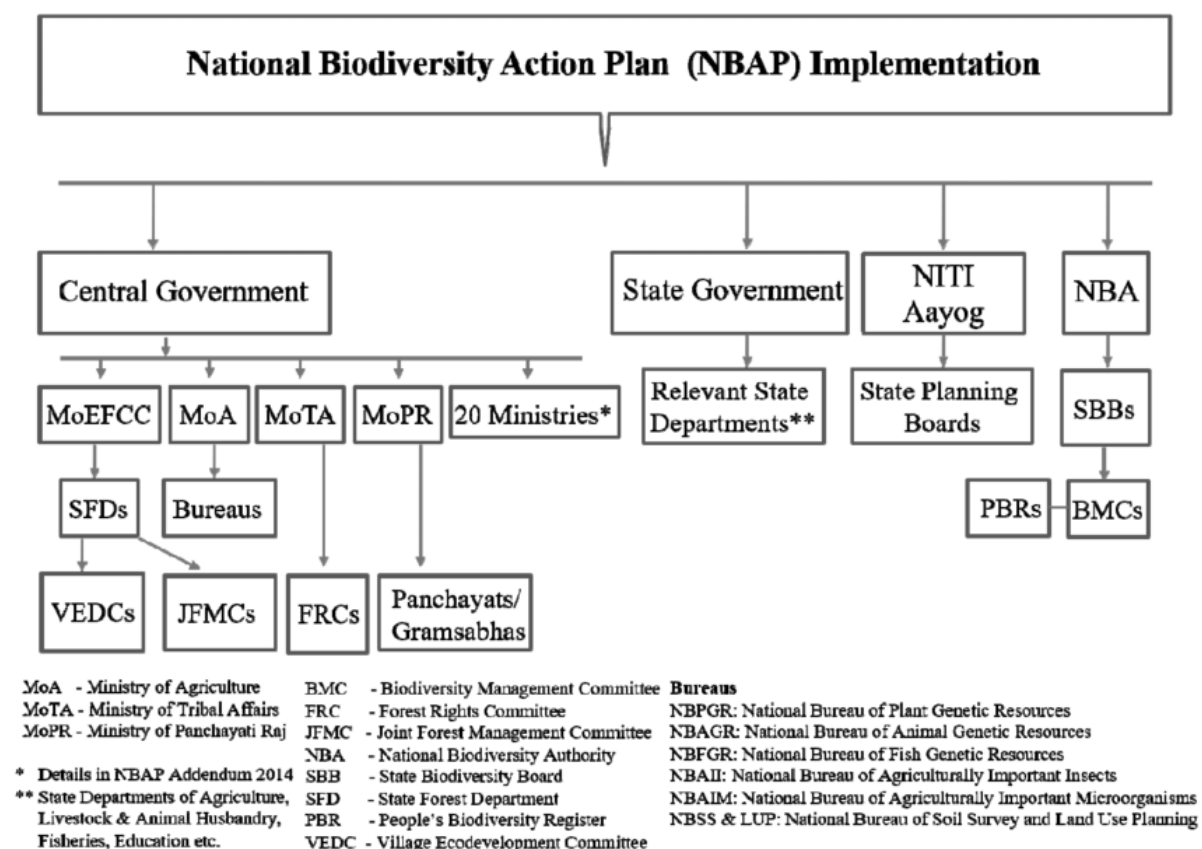


Figure 37: Institutional Implementation Plan for NBAP (Source: CBD, 2016)

APPENDIX 5: 25 CORE INDICATORS OF THE TWELFTH FIVE YEAR PLAN

TWENTY-FIVE CORE INDICATORS

Economic Growth

- 1) Real GDP Growth Rate of 8.0 percent.
- 2) Agriculture Growth Rate of 4.0 percent.
- 3) Manufacturing Growth Rate of 10.0 percent.
- 4) Every State must have an average growth rate in the Twelfth Plan preferably higher than that achieved in the Eleventh Plan.

Poverty and Employment

- 5) Head-count ratio of consumption poverty to be reduced by 10 percentage points over the preceding estimates by the end of Twelfth Five Year Plan.
- 6) Generate 50 million new work opportunities in the non-farm sector and provide skill certification to equivalent numbers during the Twelfth Five Year Plan.

Education

- 7) Mean Years of Schooling to increase to seven years by the end of Twelfth Five Year Plan.
- 8) Enhance access to higher education by creating two million additional seats for each age cohort aligned to the skill needs of the economy.
- 9) Eliminate gender and social gap in school enrolment (that is, between girls and boys, and between SCs, STs, Muslims and the rest of the population) by the end of Twelfth Five Year Plan.

Health

- 10) Reduce IMR to 25 and MMR to 1 per 1,000 live births, and improve Child Sex Ratio (0–6 years) to 950 by the end of the Twelfth Five Year Plan.
- 11) Reduce Total Fertility Rate to 2.1 by the end of Twelfth Five Year Plan.
- 12) Reduce under-nutrition among children aged 0–3 years to half of the NFHS-3 levels by the end of Twelfth Five Year Plan.

Infrastructure, Including Rural Infrastructure

- 13) Increase investment in infrastructure as a percentage of GDP to 9 percent by the end of Twelfth Five Year Plan.
- 14) Increase the Gross Irrigated Area from 90 million hectare to 103 million hectare by the end of Twelfth Five Year Plan.

- 15) Provide electricity to all villages and reduce AT&C losses to 20 per cent by the end of Twelfth Five Year Plan.
- 16) Connect all villages with all-weather roads by the end of Twelfth Five Year Plan.
- 17) Upgrade national and state highways to the minimum two-lane standard by the end of Twelfth Five Year Plan.
- 18) Complete Eastern and Western Dedicated Freight Corridors by the end of Twelfth Five Year Plan.
- 19) Increase rural tele-density to 70 per cent by the end of Twelfth Five Year Plan.
- 20) Ensure 50 percent of rural population has access to 40 lpcd piped drinking water supply, and 50 percent gram panchayats achieve Nirmal Gram Status by the end of Twelfth Five Year Plan.

Environment and Sustainability

- 21) Increase green cover (as measured by satellite imagery) by 1 million hectare every year during the Twelfth Five Year Plan.
- 22) Add 30,000 MW of renewable energy capacity in the Twelfth Plan.
- 23) Reduce emission intensity of GDP in line with the target of 20 per cent to 25 per cent reduction over 2005 levels by 2020.

Service Delivery

- 24) Provide access to banking services to 90 per cent Indian households by the end of Twelfth Five Year Plan.
- 25) Major subsidies and welfare related beneficiary payments to be shifted to a direct cash transfer by the end of the Twelfth Plan, using the Aadhar platform with linked bank accounts.

APPENDIX 6: THE FOUR PRIORITIES FOR ACTION WITH THE SENDAI FRAMEWORK

Priority 1: Understanding disaster risk

Disaster risk management should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment. Such knowledge can be used for risk assessment, prevention, mitigation, preparedness and response.

Priority 2: Strengthening disaster risk governance to manage disaster risk

Disaster risk governance at the national, regional and global levels is very important for prevention, mitigation, preparedness, response, recovery, and rehabilitation. It fosters collaboration and partnership.

Priority 3: Investing in disaster risk reduction for resilience

Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment.

Priority 4: Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction

The growth of disaster risk means there is a need to strengthen disaster preparedness for response, take action in anticipation of events, and ensure capacities are in place for effective response and recovery at all levels. The recovery, rehabilitation and reconstruction phase is a critical opportunity to build back better, including through integrating disaster risk reduction into development measures.

APPENDIX 7: SPECIES FOCUSED CONSERVATION

Apart from conserving critical habitats through the protected area network, another important strategy adopted is species-focused conservation. The two flagship schemes are Project Tiger and Project Elephant. Started in 1973, Project Tiger aims to ensure maintenance of a viable population of tigers in India. The core area of Tiger Reserves now covers almost one percent of the geographical area of the country (Panwar, 1987). In 2006, the National Tiger Conservation Authority (NTCA) was set up to further strengthen tiger conservation efforts. Project Elephant was launched in 1992 to protect elephants, their habitat and migratory routes and to address the issues of human-animal conflict (MoEF, 2012). At present, there are 41 Tiger Reserves and 32 Elephant Reserves in the country. In addition to tiger and elephant, recovery programmes for 15 other critically endangered species have also been launched recently. These include Asiatic lion (*Panthera leo leo*), One-horned rhinoceros (*Rhinoceros unicornis*), Snow leopard (*Panthera uncia*), Asian wild buffalo (*Bubalus arnee*), Malabar civet (*Viverraci zibellina*), Edible nest swiftlet (*Aerodramus fuciphagus*), Hangul (*Cervus eldieli*), Nilgiri tahr (*Nilgiritragus hylocrius*), Manipur brow-antlered deer (*Rucervus eldieli*) and Swamp deer (*Rucervus duvaucelii*). Since 1983, India is also a Party to the Convention on Migratory Species (CMS) and has signed a Memorandum of Understanding for the conservation and management of migratory species such as Siberian cranes (*Leucogeranus leucogeranus*), Marine turtles and Dugongs (*Dugong dugong*). Further, a Wildlife Crime Control Bureau has also been set up to combat illegal trade in Wildlife (MoEF, 2009, 2012).

APPENDIX 8: VARIOUS NOTIFICATIONS UNDER THE ENVIRONMENT PROTECTION ACT, 1986

- Doon Valley Notification (1989), which prohibits the setting up of an industry in which the daily consumption of coal/fuel is more than 24 MT (million tonnes) per day in the Doon Valley.
- Coastal Regulation Zone Notification (1991), which regulates activities along coastal stretches. As per this notification, dumping ash or any other waste in the CRZ is prohibited. The thermal power plants (only foreshore facilities for transport of raw materials, facilities for intake of cooling water and outfall for discharge of treated waste water/cooling water) require clearance from the MoEF.
- Dhanu Taluka Notification (1991), under which the district of Dhanu Taluka has been declared an ecologically fragile region and setting up power plants in its vicinity is prohibited.
- Revdanda Creek Notification (1989), which prohibits setting up industries in the belt around the Revdanda Creek as per the rules laid down in the notification.
- The Environmental Impact Assessment of Development Projects Notification, (1994 and as amended in 1997). As per this notification:
- All projects listed under Schedule I require environmental clearance from the MoEF.
- Projects under the delicensed category of the New Industrial Policy also require clearance from the MoEF.
- All developmental projects whether or not under the Schedule I, if located in fragile regions must obtain MoEF clearance.
- Industrial projects with investments above Rs 500 million must obtain MoEF clearance and are further required to obtain a LOI (Letter Of Intent) from the Ministry of Industry, and an NOC (No Objection Certificate) from the SPCB and the State Forest Department if the location involves forestland. Once the NOC is obtained, the LOI is converted into an industrial licence by the state authority.
- The notification also stipulated procedural requirements for the establishment and operation of new power plants. As per this notification, two-stage clearance for site-specific projects such as pithead thermal power plants and valley projects is required. Site clearance is given in the first stage and final environmental clearance in the second. A public hearing has been made mandatory for projects covered by this notification. This is an important step in providing transparency and a greater role to local communities.
- Ash Content Notification (1997), required the use of beneficiated coal with ash content not exceeding 34 percent with effect from June 2001, (the date later was

extended to June 2002). This applies to all thermal plants located beyond one thousand kilometres from the pithead and any thermal plant located in an urban area or, sensitive area irrespective of the distance from the pithead except any pithead power plant.

- Taj Trapezium Notification (1998), provided that no power plant could be set up within the geographical limit of the Taj Trapezium assigned by the Taj Trapezium Zone Pollution (Prevention and Control) Authority.
- Disposal of Fly Ash Notification (1999) the main objective of which is to conserve the topsoil, protect the environment and prevent the dumping and disposal of fly ash discharged from lignite-based power plants. The salient feature of this notification is that no person within a radius of 50 km from a coal-or lignite-based power plant shall manufacture clay bricks or tiles without mixing at least 25 percent of ash with soil on a weight-to-weight basis. For the thermal power plants the utilisation of the flyash would be as follows:
 - Every coal-or lignite-based power plant shall make available ash for at least ten years from the date of publication of the above notification without any payment or any other consideration, for the purpose of manufacturing ash-based products such as cement, concrete blocks, bricks, panels or any other material or for construction of roads, embankments, dams, dykes or for any other construction activity.
 - Every coal or lignite based thermal power plant commissioned subject to environmental clearance conditions stipulating the submission of an action plan for full utilisation of fly ash shall, within a period of nine years from the publication of this notification, phase out the dumping and disposal of fly ash on land in accordance with the plan.
 - Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms/ Genetically Engineered Organisms or Cell: Introduced in 1989 with the view to protect the environment, nature and health in connection with gene technology and micro-organisms, under the EPA, 1986. The government in 1991, further decided to institute a national label scheme for environmentally-friendly products called the 'ECOMARK'. The scheme attempts to provide incentives to manufactures and importers to reduce adverse environmental impacts, reward genuine initiatives by companies, and improve the quality of the environment and sustainability of available resources.
 - Besides the above attempts, notifications pertaining to Recycled Plastics Manufacture and Usage Rules, 1999 were also incorporated under the Environment (Protection) Act of 1986.
 - Under the EPA 1986, the MoEF has issued several notifications to tackle the problem of hazardous waste management. These include:

- Hazardous Wastes (Management and Handling) Rules, 1989, which brought out a guide for manufacture, storage and import of hazardous chemicals and for management of hazardous wastes.
- Biomedical Waste (Management and Handling) Rules, 1998, were formulated along parallel lines, for proper disposal, segregation, transport etc. of infectious wastes.
- Municipal Wastes (Management and Handling) Rules, 2000, whose aim was to enable municipalities to dispose municipal solid waste in a scientific manner.
- Hazardous Wastes (Management and Handling) Amendment Rules, 2000, a recent notification issued with the view to providing guidelines for the import and export of hazardous waste in the country.

APPENDIX 9: KOCHI CRS

City Resilience Strategy

Kochi City, India



Photo credit: Google Images



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Disclaimer: This document has been prepared by ICLEI – Local Governments for Sustainability, South Asia under the Asian Cities Climate Change Resilience Network (ACCCRN) program with support from the Rockefeller Foundation. The views expressed do not necessarily reflect Rockefeller Foundation’s official policies.

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November, 2016

Executive Summary

The coastal city of Kochi is located in the district of Ernakulam in the state of Kerala and is spread over an area of 107.13 sq. km. It is the commercial and industrial hub of Kerala and the second largest city in the state. With a population of 601,574 as recorded in 2011, the city of Kochi has Kerala's highest population density with 5,620 people per sq. km. The literacy rate of 97.36% is one of the highest in the country. The city, also known as the Queen of the Arabian Sea for its scenic beauty, is a trading port and was the spice trading centre of the world in the 14th century. The Kochi Municipal Corporation (KMC) was notified in 1967 when the Kerala Assembly approved its formation. The city is divided into 74 administrative wards, from which members of the Corporation Council are elected for a period of five years.

Kochi has a tropical climate with intense solar radiation and abundant precipitation. The annual variation of temperature in the Kochi region is between 22°C and 32°C. The maximum annual rainfall in the region is around 3,000 mm. The coastal tracts of Ernakulam district are prone to flooding. KMC area falls within the coastal wetland zone and therefore water related disasters are encountered very often. KMC area being a flat land adjacent to the coast is subjected to floods during monsoon affecting normal life and disrupting traffic in the city. Added to this, water logging is a major problem in Kochi.

Between 2011-2014, ICLEI South Asia with support from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), along with the Foundation for Innovation and Technology Transfer (FITT) of the Indian Institute of Technology Delhi (IIT Delhi), Potsdam Institute for Climate Impact Research (PIK), Germany initiated the project "Asian Cities Adapt: Impacts of Climate Change in Target Cities in India and the Philippines and Local Adaptation Strategies" in Kochi city. The project undertook a detailed climatic analysis on the precipitation, temperature changes and the occurrence of the extreme events, as well as a vulnerability assessment using the ICLEI ACCCRN Process (IAP) tool. Following up on the work under the Asian Cities Adapt project, the Kochi city team then undertook the preparation of their City Resilience Strategy (CRS) by building on the existing work using the IAP toolkit.

Regional and city level studies on past trends and climate projections were referred to in order to identify climate risks for the city. Outcomes of the regional level study 'Climate Change and India: A 4X4 Assessment - A sectoral and regional analysis for 2030s' conducted by Ministry of Environment, Forest and Climate Change, Government of India, 'Kerala State Action Plan on Climate Change' by the Government of Kerala, 'City of Cochin's Communication Strategy for Climate Change Adaptation- Guidelines' by ICLEI South Asia, Shared Learning Dialogues (SLDs) and Focus Group Discussions (FGD) with the local community, the city of Kochi defines two potential climate risks- increased temperature and increased precipitation for the city as seen below.

Changing Climate Conditions	Assessments	Climate Scenario Summary Statements
Temperature change	Regional Assessment	The mean annual temperature is projected to increase from 26.8±0.4°C to 27.5±0.4°C in the 2030s. The net rise in temperature with respect to the 1970s will be between 1.7°C and 1.8°C.
	Supplementary Assessment	The average maximum temperature is projected to increase by 1.62°C to 1.66°C and the average minimum temperature by 1.59 to 1.64°C in the 2050s with respect to the 1950-2000 in the Ernakulam district.

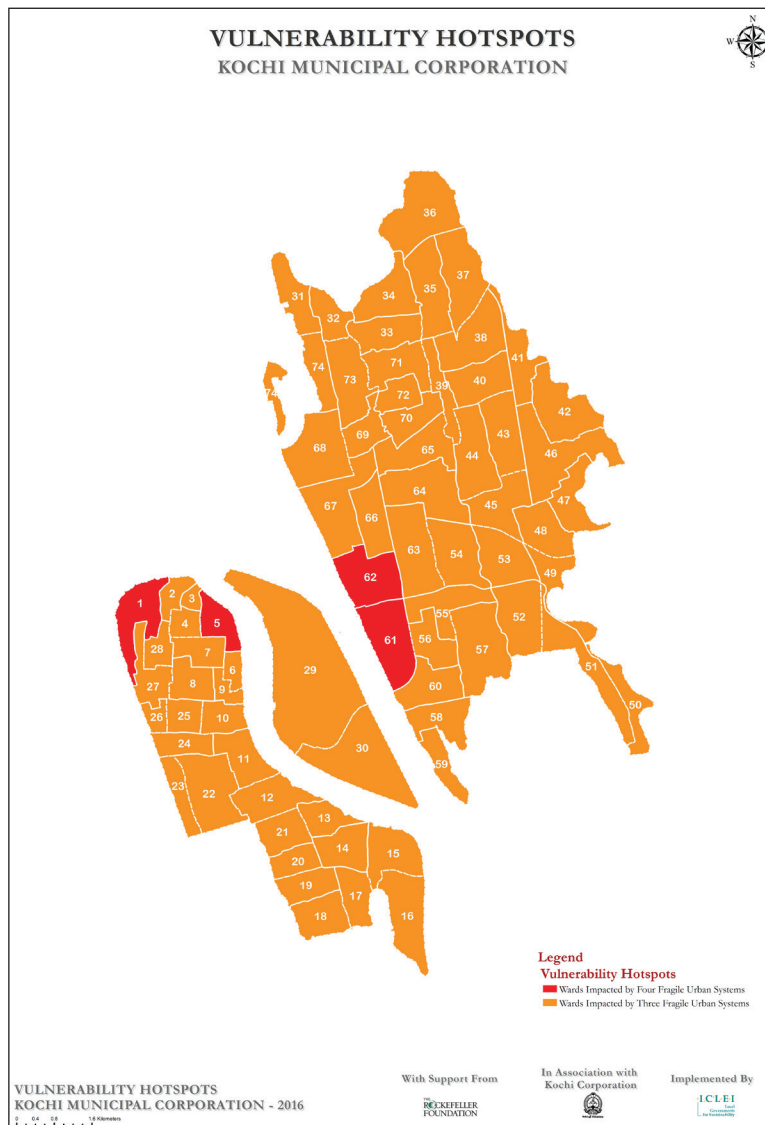
	Local Assessment	Projected mean temperature may show a net increase of 0.53°C in 2015-2044 with respect to the mean temperature of 1969-2000 in Kochi city.
Precipitation change	Regional Assessment	The annual rainfall in the Western Coastal region is likely to vary between 935±185.33mm to 1,794±247mm, which is an increase of 6%–8% with respect to the 1970s an increase that is ranging from 69 to 109 mm.
	Supplementary Assessment	The average monsoon rainfall may show a deviation of 20 to 30 cm from the normal with respect to the 1950-2000 in the Ernakulam district.
	Local Assessment	Projected precipitation may show a moderate increase in 2015-2044 with respect to the rainfall of 1971-1999 by 0.5 mm/day in Kochi city.

The IAP identified the key fragile urban systems in the city which are already impacted by infrastructural, governance, economic, social and political issues and may be aggravated by climate change. These systems were water supply, solid waste management, sewerage and drainage. A situation analysis of these urban systems was carried out to develop the fragility statements that were superimposed on the climate risks in order to formulate the climate fragility statements for each urban system. Highly vulnerable areas in the context of each urban system of the city with high and extreme risks, the actors who are vulnerable and who can play a critical role towards building urban resilience and the adaptive capacity of the fragile urban systems to absorb and respond to shocks that determines their resilience were identified as illustrated in the table below.

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive capacity of the system
			Vulnerable	Potential Supporting	
Water Supply	Higher temperatures would result in increased rates of water evaporation and demands for potable water putting stress on the system. Increased rainfall can lead to flooding and consequent contamination of the groundwater as well as salt intrusion.	Core areas of Fort Kochi and Matancherry	• Citizens • Hotels • Fisheries Industries/ Fisherman Community	• KMC • Kerala Water Authority (KWA)	• Economic- Low • Technology/ Infrastructure- Low • Governance- Low • Societal- Low • Ecosystem Services- Medium
Solid Waste Management (SWM)	Increased temperature may alter waste decomposition rate and leachate production rate which will lead to the spread of infectious diseases.	Entire city	• Citizens (includes slum dwellers) • Waste Collectors • Ward Committees • Kudumbashree • Resident Welfare Associations (RWA)	• KMC	• Economic- Medium • Technology/ Infrastructure- Medium • Governance- Low • Societal- Low • Ecosystem Services- Low

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive capacity of the system
			Vulnerable	Potential Supporting	
Sewerage	Increased temperatures would impact health as stagnating water, whether grey or black, will become a conducive breeding ground for harmful pathogens, insects and pests.	Entire city	• KWA • Commercial Establishments • Hotel Owners Associations • Government offices • Community/ Residents of flats • Citizens	• Greater Cochin Development Authority (GCDA) • KMC	• Economic-Medium • Technology/ Infrastructure-Medium • Governance-Medium • Societal- Low • Ecosystem Services-Medium
	Increased rainfall will increase incidences of water logging which will affect the sewerage management system infrastructure. Furthermore, there can be instances of freshwater and rainwater mixing with sewerage and sludge, polluting limited freshwater bodies and facilitating the spread of diseases.				
Storm Water Drainage	Increased rainfall when coupled with clogged drains will lead to increased incidences of water logging and flooding in the city. This will have profound impacts on the infrastructure, finance and health of Kochi city.	Entire city	• Citizens (includes slum dwellers) • Institutions • Commercial Establishments • Residents of low lying area	• KMC • Public Works Department (PWD)	• Economic-Low • Technology/ Infrastructure-Low • Governance-Medium • Societal- Low • Ecosystem Services-Medium

Most of city was found to be vulnerable. However after discussions with the city it was agreed upon that wards 1 (Fort Kochi), 5 (Matancherry), 61 (Ravipuram), and 62 (Ernakulam South) were the most vulnerable to all fragile urban systems. It is important to note that these wards have substantial slum population. Ward 1 has a large population who are from the Fishermen community, and thus their livelihood depends on the productivity of the sea and is greatly impacted by the climate risks. Wards 61 and 62 are areas where water logging occurs regularly because of lack of or poorly maintained infrastructure.



Interventions that would address the vulnerabilities identified through the IAP were developed for all four fragile urban systems. The 25 interventions have been divided into two categories – infrastructural measures and policy & institutional measures. Appropriate actions to address the vulnerability of each sector have been suggested. Among some of the soft measures is included better coordination among different departments involved in the administration of the relevant urban systems, development of management information systems and guidelines for management and disposal of water, waste, waste water as well as awareness generation activities and training for staff and public. The infrastructural measures include enhancement and upgradation of urban services, use of decentralised systems for waste management and involvement of public sector and their regulation for better and sustainable service delivery. These interventions can be interlinked with ongoing and upcoming programmes or projects in the city like the Smart City Mission, the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) scheme and the Swachh Bharat Mission (SBM).

Abbreviations and Acronyms

ACCCRN:	Asian Cities Climate Change Resilience Network
AMRUT:	Atal Mission for Rejuvenation and Urban Transformation
BMU:	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
BOD:	Biological Oxygen demand
cm:	Centimetre
CRS:	City Resilience Strategy
DPR:	Detailed Project Report
DEWATS:	Decentralized Wastewater Treatment Systems
FIT:	Foundation for Innovation and Technology Transfer
FGD:	Focus Group Discussions
GCDA:	Greater Cochin Development Authority
GI:	Galvanised Iron
GIDA:	Goshree Islands Development Authority
HI:	Health Inspector
IAP:	ICLEI ACCCRN Process
IMD:	India Metrological Department
INCCA:	Indian Network for Climate Change Assessment
IPCC:	Intergovernmental Panel on Climate Change
IIT:	Indian Institute of Technology
JnNURM:	Jawaharlal Nehru National Urban Renewal Mission
KMC:	Kochi Municipal Corporation
Km:	Kilometre
KSRTC:	Kerala State Road Transport Corporation

KSUDP:	Kerala Sustainable Urban Development Project
KWA:	Kerala Water Authority
lpcd:	litres per capita per day
MLD:	Million Litres per Day
mm:	Millimetre
O&M:	Operation and Maintenance
PHED:	Public Health Engineering Department
PIK:	Potsdam Institute for Climate Change
PPP:	Public Private Partnership
PWD:	Public Work Department
RDF:	Refuse Derived Fuel
RTO:	Regional Transport Office
SAAP:	State Annual Action Plan
SAPCC:	State Action Plan for Climate Change
SLD:	Shared Learning Dialogue
SLR:	Sea Level Rise
Sq m:	Square Meter
STP:	Sewerage Treatment Plant
SWM:	Solid Waste Management
UCCR:	Urban Climate Change Resilience

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1. Background

1.1. Introduction

It is projected that over 60 percent of the world's population will be based in cities by the year 2030¹. As per a report by the Global Commission on Economy and Climate², Indian urban centres will house over 600 million of the country's population by this time. Due to high concentrations of people, infrastructure and resources, the most adverse impacts of climate change will likely be in these areas according to the World Bank³. In this context, it is of the utmost urgency that a city is able to increase climate resilience to avoid these impacts.

Climate resilience is defined as the capacity for a socio-ecological system to: (1) absorb stresses and maintain function in the face of external stresses imposed upon it by climate change and (2) adapt, reorganize, and evolve into more desirable configurations that improve sustainability of the system, leaving it better prepared for future climate change impacts⁴. Urban Climate Change Resilience (UCCR) is defined by Rockefeller Foundation as the capacity of cities (individuals, communities, institutions, businesses and systems) to survive, adapt, thrive in the face of stress and shocks, and even transform when conditions require it⁵.

There are a host of benefits for cities associated with building resilience as outlined in Table 1. Investing in resilience reduces losses and damages in the event of a disaster. However, even if the anticipated disaster does not occur for a long time, increased resilience will mean reduction in background risk and unlocking of economic development potential⁶.

Table 1: Potential Benefits of Resilience Building

Economic Benefits	Environmental Benefits	Social Benefits
Avoidance of runaway costs of climate change	Biodiversity conservation	Improved public health
Livelihood creation	Preservation of vital ecosystems and species	Decreased mortality
Higher savings by population, businesses and government	Conservation of water resources	Increased benefits to low-income households
Reduced risks associated with current climate variability	Improved practices for disaster risk reduction	Reduced damage and loss due to natural disaster
		Enhanced well-being of all social groups

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1.2. Methodology

Kochi's CRS was formulated using the IAP. The process helped to identify fragile urban systems, major climate risks to urban systems and vulnerable areas and populations in the city, which were used to formulate resilience interventions.

Pioneered by the Rockefeller Foundation, the Asian Cities Climate Change Resilience Network (ACCCRN) supports practitioners to build inclusive urban climate change resilience in over 50 rapidly urbanising cities. To facilitate this initiative, the IAP toolkit was developed which targets city governments and helps them to develop their CRS with little or no external assistance.

1.2.1. Overview of ICLEI ACCCRN Process (IAP)

The IAP toolkit consists of a set of 16 tools which enables local governments to assess the climate risks of various systems in the city in context of urbanization and vulnerability, and plan resilience interventions corresponding to the fragilities identified. The IAP is designed in a step-by-step format, divided into following six phases as shown in Figure 1.

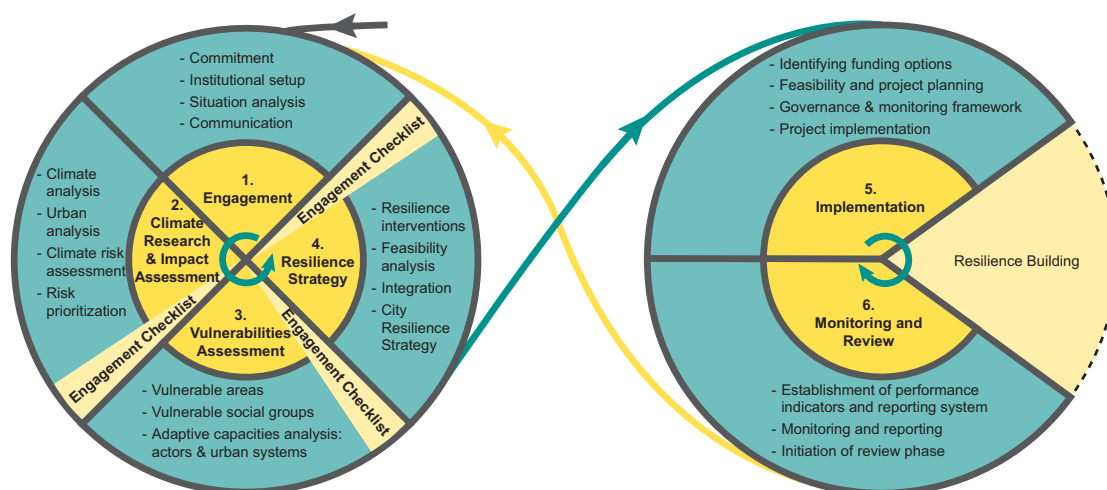


Figure 1: ICLEI ACCCRN Process

Phase 1 - Engagement: This phase begins with gaining political support in the city by formulating a Climate Core Team and a Stakeholder Committee. The Climate Core Team is responsible for the execution of project activities in the city and comprises of key officials from the city government. The Stakeholder Committee is formed with citizen representatives from various relevant institutions and organisations of the city. The Climate Core Team forms a communication plan for the city highlighting key messages to be conveyed to the public and the ways for doing so. This is followed by a scoping exercise which helps in gaining insight about the various city services and the problems faced by the city.

Phase 2 - Climate Research and Impact Assessment: This phase identifies the main impacts of climate change faced by city through SLDs with the Climate Core Team and Stakeholder Committee. An assessment of the past climate trends and future climate projections are conducted through secondary research. These are validated through analysis of city level data as well as local perceptions from city stakeholders. A risk assessment is conducted for fragile urban systems based on the likelihood and consequence of the climate risk statements for those systems.

Phase 3 - Vulnerabilities Assessment: This phase helps in identifying the key vulnerable areas with the fragile urban system and the vulnerable population for each system. This information is gathered in consultation with the stakeholder committee through SLDs. The adaptive capacity of the urban systems is also assessed in this phase.

Phase 4 - Resilience Strategy: In this phase, the city government uses the information and analysis from the previous phases to identify the relevant resilience interventions. These interventions are prioritised on the basis of their feasibility and applicability to the city. The resilience strategy is then developed and ratified through political support.

Phase 5&6 - Implementation and Monitoring & Review: After identifying the resilience interventions for the city, concrete project implementation plans can be prepared. Opportunities for financing and implementing these projects need to be explored. In all cases, monitoring and review remains a mandate of the city government, with active involvement of the Climate Core Team.

1.2.2. IAP in Kochi City

Between 2011-2014 ICLEI South Asia with support from the BMU, along with FITT of IIT Delhi, PIK, Germany initiated the project “Asian Cities Adapt: Impacts of Climate Change in Target Cities in India and the Philippines and Local Adaptation Strategies” in Kochi city. The project helped Kochi city to improve the management of the impacts of climate change based on scientific knowledge by improving their awareness and knowledge about local risks. In this project, along with undertaking a detailed scientific climatic analysis on the precipitation, temperature changes and the occurrence of the extreme events, a vulnerability assessment using the IAP tool was also carried out. The vulnerability assessment resulted in the identification of some urban systems that are already fragile in the city. Overlaying the results from the vulnerability assessments with the projected climate changes, the city team prioritised the high risks impacts and identified the vulnerable people and vulnerable areas in the city for these risks.

Following up on the work under the Asian Cities Adapt project, Kochi city team then undertook the preparation of their CRS by building up on the existing work using the IAP toolkit under the guidance of the key stakeholders such as academicians from Cochin University of Science and Technology (CUST), scientists from National Institute of Oceanography-Kochi, some of the councillors from the Municipal Corporation and the Director, Centre for Heritage Environment and Development (c-hed) - Dr. Rajan Chedambath.

An SLD was conducted with the city representatives to discuss the outputs of the previous vulnerability assessment and validate it, and use this information to identify the resilience interventions for the city. A list of resilience interventions contributing to improving urban resilience and reducing climate risk impact for all fragile urban systems was identified. Inter-linkages of these resilience interventions with on-going and planned projects were discussed to assess the opportunities of integrating these interventions with existing city-level plans. Such integration into City Development Plan and other statutory documents will help to build in climate resilience planning within the development process. KMC is committed to carrying out the implementation, monitoring and review processes using this CRS as a reference, as the city progresses with each of the prioritized interventions.

2. City Profile

The coastal city of Kochi is located in the district of Ernakulam in the state of Kerala and is spread over an area of 107.13 square km⁷. It is the commercial and industrial hub of Kerala. The city has a population of 601,574 residents according to the 2011 Census. Kochi is the largest urban agglomeration and the second largest city in the state of Kerala, and is classified as a Tier II city by the Government of India.

Three major national highways and various state highways connect Kochi with other parts of the country and the state. Major railway lines Thiruvananthapuram – Palakkad railway line via Kottayam and Thiruvananthapuram – Kozhikode connect it to major urban centres across the state and country. Cochin International Airport, 28 km from the city, is the largest airport in Kerala in terms of passengers and number of flights. Kochi has a good network of inland waterway system consisting of backwaters, canals and lagoons. National waterway no. 3 connecting Kollam and Kottappuram pass through the region.

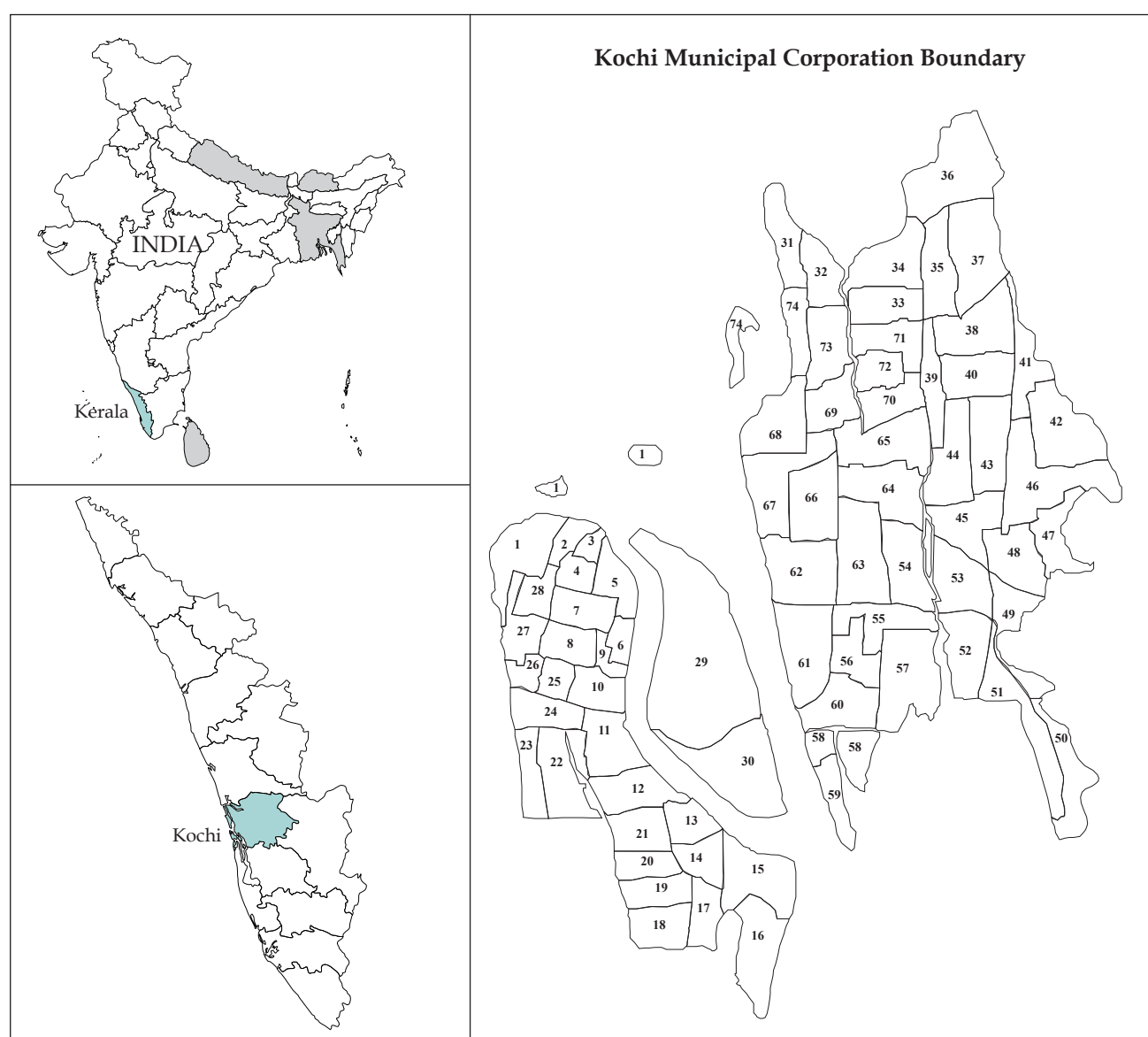


Figure 2: Location Map of Kochi

7. http://smartcities.gov.in/writereaddata/CitiesProfile/Kerala_Kochi.pdf

2.1. Geographical Location

The city of Kochi is found to the west of the Lakshadweep Sea in Ernakulam district. Geographically Ernakulam district is situated between 9° 47'N and 10° 17'N and 76° 9'E and 76° 47'E. It is bounded by Thrissur district on the north and Alappuzha and Kottayam on the south, Idukki on the east and Lakshadweep Sea on the west.

2.2. Demography⁸

With a population of 601,574 as recorded in 2011, the city of Kochi has Kerala's highest population density with 5,620 people per sq. km. The literacy rate of 97.36% is one of the highest in the country.

Table 2: Kochi Population and Decadal Growth Rate⁸

Year	Population ('000 persons)	Decadal Growth Rate (%)
1981	513,249	-
1991	564,589	10
2001	596,473	5.65
2011	601,574	0.85

2.3. Economy and Employment

The city, also known as the Queen of the Arabian Sea for its scenic beauty, is a trading port and was the spice trading centre of the world in the 14th century. To this day, the city is an important tourist site which attracts the most domestic and international tourists in Kerala, while also being a significant economic and trading hub within the state. The city is home to the only stock exchange in Kerala, and has also witnessed considerable investment for industrial growth. Its port is operates as an international container transshipment terminal, houses oil refineries, and supports commercial maritime businesses. The city is also home to the Southern Naval Command of the Indian Navy.

2.4. Municipal administration

The KMC was notified in 1967 when the Kerala Assembly approved its formation. It was formed by the amalgamation of the three ancient Municipalities of the state, viz. Ernakulam, Mattancherry and Fort Kochi, the Willingdon Island and four panchayats viz. Palluruthy, Vennala, Vyttila and Edappally and the small islands of Gundudeepu and Ramanthuruth. The city is divided into 74 administrative wards, from which members of the Corporation Council are elected for a period of five years. The corporation has a central office and six zonal offices. The KMC's elected wing is headed by a Mayor. The city is divided into administrative wards, from which the members of the corporation council are elected for a period of five years. The commissioner is the head of the administrative wing. The functions of KMC includes major civic services including roads, street lighting, SWM, slum improvement.

In addition to the KMC, the following authorities are also concerned with day to day affairs of the state and city:

- **KWA** which designs, constructs, executes, operates and maintains most of the water supply schemes as well as collects and disposes of the waste water in the State of Kerala.
- **PWD** which is responsible for design, implementation and maintenance of civil structures owned by the government.

8. Census of India.2011.Kochi City Census 2011 data. Accessed online at <http://www.census2011.co.in/census/city/459-kochi.html>

- GCDA which is the planning and development authority of the Metropolitan area of Cochin.
- **Goshree Islands Development Authority (GIDA)** whose main purpose is to develop the infrastructure facilities of scattered islands in and around the Kochi city.

3. Past Hazards and Climatic Events

The State of Kerala is vulnerable to a host of natural hazards such as coastal erosion, flood, drought, lightning, landslide and earthquake.

The coastal tracts of Ernakulam district are prone to flooding. KMC area falls within the coastal wetland zone and hence it is only natural that water related disasters are encountered very often. KMC area being a flat land adjacent to the coast is subjected to floods during monsoon affecting normal life and disrupting traffic in the city. Added to this, water logging is a major problem in Kochi.

As recently as June 2016 the city got flooded in the first spell of monsoon⁹. Roads, buildings, Kerala State Road Transport Corporation (KSRTC) bus station, railway station and other regular problem areas highly vulnerable to flooding were inundated. In 2014, heavy rains flooded the roads of the city and traffic had to be diverted¹⁰. In 2013, heavy rains have lashed Kerala resulting in floods and landslides in many areas. Nine tourists have been killed in a landslide in the Idukki district of the state while heavy showers in Ernakulam and Kochi disrupted normal life. The Cochin airport was shutdown and flights were cancelled or diverted. In 2011, many parts of the city witnessed water logging. The functioning of the KSRTC Department was partly affected as the ground floor of the building was flooded. MG Road, KSN Menon Road, Karshaka Road, Karikkamuri, Ernakulam market and St. Dominic Road were flooded¹¹.

Kochi is also considered to be prone to earthquakes and to the effect of earthquakes happening in other parts of the country or in the offshore regions.

10. <http://www.deccanchronicle.com/nation/current-affairs/090616/rain-floods-kochi-hits-traffic.html>

11. <http://www.thehindu.com/news/cities/Kochi/heavy-rain-floods-kochi-roads/article6306665.ece>

12. <http://www.thehindu.com/news/cities/Kochi/heavy-rain-floods-many-areas/article2202970.ece>

4. Climate Scenario in the City

4.1. Past Climate Trends

Kunjappy, 2010¹² collected temperature data for seven IMD stations of Kerala from the National Data Centre of IMD, Pune from 1956 to 2004 (49 years). He reported that there was an increase in the maximum temperature over Kerala by 0.64°C and an increase in the minimum temperature by 0.23°C. Overall increase in annual average temperature over the 49 year period was 0.44°C. This indicates a clear upward trend in surface air temperature of Kerala.

Between 1961 and 2003 the mean annual maximum temperature over Kerala has risen by 0.8°C the mean annual minimum temperature has risen by 0.2°C and the average annual temperature increased by 0.5°C¹².

Furthermore, IMD Pune published results of data analysed over a span of 100 years (1901-2007) for stations in north and south Kerala¹³. The data showed that the annual maximum temperature of North Kerala and South Kerala had increased by 1.2°C and 1°C respectively. The increase in temperature was 0.4°C per decade for the past three and half decades.

Kerala showed a decreasing trend in monsoon rainfall for the period 1901-2007. After 1999, rainfall was below the long term average rainfall (except in 2006). Additionally, data from 1961-2003 showed that Kerala has experienced a decline in annual monsoon rainfall in that time.

For Kochi, in a study by USAID, 2003¹⁴, it was found that over the past 50 years, Kochi has experienced an increase in its mean annual temperature of the order of 1°C¹⁵. An analysis of long-term time series (1856-2000) of sea surface temperature anomalies off the Kochi coast shows an increasing temperature over the decades except for negative anomaly periods in the 1950-59 and 1970-79 decades.

Long-term trends in total annual rainfall show a very slight decreasing trend of 8 mm/year, although total monsoon rainfall does not show a decreasing trend. More importantly, over the past 50 years there has been a considerable decrease in the number of rainy days as a part of the annual rainfall pattern¹⁴.

Unnikrishnan et al., 2006¹⁶ estimated a Sea Level Rise for Kochi of 1.14mm/year respectively on the basis of past tide gauge data whereas a study of the pattern of sea level over the period 1949 to 1998¹⁷ indicates that there isn't a significant rise. The historic sea level rise for Kochi is estimated to have been 2 cm in the last one century^{18, 19}.

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12. Kunjappy, R. 2010. Climate Change Impacts In Kerala-An Overview. Centre for Community Health Research (CCHR), FANSA-Kerala Chapter, Kerala.
 13. Indian Meteorological Department, Pune. 2010. In 'Climate Change and India: A 4X4 Assessment - A sectoral and regional analysis for 2030s'. Indian Network for Climate Change Assessment (INCCA). 2010. Ministry of Environment and Forests, Government of India.
 14. U.S. Agency for International Development (USAID). 2003. Possible Vulnerabilities of Cochin, India, to Climate Change Impacts and Response Strategies to Increase Resilience. Oakridge National Laboratory and Cochin University of Science and Technology. http://pdf.usaid.gov/pdf_docs/Pnacx944.pdf
 15. CUSAT, work in progress. Centre for Monsoon Studies, Department of Atmospheric Sciences, Cochin University of Science and Technology.
 16. Unnikrishnan A. S., Kumar K. R., Fernandes S. E., Michael G. S., and Patwardhan S K. 2006. Sea level changes along the Indian Coast: Observations and projections, Current science, 90 (3): 362-368.
 17. Kumar, P. K. 2001. "Monthly Mean Sea Level Variations at Cochin," International Journal of Ecology and Environmental Sources, 27: 209-214.
 18. Emery, K.O and Aubrey, D.G. 1989. Tide gauges of India. J. Coast.Res., 5, pp.489-500.
 19. Das, P.K. and Radhakrishna, M. 1993. Trends and the pole tide in Indian tide gauge records. Proc. Ind. Acad. Sci., (Earth Planet. Sci.), 102(1), pp. 175-183.

4.2. Climate Change Projections and Climate Scenario Statements

Kochi has a tropical climate with intense solar radiation and abundant precipitation. The annual variation of temperature in the Kochi region is between 22°C and 32°C and a more or less uniform temperature exists throughout the year. Rainfall varies from 1,500 mm to 2,000 mm during the south-west monsoon and 400 to 700 mm during the north-east monsoon. The maximum annual rainfall in the region is around 3,000 mm. The humidity is high all round the year because of the nearness to the sea and due to the large area of backwaters in the region.

According to the Indian Network for Climate Change Assessment (INCCA)²⁰ regional assessment, the projected precipitation in the Western Coastal region shows a net increase in 2030's with respect to the simulated rainfall of 1970's by 69mm-109 mm. June, July and August (monsoon) show an average increase of 8 mm rainfall, winter rainfall is projected to decrease on an average by 19 mm during the period January and February and the period of March, April and May also show a decrease in rainfall with respect to 1970s. The assessment also reports that the net increase in temperature will range from 1.7°C to 1.8°C with respect to the 1970's.

The State Action Plan on Climate Change (SAPCC)²¹ local assessment for Kerala using PRECIS models with the help of the Indian Institute of Tropical Meteorology ran climate scenarios for the summer monsoon rainfall and the annual average temperature for 1970s, 2020s, 2050s and 2080s. In terms of rainfall, from the average it was observed that South -Central Kerala districts (Ernakulum, Alappuzha, Kottayam, Pathanamthitta and Idukki) clearly show a positive deviation of 20 to 30 cm from the normal in the 2050s. The maximum temperature increase can be seen in the Southern and Central Districts of Kerala. Palaghat, Ernakulam and Alappzuha would be observed a change of 1.62°C to 1.66°C in the 2050s. The minimum temperature rise in the central districts other than Thrissur will be 1.59°C to 1.64°C. The report also presented the scenario of future sea level. This was obtained by adding the projected values for a given year to the local trend of 0.02 cm per year times the number of years from present. The projected Sea Level Rise (SLR) along Kerala coast on a conservative estimation is about 100 to 200 mm over the next 100 years.

A communication strategy produced under the project Asian Cities Adapt²² developed by ICLEI – Local Governments for Sustainability, in collaboration with Indian Institute of Technology, Delhi and Potsdam Institute for Climate Impact Research came out with the following:

- Projected precipitation may show a net increase over the time duration of 2015-2044 with respect to the simulated rainfall of 1971-1999 by 0.5 mm/day over Kerala subdivision as well as over Kochi.
- Projected mean temperature may show a net increase over the time duration of 2015-2044 with respect to the mean temperatures of 1969-2000 by 0.67oC and 0.53oC over Kerala Subdivision and Kochi respectively.

The information on climate projections from these reports were analysed to determine the climate scenario statements presented in the Table 3. Further details can be found in Annexure 1.

20. Indian Network for Climate Change Assessment. 2010. Climate Change and India: A 4X4 Assessment - A sectoral and regional analysis for 2030s. Ministry of Environment and Forests, Government of India.

21. Government of Kerala. 2014. Kerala State Action Plan on Climate Change. Department of Environment and Climate Change. Government of Kerala.

22. ICLEI South Asia. 2013. City of Cochin's Communication Strategy for Climate Change Adaptation- Guidelines. AsianCitiesAdapt - Impacts of Climate Change in Target Cities in India and the Philippines and Local Adaptation Strategies (ACA), ICLEI- South Asia.

Table 3: Climate Scenario Statements

Changing Climate Conditions	Assessments	Climate Scenario Summary Statements
Temperature change	Regional Assessment ²⁰	The mean annual temperature is projected to increase from 26.8±0.4°C to 27.5±0.4°C in the 2030s. The net rise in temperature with respect to the 1970s will be between 1.7°C and 1.8°C.
	Supplementary Assessment ²¹	The average maximum temperature is projected to increase by 1.62°C to 1.66°C and the average minimum temperature by 1.59 to 1.64°C in the 2050s with respect to the 1950-2000 in the Ernakulam district.
	Local Assessment ²²	Projected mean temperature may show a net increase of 0.53°C in 2015-2044 with respect to the mean temperature of 1969-2000 in Kochi city.
Precipitation change	Regional Assessment ²⁰	The annual rainfall in the Western Coastal region is likely to vary between 935±185.33mm to 1,794±247mm, which is an increase of 6%–8% with respect to the 1970s an increase that is ranging from 69 to 109 mm.
	Supplementary Assessment ²¹	The average monsoon rainfall may show a deviation of 20 to 30 cm from the normal with respect to the 1950-2000 in the Ernakulam district.
	Local Assessment ²²	Projected precipitation may show a moderate increase in 2015-2044 with respect to the rainfall of 1971-1999 by 0.5 mm/day in Kochi city.
Sea Level Rise	Supplementary Assessment ²¹	It is projected that there will be a 100-200 mm rise in sea level over the next 100 years along the coast of Kerala.

In a citizens' perception survey, almost 60% of the respondents expected an increase in heat wave events but perceived no changes in precipitation events.

Sea level rise would increase chances of coastal flooding, which might affect some areas of tourism interest. It would increase saltwater intrusion in both surface waters and ground water sources. It would increase the extent of water logging in Kochi, especially if combined with increased flooding from intense storm events, and could affect some building foundations. The main climate risks likely to affect Kochi as noted from the local assessments and citizen's perceptions have been taken as:

Climate risk 1: Increased Temperature and

Climate Risk 2: Increased Rainfall.

5. Climate Impact Assessment

Climate impact assessment of urban systems helps to assess their fragilities with respect to the climate impacts identified earlier. These urban systems could include '**core systems**' such as water, sewerage, transport which are essential for the running of the city, and '**secondary systems**' such as health, education, sanitation which rely on the core systems. The urban system analysis identified four fragile urban systems for Kochi:

- A. Water Supply
- B. Solid Waste Management
- C. Sewerage Management
- D. Drainage

The current issues, the corresponding fragility caused as a result of these issues and finally the impact of climate on these systems are detailed henceforth.

Annexure 2 details how the urban fragile systems were arrived at.

5.1. Urban Systems Analysis

5.1.1. Water Supply

Situation Analysis

Across Kochi, a majority of the ground and surface water sources are saline or polluted and therefore are not potable. This is mostly due to salt water ingress and poor septage management practices. Water is sourced from the Periyar River which is 20 km away. Rural and urban domestic consumers depend on this protected water source for their drinking water needs. At the Aluva head works and treatment plant which has a capacity of 225 MLD, this water is treated. Approximately 70 MLD²³ of treated water is supplied to the corporation of Kochi and rest is supplied to adjacent areas. There are four clear water reservoirs in the Aluva Water Treatment Plant with holding capacities of 676.8 m³, 172.8 m³, 4,009.9 m³ and 1,513.75 m³. Water that is treated is then distributed by the KWA. KWA (formerly the Public Health Engineering Department (PHED)) is responsible for the planning, implementation and maintenance of water supply and sewerage schemes for the Government of Kerala.

Kochi has the unique characteristic of being the industrial and commercial capital of Kerala, having the largest number of wards (74) and is densely populated. Due to a high standard of living the estimated water demand is 200 lpcd²⁴ which is 65 lpcd more than the national standard of 135 lpcd. The quantum of water supplied varies from 165 lpcd²¹ to 138 lpcd²⁵ as per different sources. The City Development Plan also estimates a gap of 135 MLD in supply.

Some amount of ground water is extracted to overcome the shortage of water mainly for non-consumption purposes. Large households or apartment complexes with only one connection, buy water from tankers. The corporation therefore depends on three sources of water: KWA, groundwater and tankers. Duration of water supply by KWA ranges from eight hours to a half to ½ hour every day in the corporation and other surrounding areas.

23. <http://cpheeo.nic.in/SDWQ%20-%202025/12%20KOCHI.pdf>

24. Department of Town and Country Planning, 2010. Development Plan for Kochi City Region 2031- Volume 1-Study and Analysis. Government of Kerala.

25. Personal Communication, Kochi Municipal Corporation. 2016.

Scarcity of potable water (due to pollution and inefficiencies in use) is one of the most “urgent and visible sources of political discontent in the city”¹⁴. The huge demand/supply gap, is likely to widen drastically in future. Other issues are limited revenue recovery attributed to poor metering (40% of meters are faulty), exorbitant illegal connections and public stand posts. Furthermore, the regulatory mechanism to oversee the functioning of the sector and to fix service standards as well as tariff to meet capital and operating expenditure is lacking and the available Government mechanism is not functioning properly.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Water Supply in Kochi, the fragility statement for this system is ‘The efficiency of the city’s water supply system is constrained by limited sources to meet the potable water needs of the city, contaminated ground water due to poor sanitary practices and poor infrastructure.’

Projected increase in temperature, spells increased demand for water. Furthermore, limited, unpolluted, freshwater water sources within the city will be extremely stressed. Increase in rainfall can have an effect on the quality of the drinking water supply by increasing erosion and the sediment load of the river. It can also increase flooding, resulting in the release of additional pollution into the supply and reducing the proportion of precipitation that is captured for productive use.

The climate fragility statements for this system are:

Climate risk 1: Higher temperatures would result in increased rates of water evaporation and demands for potable water putting stress on the system.

Climate risk 2: Increased rainfall can lead to flooding and consequent contamination of the groundwater as well as salt intrusion.

5.1.2. Solid Waste Management

Situation Analysis

KMC generates around 350 tonnes of solid waste daily. Most of the waste is organic in nature (48%) having a low calorific value. Households and small shops contribute about 67%, markets (vegetable, fruits, and meat) about 10%, hospitals and health care establishments another 10%, and hotels and restaurants the remaining 13%.

The Health Department of KMC is the management authority concerned with SWM. The collection, transportation, disposal of municipal solid waste is the responsibility of the Health Department while the Engineering Department assists them in planning, formulation of programs and in procurement of vehicles, equipment and developing the landfill site.

The corporation is divided into 21 circles for the purpose of SWM. Each circle comprises of 1 to 5 wards and is managed by a Health Inspector (HI) who is assisted by Junior Health Inspectors. The Vehicle Section (Circle 22) headed by a senior HI is responsible for deployment of vehicles and for direct collection of waste from hotels and hospitals in eastern zone of the city.

30% of households are serviced by a door to door collection. Rag pickers, Kudumbashree and private operators are engaged to provide this service through either the RWA or the Ward Councillor²⁶. There is a network of community collection points, a significant number of which are open points where the waste is

26. German Agency for Technical Cooperation . 2010. City Sanitation Plan for Kochi.2010: Status report. ICRA Management Consulting Services Ltd. GTZ.

transported to. Only 50% of waste is collected at secondary collection points and transported. The remainder is dumped illegally on road sides, vacant plots and water bodies. Container *lorries* and trailers deposit the collected waste on municipal land at Willingdon Island, Cheranellur, and Brahmapuram. Dumping of waste at Cheranellur was discontinued due to protests from the locals.

Although 40%²³ of the corporation's revenue goes into the O&M of the SWM system, service is inadequate and poor in urban areas. A lack of designated waste disposal sites and an inadequate collection and disposal system pose chronic challenges for health, sanitation, and environmental degradation.

Fragility Statement and Climate Fragility Statement

Considering the present situation of SWM in Kochi, the **fragility statement** for this system is '*Inadequate designated waste disposal sites, open dumping of waste and an inadequate collection and disposal system cause chronic challenges for health, sanitation, and ecosystem functioning.*'

The impacts of the climate scenarios (increased temperature and increased precipitation), were then superimposed on this fragile urban system. The combination of water stagnation, waste accumulation, and warm temperatures provide an excellent breeding ground for disease causing organisms and the disease vectors (mosquitoes, flies and rodents) which can transmit the diseases to humans. At the same time, increased precipitation can lead to an extreme risk of improper waste management related problems, especially clogging of drains and other outlets. Though increased temperature and precipitation pose threats, the stakeholders in the SLD agreed to the scenario of increased temperature having a more serious impact, thereby needing greater attention.

The climate fragility statement for this system is:

Climate risk 1: Increased temperature may alter waste decomposition rate and leachate production rate which will lead to the spread of infectious diseases.

5.1.3. Sewerage Management

Situation Analysis

In the 1970s a sewage scheme was commissioned which envisaged coverage of the entire city. Unfortunately, it could not be implemented and today, only 3% of the total area in the heart of the city i.e. General Hospital area (2.5 sq. km) and Gandhi Nagar (1.50 sq. km) is covered by the existing sewerage system²⁷. A Sewage Treatment Plant (STP) of 4.5 MLD capacity commissioned in 1955 which treats sludge, is located at Ernakulam. The sewerage system and treatment plant is maintained by the KWA.

Sewerage service levels in Kochi have not kept pace with the growth of the city and fall below service level norms. The corporation therefore depends on on-site disposal of toilet waste and open surface drain disposal of sullage. In areas which do not suffer from water logging, have good soil permeability and low population density, onsite options like septic tanks with twin pits are good options. This unfortunately cannot be applied to the western coastal parts of the Kochi City as the area is often flooded during monsoon. Service provision for the cleaning and ongoing maintenance of the septic tanks is done by private sector providers who have no scientific or technical knowledge of the management of sewage. These providers illegally release the sewage into water bodies and open spaces²⁶.

27. Personal Correspondence, KMC.2016.

Effluents from toilets are commonly seen overflowing into drains, backwaters and rivers in the region. In the monsoon, sullage mixes with rainwater and contaminates drinking water. In summer, stagnating sewerage having high Biological Oxygen demand (BOD) levels in open drains provide excellent areas for mosquito breeding. Besides, there is a prevalence of water /excreta related diseases like typhoid, gastroenteritis, diarrhoea, amoebic dysentery etc.

According to the Development Plan for Kochi City, 2010²⁴, the major issues emerging are:

- The ground water contamination from on-plot systems. The contamination leads to health issues in dense urban pockets in West Kochi.
- The contamination in open drains, canals, back waters and rivers caused by the combined flow of sullage and storm water. Combined drains are often difficult to maintain in a situation as in flat terrain areas of Kochi City Region.

Fragility Statement and Climate Fragility Statement

Considering the present situation of sewerage in Kochi, the **fragility statement** for this system is '*insufficient infrastructure for the collection and management of sewerage and septage, the high water table and poor civic sense of citizens, results in waste being disposed into the canals and drains.*'

In the case of sewerage, the stakeholders felt that the impacts of the increase in rainfall events would significantly impact the system. Poor sewerage coverage, the high water table, poorly serviced septic tanks, leakages from the soak pits will create environments that are favourable for the spread of water and vector borne diseases during heavy rainfall events. The climate fragility statement for this system is:

Climate Risk 1: Increased temperatures would impact health as stagnating water, whether grey or black, will become a conducive breeding ground for harmful pathogens, insects and pests.

Climate Risk 2: Increased rainfall will increase incidences of water logging which will affect the sewerage management system infrastructure. Furthermore, there can be instances of freshwater and rainwater mixing with sewerage and sludge, polluting limited freshwater bodies and facilitating the spread of diseases.

5.1.4. Storm Water Drainage

Situation Analysis

Kochi city has a relatively flat topography with western parts of the city being only one meter above Mean Sea Level. The drainage system is made up of primary canals which are the major natural canals, secondary drains which can be either natural or manmade and are the feeder drains of the primary canal, and finally, area drains which discharge storm water and sullage to the secondary drains (Table 4). Overall, the contents of the drains in Kochi are carried to the Vembanad Lake and back waters.

Table 4: Length of various drains present in KMC area

S. No.	Drain type	Length (km)
1	Primary drains	77
2	Secondary drains	222
3	Area Drains	740

The primary canals run in the north-south direction and convey storm water runoff into the back waters. Once navigable, they are now highly degraded due to encroachments, waste dumping, silting, weed growth and an absence of any form of protective measures. Area drains due to rapid urbanization and extension of the city boundaries are absent in many places. Neighbourhoods which lack these are highly prone to water logging especially during the monsoons. These drains need immediate priority according to the City Development Plan of Kochi, 2010²⁴.

The drainage network coverage is about 41% relative to the road networks and the drains are absent in many areas with urban proliferation²⁸. The drains of the city are inadequate either due to their size, design or maintenance level. In the absence of sewerage, the storm water drains carry sillage and effluent from septic tanks and excreta disposal systems. It is estimated that in Kochi City about 72,000²⁹ septic tanks discharge to open drains. Waste dumping in the drains clogs them and renders them ineffective during excess rainfall events. It also exacerbates disease risk as the conditions of the drains become very unhygienic due to poor civic behaviour.

Additionally the city is very prone to water logging for a number of reasons which include its topography type, the permeability of the soil, and the drainage infrastructure.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Storm Water Drainage in Kochi, the **fragility statement** for this system is *'Encroachment and poor conditions of the canals, heavy deposits of silt and discharge of solid and liquid waste into the drains, and inadequate coverage of the drainage system is resulting in many parts of the city being waterlogged and susceptible to disease.'*

During heavy rainfall events, instances of flooding and water logging will only increase. Areas that used to be drained off by the canal system of the city (now encroached and largely polluted), as well as areas that are poorly drained and susceptible to water logging will be prone to more damaging flooding. Stagnating water, backflow of sewerage and solid waste into homes will impact health and wellbeing of residents and increase the incidence of mosquitoes and flies. Given that the water table in Kochi is quite high, increased rainfall will further add to ground water contamination by pollutants. Even a relatively modest degree of sea level rise will add to the city's flooding risk.

Climate Risk 1: Increased rainfall when coupled with clogged drains will lead to increased incidences of water logging and flooding in the city. This will have profound impacts on the infrastructure, finance and health of Kochi city.

5.2. Risk Assessment

The risks associated with the fragilities of these systems were calculated through a risk assessment exercise conducted by the stakeholder group. The fragile urban systems with the highest risks as per the assessment were investigated further.

The risk score for each climate fragility statement is defined as a combination of the likelihood of an event to occur and the consequences faced if the event occurred. The process followed for risk scoring is detailed in Annexure 3. Table 5 shows the risk status of the climate fragility statements.

28. <http://www.sswm.info/content/case-study-kochi>

29. Irrigation Division, Ernakulam, CoC, Municipalities, Panchayats

Table 5: Risk Assessment of Climate Fragility Statements

Urban System	Impacts of Climate Change	Risk Status
Water Supply	Higher temperatures would result in increased rates of water evaporation and demands for potable water putting stress on the system.	High
	Increased rainfall can lead to flooding and consequent contamination of the groundwater as well as salt intrusion.	
Solid Waste Management	Increased temperature may alter waste decomposition rate and leachate production rate which will lead to the spread of infectious diseases.	Extreme
Sewerage Management	Increased temperatures would impact health as stagnating water, whether grey or black, will become a conducive breeding ground for harmful pathogens, insects and pests.	Extreme
	Increased rainfall will increase incidences of water logging which will affect the sewerage management system infrastructure. Furthermore, there can be instances of freshwater and rainwater mixing with sewerage and sludge, polluting limited freshwater bodies and facilitating the spread of diseases.	
Storm Water Drainage	Increased rainfall when coupled with clogged drains will lead to increased incidences of water logging and flooding in the city. This will have profound impacts on the infrastructure, finance and health of Kochi city.	Extreme

Based on this risk assessment, all the fragile urban systems show extreme and high risk and require urgent attention.

6. Vulnerability Assessment

6.1. Overview

In order to build resilience there is a need to understand the extent of vulnerability of the city to climate change. This vulnerability depends upon the geographical location, demography, infrastructure, socio economic condition, ecological condition of the city. The Intergovernmental Panel on Climate Change (IPCC, 2007)³⁰ defines vulnerability as a function of three parameters of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

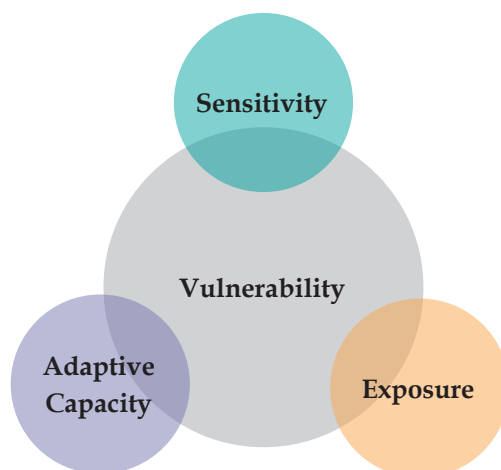


Figure 3: Vulnerability Constituents³⁰

Vulnerability assessment through the IAP consists of identification of vulnerable areas and actors for all the prioritized climate fragility statements of the fragile urban systems and analysis of the adaptive capacities of these systems. Vulnerability assessment of Kochi city was carried out in consideration of the following elements:

1. **Identification of Vulnerable Places:** Highly vulnerable areas in context of identified fragile urban system of the city were identified and mapped to arrive at vulnerable hotspots affected by maximum number of fragile urban systems.
2. **Identification of Vulnerable actors and their adaptive capacity:** In each of the vulnerable areas, the actors that play a critical role towards building urban resilience were identified and assessed in terms of their capacity to organize and respond to threat or disruption, access to resources necessary for response (manpower, technology, funds) and access to information necessary to develop effective plans and actions and to improve responses to disruptions. These determine the adaptive capacity/resilience of the identified actors for a particular fragile system.
3. **Assessment of Capacities of Urban Systems:** Adaptive capacity of urban systems is its capacity to absorb and respond to shocks that determines their resilience. The adaptive capacity was determined in the context of economy, technology/infrastructure, governance, social systems and ecosystems.

The sections below identify the vulnerable areas, vulnerable actors and adaptive capacity of the fragile urban systems using the climate fragility statements developed in consultation with the Stakeholder Committee. Identification of vulnerable areas of Fragile Urban Systems.

30. IPCC. 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Annex I., M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK.

6.2. Identification of vulnerable areas of Fragile Urban Systems

6.2.1. Water Supply: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Higher temperatures would result in increased rates of water evaporation and demands for potable water putting stress on the system.	Core areas of Fort Kochi and Matancherry, ward 61 and ward 62 (Figure 4).
Increased rainfall can lead to flooding and consequent contamination of the groundwater as well as salt intrusion.	

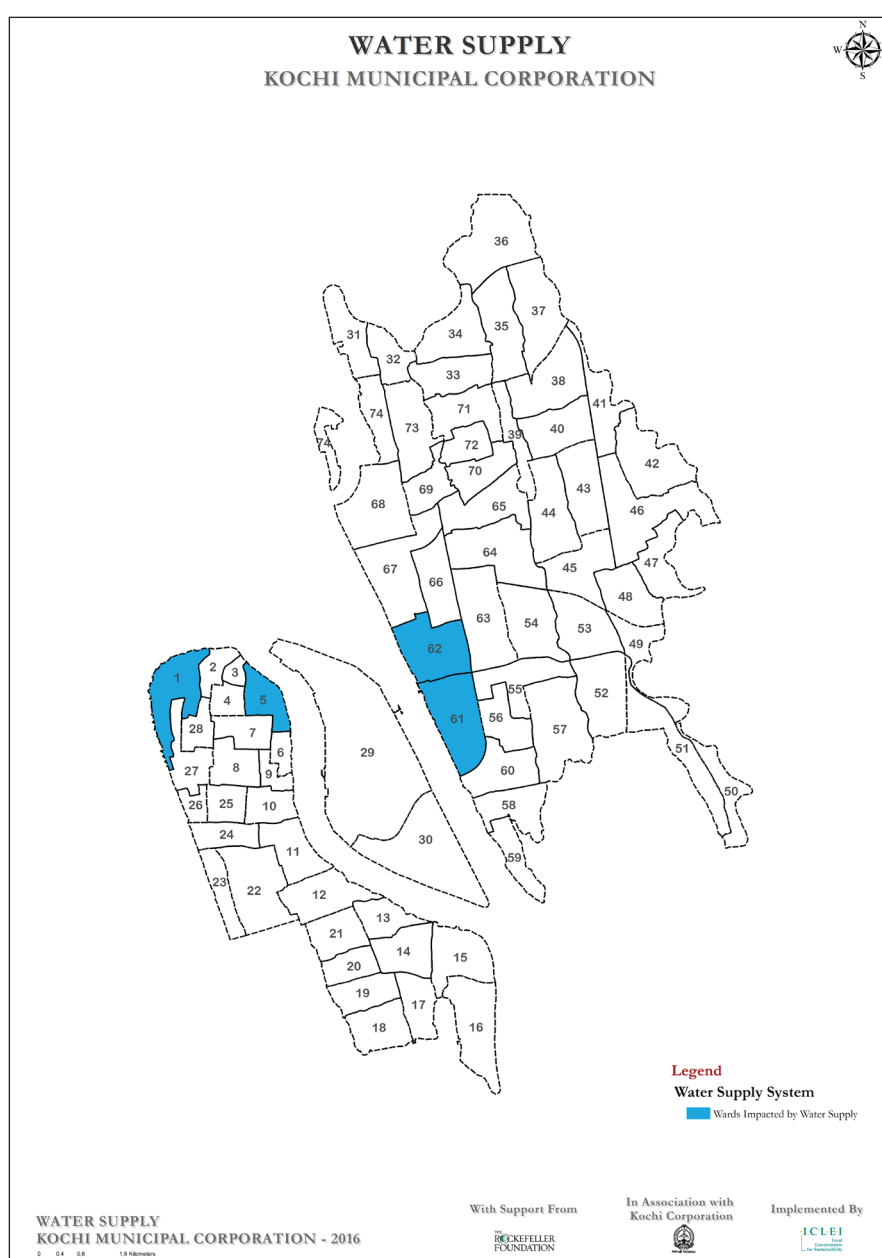


Figure 4: Areas most vulnerable to climate risks in the context of Water supply, Kochi

6.2.2. SWM: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Increased temperature may alter waste decomposition rate and leachate production rate which will lead to the spread of infectious diseases.	Entire city (All 74 wards) (Figure 5)



Figure 5: Areas most vulnerable to climate risks in the context of SWM, Kochi

6.2.3. Sewerage: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Increased temperatures would impact health as stagnating water, whether grey or black, will become a conducive breeding ground for harmful pathogens, insects and pests. Increased rainfall will increase incidences of water logging which will affect the sewerage management system infrastructure. Furthermore, there can be instances of freshwater and rainwater mixing with sewerage and sludge, polluting limited freshwater bodies and facilitating the spread of diseases.	Entire city (All 74 wards) (Figure 6).



Figure 6: Areas most vulnerable to climate risks in the context of Sewerage, Kochi

6.2.4. Storm Water Drainage: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Increased rainfall when coupled with clogged drains will lead to increased incidences of water logging and flooding in the city. This will have profound impacts on the infrastructure, finance and health of Kochi city.	Entire city (All 74 wards) (Figure 7).



Figure 7: Areas most vulnerable to climate risks in the context of Drainage, Kochi



Figure 8: Vulnerability Hotspot map, Kochi

Through these assessments, most of city was found to be vulnerable. However after discussions with the city, wards 1 (fort Kochi), 5 (Matancherry), 61 (Ravipuram), and 62 (Ernakulam South) were assessed as the most vulnerable to all fragile urban systems. It is important to note that these wards have substantial slum population. Ward 1 has a large population who are from the fishermen community, and thus their livelihood depends on the productivity of the sea and is greatly impacted by the climate risks. Wards 61 and 62 are areas where water logging occurs regularly because of lack of or poorly maintained infrastructure. Ward 62 also has a slum population. These wards are therefore considered as the vulnerability hotspots. The vulnerability hotspot map (Figure 8) helps to identify the wards which must be focused on for future interventions to build resilience that are identified in later chapters.

6.3. Actor Analysis

This section focuses on the analysis of the adaptive capacities of urban actors identified within the vulnerable wards.

The assessment was done based on three parameters including 1) capacity to organize and respond, 2) availability of resources, and 3) access to information. Actors who receive a low adaptive capacity score are classified as vulnerable actors while those who receive medium and high scores are classified as supporting actors who can aid the local government in helping the vulnerable households better deal with climate risk.

Table 6 below shows that most of government departments (such as KWA, GCDA, PWD, KMC) of Kochi city were scored as medium or high illustrating that they can be supporting actors while slum population, Women Self Help Group (*Kudumbashree*), citizen, fishermen community received low scores underlining the importance of building their capacities in order to build resilience within the wards.

It is interesting to note that parastatal departments such as KWA (responsible for the provision of potable water in the city) scored high despite the poor state of the relevant urban systems. This may be because these departments have the technical capacities, the access to information and some amount of resources however they are unable to meet the demand brought on by high rates of urbanisation due to several political, administrative and financial limitations which operate at other levels. *Kudumbashree* play an important role in waste collection, but their technical knowledge of the aspects of waste management is lacking. The hotel owners are financially very strong; however, their lack of willingness, awareness makes them also a vulnerable group like slum dwellers or fishermen communities who lack financial resources and access to information.

Table 6: Analysis of the adaptive capacities of local actors identified

Fragile Urban System	Climate Fragility Statements	Area/ ward	Actors	Level of Adaptive Capacity
Water Supply	Higher temperatures would result in increased rates of water evaporation and demands for potable water putting stress on the system. Increased rainfall can lead to flooding and consequent contamination of the groundwater as well as salt intrusion.	Core areas of Fort Kochi and Matancherry, ward 61 and ward 62	Citizens	Low
			Hotels	Low
			Fisheries Industries/ Fisherman Community	Low
			KMC	High
			KWA	High
Solid Waste Management	Increased temperature may alter waste decomposition rate and leachate production rate which will lead to the spread of infectious diseases.	Entire city	Citizens (includes slum dwellers)	Low
			KMC	Medium
			Ward Committees	Low
			RWA	Low
			Kudumbashree	Low

Fragile Urban System	Climate Fragility Statements	Area/ ward	Actors	Level of Adaptive Capacity
Sewerage	Increased temperatures would impact health as stagnating water, whether grey or black, will become a conducive breeding ground for harmful pathogens, insects and pests. Increased rainfall will increase incidences of water logging which will affect the sewerage management system infrastructure. Furthermore, there can be instances of freshwater and rainwater mixing with sewerage and sludge, polluting limited freshwater bodies and facilitating the spread of diseases.	Entire city	KWA	Low
			Commercial Establishments	Low
			Hotel Owner Associations	Low
			Government offices	Low
			Community/ Residents of flats	Low
			Citizens	Low
			GCD	High
			KMC	Medium
Storm Water Drainage	Increased rainfall when coupled with clogged drains will lead to increased incidences of water logging and flooding in the city. This will have profound impacts on the infrastructure, finance and health of Kochi city.	Entire city	Citizens (includes slum dwellers)	Low
			KMC	High
			Institutions	Low
			Commercial Establishments	Low
			Residents of low lying areas	Low
			PWD	High

KMC emerged as a supporting actor across all urban systems. The corporation has the means and will to build resilience and has established good relationships with other government departments. KMC only lacks the access to finance as the work within the municipality is dependent on release of funds from the State department.

6.4. Adaptive Capacity of Fragile Urban Systems

The adaptive capacities of the four fragile urban systems were assessed during the SLD against the five parameters of economy, technology, governance, societal and ecosystem services (Table 7).

Most of the parameters fell in the low-medium category under each urban system. Across most of the fragile urban systems, governance has scored low because of lack of or low scope for interdepartmental coordination between multiple agencies and their areas of jurisdiction, low political willingness especially across water and sanitation. Although the technical and infrastructural parameter may have a medium score across SWM and sewerage, inadequate exposure of officials to modern practices in water supply, sanitation and SWM has affected effective delivery of projects.

Low civic sense and irresponsible behaviour of citizens has resulted in low societal scores especially for Water supply, SWM and drainage. Cost recovery, revenue streams and capital is very low for most of the urban systems and should be prioritised as it can drive technological and infrastructural as well as governance parameters of adaptive capacity.

The assessment illustrates that the city needs to give special focus on strengthening the city's financial system. The city has to adopt advanced technology and sustainable infrastructure to deal with the water supply and storm water drainage system. Additionally, sensitising and involving citizens will improve the adaptive capacity of all the systems and lead to a more resilient city.



Table 7: Consolidated vulnerability analysis of Fragile Urban Systems identified for Kochi city

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive capacity of the system		
			Vulnerable	Potential Supporting	Low	Medium	High
Water Supply	Higher temperatures would result in increased rates of water evaporation and demands for potable water putting stress on the system.	Core areas of Fort Kochi and Matancherry	• Citizens • Hotels • Fisheries	• KMC • KWA	• Economic • Technology/Infrastructure • Governance • Societal	• Ecosystem Services	
	Increased rainfall can lead to flooding and consequent contamination of the groundwater as well as salt intrusion.						
Solid Waste Management	Increased temperature may alter waste decomposition rate and leachate production rate which will lead to the spread of infectious diseases.	Entire city	• Citizens (includes slum dwellers) • Waste Collectors • Ward Committees • Kudumbashree • RWA	• KMC	• Societal • Ecosystem Services • Governance	• Economic • Technology/Infrastructure •	

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive capacity of the system		
			Vulnerable	Potential Supporting	Low	Medium	High
Sewerage	Increased temperatures would impact health as stagnating water, whether grey or black, will become a conducive breeding ground for harmful pathogens, insects and pests.	Entire city	- KWA - Commercial Establishments - Hotel Owners Associations	- GCDA - KMC	- Economic - Governance	- Technology/Infrastructure - Societal	Ecosystem Services
	Increased rainfall will increase incidences of water logging which will affect the sewerage management system infrastructure. Furthermore, there can be instances of freshwater and rainwater mixing with sewerage and sludge, polluting limited freshwater bodies and facilitating the spread of diseases.		- Government offices - Community/Residents of flats - Citizens				
Storm Water Drainage	Increased rainfall when coupled with clogged drains will lead to increased incidences of water logging and flooding in the city. This will have profound impacts on the infrastructure, finance and health of Kochi city.	Entire city	- Citizens (includes slum dwellers) - Institutions - Commercial Establishments - Residents of low lying areas	- KMC - PWD	- Economic - Technology/Infrastructure - Societal	- Ecosystem Services - Governance	

7. Resilience Interventions

Possible adaptation interventions were identified for the four fragile urban systems in Kochi on the basis of their climate risks and vulnerabilities, the vulnerable areas and the vulnerable actors to adapt to the possible impacts of climate change on these systems. Once the interventions were determined, their resilience score was calculated as high, medium, average and low on the basis of their resilience potential assessed in terms of their redundancy, flexibility, responsiveness and ability to increase access to information. If the interventions improved only one indicator mentioned above, their score was low, if they addressed two, their score was average, if they addressed three, their score was medium and if they addressed all four, their score was high. The climate resilience interventions were also assessed qualitatively for their technical, financial and political feasibility. The overall feasibility was calculated as an average of the qualitative feasibility for all three indicators. Finally their impact on the overall resilience of the city (short, medium or long term) was considered to assess the average time taken for the impacts to be felt on the resilience of the city.

These interventions were linked to existing city plans and schemes so as to determine whether the required interventions can be integrated with little or no additional resources into existing departmental programs or projects.

A total of 25 resilience interventions have been identified in the process as listed in **Table 8**. The interventions are grouped by fragile urban system and as infrastructural or non-infrastructural measures. The overall resilience score, overall feasibility and impact on the resilience of the city is given in the table. The table also gives an indicative duration for implementing the intervention as short (0-3 years needed), medium (3-5 years needed) or long term (more than 5 years needed) and an indicative cost requirement for the intervention as high (requiring substantial financial support), medium (requiring partial financial support) or low (can be covered by city budget). Each intervention's possible co-benefits are also outlined in the table.



Table 8: Prioritised Resilience Interventions

Prioritised Resilience Interventions	Overall Resilience score	Overall Feasibility	Time taken for Impact on Resilience of City	Duration of Implementation Short/ Medium/ Long term	Indicative Cost (Low/ Medium/ High)	Potential Co-benefits
Water Supply						
Infrastructural Measures						
Upgrade and modernize the water supply distribution system.	Average	High- medium	Medium term	Medium	High	
Rain water harvesting structures for reuse of water especially in public buildings.	Medium	High	Short term	Short	Medium	Can be used for recharge if excess rainfall is there.
Desalinization of the sea water to enhance water sources.	High	Medium	Long term	Medium	High	
Policy/ Non-Infrastructural Measures						
Mapping of the water supply system.	Average	High	Medium term	Short	Medium	
Developing a Management Information System to monitor the water supply system.	Average	High	Long term	Short	High	
Solid Waste Management						
Infrastructural Measures						
Decentralized SWM system with community level composting and processing units. Recyclables recovered at the processing units can be sent to recycling centres and non recyclables can be used to prepare Refuse Derived Fuel (RDF).	High	Medium	Long term	Short	Medium	Can generate income, promote resource recovery, reduce emissions.
Source segregation at the household level.	High	High	Medium term	Short	Medium	Can promote resource recovery and create income generating options.

Prioritised Resilience Interventions	Overall Resilience score	Overall Feasibility	Time taken for Impact on Resilience of City	Duration of Implementation Short/ Medium/ Long term	Indicative Cost (Low/ Medium/ High)	Potential Co-benefits
Policy/ Non-Infrastructural Measures						
Awareness generation on the three Rs as well as on the benefits of source segregation.	Medium	High	Long term	Short	Medium	
Training of Kudumbashree members on the aspects of decentralised SWM.	High	High- Medium	Long term	Short	Medium	Create skills to enhance capacity of members.
Sewerage						
Infrastructural Measures						
Replace brick made tanks, with readymade prefabricated tanks/ Ferro cement pits which are leakage free.	Medium	High	Medium term	Short	High	
Implementation of recommendations within the City Sanitation Plan.	High	High	Medium term	Medium	High	
Public Private Partnership (PPP) mode of sewage treatment wherein private players collect and transport waste and the city is responsible for waste treatment.	Medium	Medium	Long term	Short	High	Can promote efficiency and good governance.
Policy/ Non-Infrastructural Measures						
Improve interdepartmental coordination.	Average	High	Long term	Short	Low	Better governance and transparency, along with better developmental planning.
Strict regulation of private sewage removal service providers.	Medium	Medium	Long term	Short	Low	Can generate revenue for municipal authority.

Prioritised Resilience Interventions	Overall Resilience score	Overall Feasibility	Time taken for Impact on Resilience of City	Duration of Implementation Short/ Medium/ Long term	Indicative Cost (Low/ Medium/ High)	Potential Co-benefits
Development of guidelines as to how sewage and septage must be collected, transported and treated.	Medium	High	Long term	Short	Low	
Awareness generation activities on hygiene, appropriate sewage disposal alternatives, solid waste disposal.	Medium	High	Long term	Short	Medium	Can be used simultaneously for various issues.
Drainage						
Infrastructural Measures						
Covering of drains with prefabricated cover which can be opened for cleaning purpose in a regular basis.	Average	Medium	Medium term	Short	High	
Regular cleaning of drains especially before the monsoons.	Medium	High- Medium	Short term	Short	Medium	
Procurement of flood control pumps.	Average	High- Medium	Short term	Short	High	
Removal of encroachments.	Average	Medium- Low	Long term	Short	High	Land use can be managed better.
Policy/ Non-Infrastructural Measures						
Contour mapping of drainage system.	Average	High- Medium	Medium term	Short	Medium	
Preparation of a city-wide drainage and canal master plan.	Average	Medium	Medium term	Short	Medium	
Monitoring Information System that will assist in Monitoring & Evaluation and O&M of the drainage system.	Average	High	Long term	Short	High	Good governance practices will be encouraged.
Awareness generation on prevention of waste dumping into drains and canals.	Medium	High	Long term	Short	Medium	Can be used for other issues as well.

Interventions that scored high or medium on resilience and high on feasibility can be taken up by the city and its departments especially those that can be implemented in a short time like awareness generation programmes, enforcement of bye laws etc.

7.1. Integration into City Plans

7.1.1. Water Supply

The city has arranged work on rainwater harvesting structures at the household level. A total of 1,212 units have been commissioned, with the government contributing 11,000 INR and a beneficiary contribution of 2,750 INR.

Table 9: Status of projects in water supply sanctioned under the State Annual Action Plan (SAAP) work plan of AMRUT 2015-2016³¹

Sl. No.	Name of Project	Cost (In Crores)	Status (As on 2015)
1.	Replacement of existing distribution cum pumping main with 600mm rider pumping main from Karuvelipady to Koovapadam.	3.65	DPR prepared by Kerala Water Authority & submitted
2.	Construction 15l Capacity Galvanised Iron (GI) Tank at Karuvelipady.	3.2	

KMC has also applied for funding under the AMRUT programme 2016-2017 to augment the water supply infrastructure as detailed in table 10.

Table 10: Details of projects under SAAP 2016-2017, Kochi city

S. No.	Sector	Amount in Crores
1.	Replacement of old damaged pipeline along Pandit Karuppan road.	1.65
2.	Replacement of old damaged pipe line from Valanjambalam to Ravipuram.	0.69
3.	Replacement of old damaged pipe line along Konthuruthy branch road.	0.70
4.	Zoning by renovation of existing Kadanthra overhead tank 22 lakh litre capacity including laying pumping main from Thammanam to Kadanthra.	10.00
5.	Zoning by constructing new sump of capacity of 2.5 lakhs and overhead tank 17l at Pachalam Division.	8.00
6.	Laying transmission main from Kathrukadavu to Pachalam.	7.00
7.	Edakochi south second reach-laying pipe line.	1.50
8.	Laying pumping main 700 mm DI pipe from JnNURM treatment plant Maradu to Thammanam pump house for additional pumping of water (up to 40 mld) to Kochi city.	17.50
9.	Laying rider line from Kathrikadavu to Elamkulam Chettichira, Ponnurunni areas & distribution lines in Chakaraparambu Chalikavattom areas.	5.00

31. http://smartkeralamission.org/wp-content/uploads/2016/08/Review-meeting-6th-oct-16-ULB_KOC.pdf

7.1.2. Sewerage

Under the SAAP 2015-2016, a new STP is being constructed, rehabilitation of the STP at Elamkulam is underway and arrangements are being made for septage treatment. Furthermore a DEWATS unit for three divisions is in phase 1 of installation.

All projects currently underway and planned for sewerage are consolidated in Table 11 below:

Table 11: Sewerage projects approved under the SAAP 2015-2017

Sl. No.	Name of Project	Cost (In Crores)	Implementation
1.	Construction of new STP and rejuvenation of existing STP at Elamkulam and arrangements for septage treatment	20	DPR to be prepared
2.	Phase I: Decentralised sewage system one unit for divisions 15,16,17	13.78	DPR under preparation by Shah consultancy
	Phase II: Decentralized sewerage system for Three Divisions	total cost required =60 Cr. for year 15-16 & 16-17	Projects as per SAAP 2016-2017
3.	Construction of 2 lakh litre sump, pump house and allied electrical works and 15 lakh litre capacity Overhead tank at Vadathode Kunnumpuram	8.00	
4.	Construction of OHT of 10 lakh litre capacity at Thevara	3.00	

7.1.3. Drainage

Presently KMC is renovating Pashnithodu Canal and silt removal is in progress. This is being done with funds released under the SAAP 2015-2016 of the AMRUT scheme (Table 12). KMC has proposed the following projects³² with respect to storm water drainage. This will contribute to the expansion of the current network.

Table 12: Projects proposed under AMRUT 2015-2016

Sl. No.	Name of Project	Cost (In Crores)	Implementation
1.	Rejuvenation of Pashnithodu Canal	2	DPR prepared
2.	Thevara Perandoor Canal renovation	22.56	DPR under preparation by CMMU& KMC
3.	Construction of Stadium Link road drainage		
4.	Renovation of canals and sub drains	13.00	Projects as per SAAP 2016-2017
5.	Construction & renovation of area drains	4.44	

A summary of the issues, climate impacts, vulnerable areas and resilience actions sector-wise is given below.

32. AMRUT SLIP Storm water Drainage, Kochi city

Water Supply

Issues:	- Shortage in water supply during summer - Salt water intrusion - Ground water contamination due to the poor functioning of the septage management system	
Some Existing / Planned Measures:	Rainwater harvesting structures at the household level	
Potential Climate Impacts:	Higher temperatures would result in increased rates of water evaporation and demands for potable water putting stress on the system. Increased rainfall can lead to flooding and consequent contamination of the groundwater as well as salt intrusion.	
Potentially Impacted Prabhags / Areas:	Core areas of Fort Kochi and Matancherry, ward 61 and ward 62	
Risk Status:	High	
Actors:	Vulnerable - Citizens - Hotels - Fisheries Industries / Fisherman Community	Supporting - KMC - KWA

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Developing a Management Information System to monitor the water supply system.	Consultant costs, cost of infrastructure.	INR 50 lakhs
Infrastructural Measures		
Rain water harvesting structures for reuse of water especially in public buildings.	Cost of structures for individual units, civil and construction work.	INR 5 lakhs per unit

Solid Waste Management

Issues:	- Significant amount of unsegregated waste generated - Lack of a proper SWM system - Limited functioning of the only composting plant in the city - Common practice of open dumping instead of proper disposal	
Some Existing / Planned Measures:		
Potential Climate Impacts:	Increased temperature may alter waste decomposition rate and leachate production rate which will lead to the spread of infectious diseases.	
Potentially Impacted Areas:	Entire city	
Risk Status:	Extreme	
Actors:	Vulnerable - Citizens (includes slum dwellers) - Waste Collectors - Ward Committees - Kudumbashree - RWA	Supporting KMC

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Training of <i>Kudumbashree</i> members on the aspects of decentralised solid waste management.	Cost of training materials, venue, staff.	INR 2 lakhs per training
Infrastructural Measures		
Decentralized SWM system with community level composting and processing units. Recyclables recovered at the processing units can be sent to recycling centres and non recyclables can be used as RDF.	Cost of setting up of composting units, recyclable processing unit, RDF facility.	Ranges from 140-370 INR per tonne of waste for annual capacities of 45 MT to 500 MT. Higher the capacity lower the rate. Operation and maintenance costs are in the range of 120 – 290 INR per tonne.

Sewerage

Issues:	- Only 5% of the city is covered by the sewerage system, which is operating below efficiency. - The rest of the city (95%) is connected to septic tanks, many of which are not properly functioning. - Due to the water table being very high, the tidal effect and the heavy rainfall, soak pits do not operate properly. - Waste (including sludge and grey water) ends up in the open drains and contaminates ground water.	
Some Existing/Planned Measures:	Phase I of the decentralised sewage system is underway.	
Potential Climate Impacts:	- Increased rainfall will increase incidences of water logging which will affect the sewerage management system infrastructure. Furthermore, there can be instances of freshwater and rainwater mixing with sewerage and sludge, polluting limited freshwater bodies and facilitating the spread of diseases. - Increased temperatures would impact health as stagnating water, whether grey or black, will become a conducive breeding ground for harmful pathogens, insects and pests.	
Potentially Impacted Areas:	Entire city	
Risk Status:	Extreme	
Actors:	Vulnerable - KWA - Commercial Establishments - Hotel Owners Associations - Government offices - Community/ Residents of flats - Citizens	Supporting - GCDA - KMC

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Strict regulation of private sector sewage removal service providers.	Cost of meetings, cost of developing by-laws, staff costs.	INR 2.5 lakhs per year
Infrastructural Measures		
Strict regulation of private sector sewage removal service providers.	Cost of meetings, cost of developing by-laws, staff costs.	INR 2.5 lakhs per year

Storm Water Drainage

Issues:	- The system is very old. - There is no planned drainage system following the contour maps of the city. - More than 50% of the drains are uncovered or open drains. - Solid and liquid waste is dumped in the drains.	
Some Existing / Planned Measures:	Rejuvenation of Pashnithodu Canal	
Potential Climate Impacts:	Increased rainfall when coupled with clogged drains will lead to more incidences of water logging and flooding in the city. This will have profound impacts on the infrastructure, finance and health of Kochi city.	
Potentially Impacted Prabhags / Areas:	Entire city	
Risk Status:	Extreme	
Actors:	Vulnerable - Citizens (includes slum dwellers) - Institutions - Commercial Establishments - Residents of low lying areas	Supporting - KMC - PWD

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Monitoring Information System that will assist in M&E and O&M of the drainage system.	Cost of consultants and systems.	INR 50 lakh
Infrastructural Measures		
Regular cleaning of drains especially before the monsoons.	Staff costs, material costs.	INR 15 lakh per km

8. Conclusion

The implementation of the IAP toolkit in the rapidly urbanising seaside city of Kochi revealed its vulnerabilities to climate risks of increased temperature, rainfall and sea level rise. The city needs to adapt to possible impacts of these changes. Although sea-level rise was not considered in the overall analysis, Kochi being an industrial centre, in close proximity to the sea, dense population with a significant number dependent on the sea for their livelihood necessitates building of resilience through appropriate and feasible adaptation interventions. Four urban systems were identified as fragile through a series of stakeholder dialogues and climate fragility statements were formulated for all of them corresponding to the two climate scenarios of increased temperature and rainfall.

The vulnerability assessment showed that the entire city is extremely vulnerable to the impacts of the climate risks. Four wards (Ward no. 1, 5, 61 and 62) were identified as vulnerable hotspots across all urban systems because they contained a substantial vulnerable population and had poor levels of basic infrastructure. Although the supporting actors identified in the actor analysis, consisting of some of the government departments which are involved in the administration of the fragile urban systems, have the capacity to organise and respond, access to resources and access to information, financial, and political constraints acted as barriers for effective delivery of services and infrastructure. Fishermen, citizens, slum dwellers were some of the vulnerable actors identified.

The list of interventions identified in this CRS includes both hard and soft measures. The measures also have co-benefits that not only help to increase resilience but also generate income, prevent environmental damage, protect natural resources among others. These measures either directly or indirectly contribute to climate change adaptation while making the city more resilient. Among some of the soft measures are included better coordination among different departments involved in the administration of the relevant urban systems, development of management information systems and guidelines for management and disposal of water, waste, waste water as well as awareness generation activities and training for staff and public. The infrastructural measures include enhancement and upgradation of urban services, use of decentralised systems for waste management and involvement of public sector and their regulation for better and sustainable service delivery.

The finances required for implementation of the interventions can be obtained through assessment of the existing financial statements, existing projects, other national and state schemes, and also international programs. The corporation and other implementing agencies can pick projects according to their priority and need within a specific fragile urban system as well as the different climate scenarios agreed upon during initial stages of IAP. The report also identifies certain prioritised interventions that can be implemented to gain better resilience relatively easily. Integration of all prioritised interventions into other plans of the city is also important in order to avoid duplicity of efforts and enhance coordination.

Annexure 1 : Climatic Assessment

Changing Climate Condition		Assessments	Observed data (1969-2005)	Emissions Scenario	Scenario data (1969 - 2000)	Change in future periods Scenario data			Extent of Variability
						2015-2024	2015-2034	2015-2044	
Temperature Change	Maximum	Regional Assessments (Kerala)	0.50oC	A1B Scenario, IPCC					Annual
		Local Assessments (Kochi)	0.40 0C ***	A1B Scenario, IPCC					Annual
	Minimum	Regional Assessments Kerala	0.46oC	A1B Scenario, IPCC					Annual
		Local Assessments (Kochi)	0.42oC **	A1B Scenario, IPCC					Annual
	Mean	Regional Assessments Kerala	0.30oC ***	A1B Scenario, IPCC	0.25	0.45**	0.5***	0.92***	Annual
		Local Assessments (Kochi)	0.15oC ***	A1B Scenario, IPCC	0.35*	0.40***	0.5***	0.88***	Annual

- There is a 1% significant increase in mean temperature at the rate of 0.3oC/year during 1969-2005 at Kerala meteorological subdivision based on observed IMD data.
- In the future, during 2015-2024 the mean temperature may increase at the rate of 0.45oC/year which may be significant at 5% level. However, during 2015-2034 and 2015-2044 the mean temperature may increase significantly at 1% at the rate of 0.5°C/year and 0.92°C/year respectively. Projected mean temperature may show a net increase in 2015-2044 with respect to the mean temperatures of 1969-2000 by 0.67°C.
- There is a 1% significant increase in mean temperature at the rate of 0.15°C/year during 1969-2005 at Kochi. In the future, during 2015-2024, 2015-2034 and 2015-2044 the mean temperature may increases significantly at 1% at the rate of 0.4°C/year, 0.5°C/year and 0.88°C/year respectively. Projected mean temperature may show a net increase in 2015-2044 with respect to the mean temperature of 1969-2000 by 0.53°C.

Kerala state:

- Projected mean temperature may show a net increase in the time duration of 2015-2044 with respect to the mean temperatures of 1969-2000 by 0.67°C.

Kochi city:

- Projected mean temperature may show a net increase in the time duration of 2015-2044 with respect to the mean temperature of 1969-2000 by 0.53°C.

Changing Climate Condition	Assessments	(1971-1999) Observed data	Emissions Scenario	(1971-1999) Scenario data	Change in future periods Scenario data			Extent of Variability
					2015-2024	2015-2034	2015-2044	
Precipitation Change	Regional Assessments (Kerala)	-2.1 mm/day	A1B Scenario, IPCC	-0.3 mm/day	-0.2 mm/day	-0.95 mm/day * decreasing trend	0.7 mm/day * increasing trend	JJAS
	Local Assessments (Kochi)	0.4 mm/day	A1B Scenario, IPCC	-0.3 mm/day	0.1 mm/day	-0.95 mm/day * decreasing trend	0.6 mm/day	JJAS

- There is a decrease in precipitation at the rate of -2.1 mm/day during 1971-1999 at Kerala meteorological subdivision. In the future, during 2015-2034 the precipitation may decrease at the rate of -0.95mm/day significant at 10% level. However during 2015-2044 the precipitation may increase at the rate of 0.7mm/day which is 10% significant.
- Projected precipitation may show a net increase in 2015-2044 with respect to the simulated rainfall of 1971-1999 by 0.5 mm/day.
- There is an increase in precipitation at the rate of 0.4 mm/day for the time period 1971-1999 at Kochi. In the future, during 2015-2034 the precipitation may decreases at the rate of -0.95mm/day significant at 10%. However during 2015-2044 the precipitation may increase at the rate of 0.6mm/day.
- Projected precipitation may show a net increase in 2015-2044 with respect to the simulated rainfall of 1971-1999 by 0.5 mm/day.

Kerala state:

- Projected precipitation may show a net increase in the time duration of 2015-2044 with respect to the simulated rainfall of 1971-1999 by 0.5 mm/day.

Kochi city:

- Projected precipitation may show a net increase in the time duration of 2015-2044 with respect to the simulated rainfall of 1971-1999 by 0.5 mm/day.

Changing Climate Condition			Assessments	(1969-2005 observed data	Emissions Scenario	(1969-2000) Scenario data	Change in future periods Scenario data			Extent of Variability
							2015-2024	2015-2034	2015-2044	
Extreme Temperature Events	Warm Temp	T90p	Regional Assessments Kerala	Increase by 7 days*	A1B Scenario, IPCC		Increasing	Increasing	Increasing by 7 days*	Annual
		T95p		Increase by 4 days*			Increasing	Increasing	Increasing by 3 days **	
		T99p		Increase by 1 day*			Increasing	Increasing	Increasing	
	Warm Temp	T90p	Local Assessments (Kochi)	Increasing	A1B Scenario, IPCC		Increasing	Increasing	Increase by 7 days***	Annual
		T95p		Increasing			Increasing	Increasing	Increase by 2.5***	
		T99p		Increasing			Increasing	Increasing	Increasing	
	Cold Temp	T10p	Regional Assessments Kerala	Decrease by 9 days**	A1B Scenario, IPCC		Decreasing	Decreasing	Decreasing	Annual
		T05p		Decrease by 6 days***			Decreasing	Decreasing	Decreasing	
		T01p		Decrease by 2 days **			Decreasing	Decreasing	Decreasing	
	Cold Temp	T10p	Local Assessments (Kochi)	Decreasing by 8 days**	A1B Scenario, IPCC		Decreasing	Decreasing	Decrease by 5 days***	Annual
		T05p		Decreasing by 5 days**			Decreasing	Decreasing	Decrease by 3 days***	
		T01p		Decreasing			Decreasing	Decreasing	Decreasing	

- There is a 10% significant increase in warm temperature events T90p, T95p and T99p and 5% significant decrease in cold temperature events (T10p and T01p) and 1% significant increase in T05p during 1969-2005 at Kerala meteorological subdivision.
- In the future, during 2015-2024 and 2015-2034 the warm temperature events may increase and cold

temperature events may decrease. However, during 2015-2044 the warm temperature event T90p may increase significantly at 10% and T95p may increase significantly at 5%. The cold temperature events may decrease but may not be significant.

- There is an increase in warm temperature events T90p, T95p and T99p and the cold temperature events T10p and T05p decrease at 5% significant level during 1969-2005 at Kochi.
- In the future, during 2015-2024 and 2015-2034 the warm temperature events may increase and cold temperature events may decrease. However, during 2015-2044 the warm temperature event T90p and T95p may increase significantly at 1% level. The cold temperature events T10p and T05p may decrease significantly at 1%.

Kerala state:

- The warm temperature event T90p and T95p may increase significantly at 1% level during 2015-2044. The cold temperature events T10p and T05p may decrease significantly at 1% over Kerala Subdivision.

Kochi city:

- The warm temperature event T90p may increase significantly at 10% and T95p may increase significantly at 5% during 2015-2044. The cold temperature events may decrease but may not be significant over Kochi.

Key messages:

- Projected mean temperature may show a net increase in the time duration of 2015-2044 with respect to the mean temperatures of 1969-2000 by 0.67°C over Kerala Subdivision.
- Projected mean temperature may show a net increase in the time duration of 2015-2044 with respect to the mean temperature of 1969-2000 by 0.53°C over Kochi.
- The warm temperature events T90p and T95p may increase significantly at 1% level during 2015-2044. The cold temperature events T10p and T05p may decrease significantly at 1% over Kerala Subdivision.
- The warm temperature event T90p may increase significantly at 10% and T95p may increase significantly at 5% during 2015-2044. The cold temperature events may decrease but may not be significant over Kochi.
- Projected precipitation may show a net increase in 2015-2044 with respect to the simulated rainfall of 1971-1999 by 0.5 mm/day over Kerala Subdivision.
- Projected precipitation may show a net increase in 2015-2044 with respect to the simulated rainfall of 1971-1999 by 0.5 mm/day over Kochi.

Annexure 2: Urban System Analysis

Urban system	Why is it critical or fragile?	How may climate change affect this system?	Part of city function (Completely / Shared / No)	Fragile system summary statement
Sewerage and Septage Management system	Only 5% of the city is covered by a sewerage system. Rest of the city (95%) is connected with septic tank which mal-function often as they are not fitted with twin pits. Soak pits can't operate properly because there is a tidal effect, high rainfall in the city and high water. Waste (includes sludge and grey water) are let directly into the open drains contaminating ground water.	Increased precipitation (specially torrential rainfall) can: Disrupt/ damage sewerage infrastructure causing blocking of sewers. Can bring all the sludge from soak pits to open drains. Cause increased incidences of water logging.	Shared (KWA, KSUDP and KMC)	Insufficient infrastructure for the collection and management of sewerage and septage, the high water table and poor civic sense of citizens, results in waste being disposed into the canals and drains.
Storm Water Drainage	The drainage system of the city is old. No planned drainage system following the contour mapping. More than 50% of the drains are uncovered or open drains.	Increased precipitation can: Disrupt/ damage drainage system. The road infrastructure will be affected.	Completely	Encroachment and poor conditions of the canals, heavy deposits of silt and discharge of solid and liquid waste into the drains, and inadequate coverage of the drainage system is resulting in many parts of the city being waterlogged and susceptible to disease.

Urban system	Why is it critical or fragile?	How may climate change affect this system?	Part of city function (Completely / Shared / No)	Fragile system summary statement
SWM	Generation of waste is very high (approximately 600 tonnes per day). There is no proper SWM system (specifically transportation and disposal system). One composting plant exists in the city, but that is not working properly. Open dumping is being practised for disposal.	Increased precipitation can: Lead to clogging of drains and other outlets.	Completely	Inadequate designated waste disposal sites, open dumping of waste and an inadequate collection and disposal system cause chronic challenges for health, sanitation, and ecosystem functioning
Water Supply & Resources	Shortage in water supply during summer. Salt water intrusion. Ground water contamination due to poor septage management.	Increased precipitation can : Contaminate the ground water dispersing the sludge/grey water with the ground water. Increased temperatures will Lead to increased demand for water thereby posing additional stress on the supply system.	KWA	The efficiency of the city's water supply system is constrained by limited sources to meet the potable water needs of the city, contaminated ground water due to poor sanitary practices and poor infrastructure.

Annexure 3: Risk Assessment Scoring

Urban system	Impacts of climate change	Likelihood	Consequence	Risk score	Risk status
Storm Water Drainage	Increased rainfall when coupled with clogged drains will lead to increased incidences of water logging and flooding in the city. This will have profound impacts on the infrastructure, finance and health of Kochi city.	5	4	20	Extreme
Sewerage Management system	Increased rainfall will increase incidences of water logging which will affect the sewerage management system infrastructure. Furthermore, there can be instances of freshwater and rainwater mixing with sewerage and sludge, polluting limited freshwater bodies and facilitating the spread of diseases.	5	4	20	Extreme
	Increased temperatures would impact health as stagnating water, whether grey or black, will become a conducive breeding ground for harmful pathogens, insects and pests.	5	4	20	Extreme
SWM	Increased temperature may alter waste decomposition rate and leachate production rate which will lead to the spread of infectious diseases.	5	4	20	Extreme
Water Supply & Resources	Increased rainfall can lead to flooding and consequent contamination of the groundwater as well as salt intrusion.	4	4	16	High
	Higher temperatures would result in increased rates of water evaporation and demands for potable water putting stress on the system.	4	3	12	High



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APPENDIX 10: PANAJI CRS

City Resilience Strategy

Panjim City, India



Photo credit: Google Images



Disclaimer: This document has been prepared by ICLEI – Local Governments for Sustainability, South Asia under the Asian Cities Climate Change Resilience Network (ACCCRN) program with support from the Rockefeller Foundation. The views expressed do not necessarily reflect Rockefeller Foundation’s official policies.

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Executive Summary

Panjim city is located along the West Coast of India along the Arabian Sea and is a part of the Tiswadi Taluka in the northern part of the State of Goa. The city is bound by the Arabian Sea along the south-west, Mandovi River along the north and west and Zuari River towards the south-east. It also has two Creeks: Querem Creek on the east and St. Inez Creek along the west. The total population that falls within the jurisdiction of the Corporation of the City of Panaji (CCP) is 40,017 as per Census 2011 while the population for the entire metropolitan region is 114, 759. The city also deals with a high influx of tourist population throughout the year. As per the tourist statistics for 2011, Tiswadi taluka received 1,136,861 tourists which comprised of 690,926 domestic tourists and 445,935 foreign tourists. The main occupation in the city is based on tourism and agriculture. The state is famous nationally and internationally for coastal tourism.

The climate in Panjim is hot in the summer and mild in the winter. During summers temperatures reach up to 32°C and in winter it ranges from 20°C to 28°C. Goa receives an average annual rainfall of 2,932 mm, largely spread over the monsoon months. The entire state especially North Goa is prone to natural disasters like earthquakes, floods / heavy rains, cyclones, landslides, and tsunamis.

Panjim's City Resilience Strategy (CRS) was formulated using the ICLEI ACCCRN Process (IAP) with the support of ICLEI South Asia. The IAP process was led by the Commissioner, with support from the municipal technical staff who guided the process through Shared Learning Dialogues (SLDs). Panjim city had already developed an urban vulnerability assessment (under the Urban Vulnerability Assessment (UVA) Project supported by GIZ that was conducted by ICLEI South Asia) and a lot of the information generated during this project was utilized and built upon in the IAP.

Regional and city level studies on past trends and climate projections were referred to in order to identify climate risks for the city. Outcomes of the regional level study 'Climate Change and India: A 4X4 Assessment - A sectoral and regional analysis for 2030s' conducted by Ministry of Environment, Forest and Climate Change, Government of India, SLDs and Focus Group Discussions (FGD) with the local community, the Stakeholder Committee and Core Climate Team defines two potential climate risks- increased temperature and increased precipitation for the city as seen below.

Changing Climate Conditions	Assessments	Climate Scenario Summary Statements
Temperature	Regional Assessment	The mean annual temperature is projected to increase by 1.5°C to 2.2°C in the 2030s. The net increase in temperature ranges from 1.7°C to 1.8°C with respect to the 1970s. Temperatures also show a rise in all seasons.
Precipitation	Regional Assessment	The annual rainfall in the western coastal region is likely to vary between 935 ± 185.33 mm to 1,794 ± 247.1 mm. The projected precipitation is likely to increase by 6% to 8% in 2030s with respect to 1970s.

The IAP and UVA identified the key fragile urban systems in the city which are already impacted by infrastructural, governance, economic, social and political issues and may be aggravated by climate change. These systems were water supply, sanitation, drainage, land use, ecosystem, health and transportation. A situation analysis of these urban systems was carried out to develop the fragility statements that were

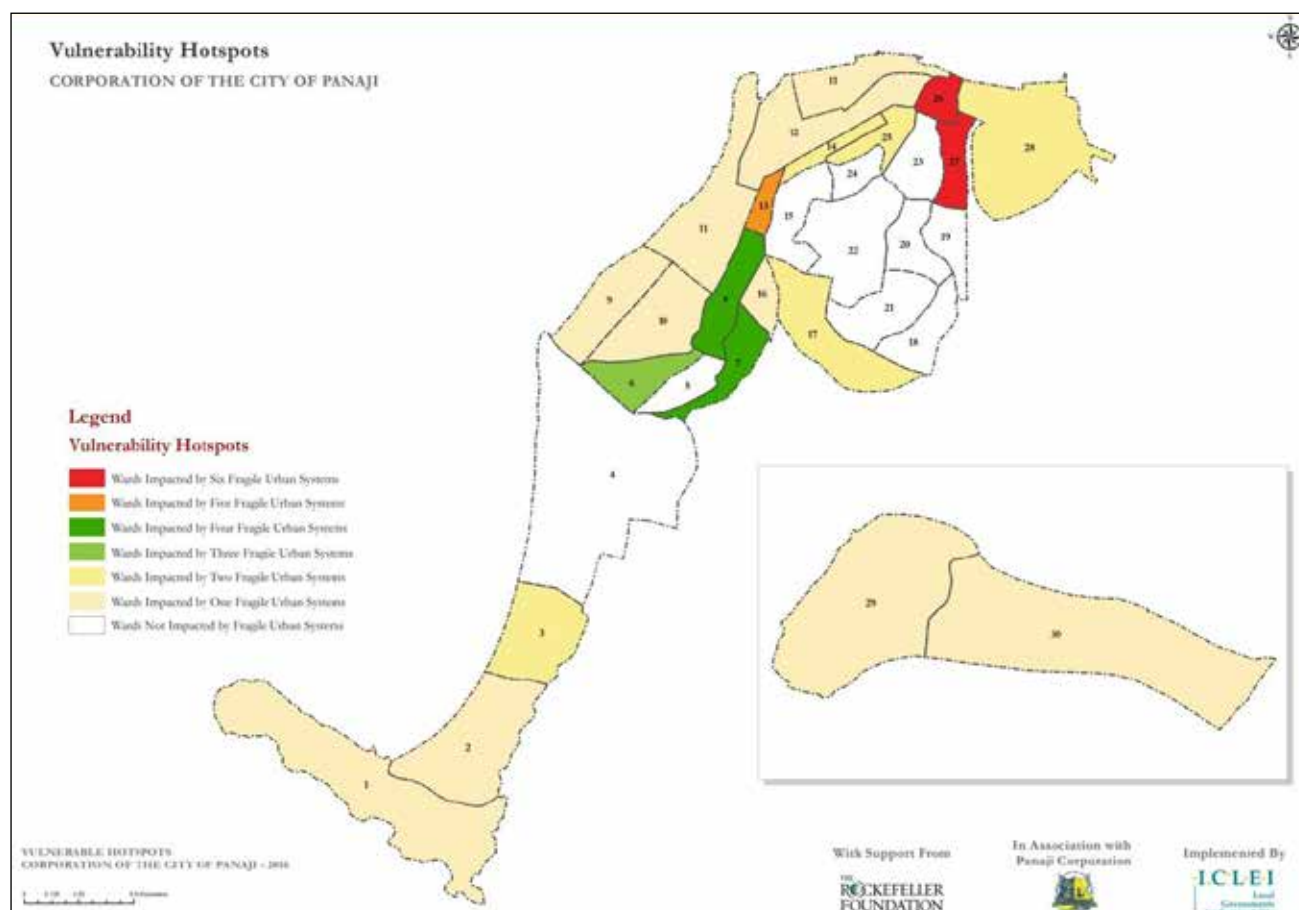
superimposed on the climate risks in order to formulate the climate fragility statements for each urban system. Highly vulnerable areas in the context of each urban system of the city with high and extreme risks, the actors who are vulnerable and who can play a critical role towards building urban resilience and the adaptive capacity of the fragile urban systems to absorb and respond to shocks that determines their resilience were identified as illustrated in the table below.

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive capacity of the system
			Vulnerable	Potential Supporting	
Water Supply	Increased temperatures can lead to increased demand for water thereby posing additional stress on the supply system. Increased precipitation would lead to increased flooding situation resulting in contamination of potable water.	Dando (Carazalem), St. Inez Band, pockets of Mala area; Parts of old Latin localities of Bairo Portais, and Bhatulem; Includes a few heritage structures namely Maruti Temple, Portais Chapel, Panjim Inn etc.	● Citizens/Residents ● Floating Population ● Unorganized Societies/ Slum Population ● Private Corporations ● Educational Institutions ● Water Resource Department (WRD) ● Public Works Department (PWD) ● CCP		● Economic-Low ● Technology/ Infrastructure- Medium ● Governance-Low ● Societal- Medium ● Ecosystem Services-Low
Sanitation	Increased precipitation would lead to unhygienic conditions and health hazards due to increased incidences of water borne diseases.	St. Inez band area, pockets at Mala area; Parts of Bhatulem; Sea beach in Avivao Sea beach in Dando, Caranzalem; Forest/ plantation area/ vacant lots near Dhempe Higher Secondary School of Arts and Science; Forest/ plantation area in Valice Bhat, Storm water drains near Lopez Bar/ Tamdi Mati Bus Stop	● Citizens/Residents ● Floating Population ● Unorganized Societies/ Slum Population ● Private Corporations ● PWD	● CCP	● Economic-Medium ● Technology/ Infrastructure-Medium ● Governance-Medium ● Societal- Low ● Ecosystem Services-Low

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive capacity of the system
			Vulnerable	Potential Supporting	
Storm Water Drainage	Increased precipitation would lead to increased instances of flooding. Increased precipitation would also increase the chances of greater 'knock-on' impacts on human health and wellbeing.	Dr. Pissurlekar road (near CCP); MG road; KTC; Avenida Dom Joao de Castro; Mala Area; 18th June Road; Near Don Bosco's campus road; DB road; Atmaram Borkar road, Swami Vivekanand road; Dr. Shivgaonkar road; St. Inez Road; Ward 6 (St. Inez); Miramar circle road; Rua de Ourém creek road; Carazalem road	● Citizens/Residents ● Floating Population ● Unorganized Societies/Slum Population ● Educational Institutions ● Private Corporations ● CCP ● WRD		● Economic-Low ● Technology/Infrastructure-Low ● Governance: Medium ● Societal-Medium ● Ecosystem Services-Low
Land Use	In case of increased short duration-high intensity rainfall events the water logging and flooding situation in low-lying areas would only get worse, thereby reducing access to usable land.	Mala Area; Ward 6 (St. Inez); St. Inez Road; Rua de Ourém creek road	● Citizens/Residents ● Floating Population ● Unorganized Societies/Slum Population ● WRD ● CCP ● North Goa Planning And Development Authority (NGPDA) ● Town And Country Planning (TCP)		● Economic-Medium ● Technology/Infrastructure-Low ● Governance-Low ● Societal-Medium ● Ecosystem Services-Low

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive capacity of the system
			Vulnerable	Potential Supporting	
Ecosystem	Increased temperature would impact the fundamental functioning of the ecosystem by bringing about changes in pollinators, migratory species and seed dispersers' behaviour. Increased temperatures can affect mangrove survival.	Mala areas, along St. Inez creek; along causeway(salt pans and mangroves)	● Citizens/Residents ● Unorganized Societies/ Slum Population ● Fishermen ● Coastal Regulation Zone Authority (CRZA) ● Forest Department ● Department Of Science And Technology ● Goa State Biodiversity Board		● Economic- Low ● Technology/ Infrastructure- Low ● Governance- Medium ● Societal- Low ● Ecosystem Services- Medium
Health	Increased temperature can lead to heat stress and increased morbidity and illness. Increased precipitation would lead to water logging/ flooding which will increase chances of water/ vector borne communicable diseases.	Pockets of Mala Area; St. Inez Band; Parts of Bhatulem	● Citizens/Residents ● Floating Population ● Unorganized Societies/ Slum Population ● Educational Institutions ● NGOs ● Health Department	● Private Hospitals	● Economic- Medium ● Technology/ Infrastructure- Medium ● Governance- Medium ● Societal- Low ● Ecosystem Services- Low
Transportation	Increased precipitation would lead to flooding situation leading to congestion and in extreme cases loss of connectivity/ access.	Central Business District (CBD) area	● Private Corporations ● Floating Population ● Citizens/Residents ● Educational Institutions ● CCP ● Transport Department	● Traffic Police	● Economic- Medium ● Technology/ Infrastructure- Medium ● Governance- Low ● Societal- Medium ● Ecosystem Services- Low

The areas in Panjim that were found to be the most vulnerable are wards 26 and 27 which are vulnerable to six fragile urban systems, while ward 13 is vulnerable to five fragile urban systems. Wards 26 and 27 have very poor levels of infrastructure, a substantial slum population and are inundated annually following heavy rainfall. Ward 13 also has a large slum population on private land and due to issues with ownership of the land, is extremely poor in basic services.



Interventions that would address the vulnerabilities identified through the IAP were developed for all seven fragile urban systems. The 38 interventions have been divided into two categories – infrastructural measures and policy & institutional measures. Appropriate actions to address the vulnerability of each sector have been suggested. The most important measures include awareness generation activities for better sanitation, conservation of water and improved waste management; capacity building for better locally available healthcare; planning and policy measures for better land use, protection of *Khazan* lands, and non-motorised transportation in the soft measures. Improvements in water supply systems, sanitation and drainage systems, decentralised management systems for waste and waste water, plantation and dune management for protection of ecosystems, provision of non-motorised infrastructure for public transit were identified among Infrastructural Measures. A number of government schemes like the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) scheme, the Swachh Bharat Mission (SBM), the Smart Cities Mission can be used and leveraged to provide funding for these interventions.

Abbreviations and Acronyms

ACCCRN:	Asian Cities Climate Change Resilience Network
AMRUT:	Atal Mission for Rejuvenation and Urban Transformation
CBD:	Central Business District
CCP:	Corporation of the City of Panaji
cm:	centimetre
CPHEEO:	Central Public Health and Environmental Engineering Organisation
CRS:City	Resilience Strategy
CRZ:	Coastal Regulation Zone
CRZA:	Coastal Regulation Zone Authority
FGD:	Focus Group Discussion
GDP:	Gross Domestic Product
GHG:	Green House Gases
GI:	Galvanized Iron
GIS:	Geographic Information System
ha:	Hectare
IAP:	ICLEI ACCCRN Process
IEC:	Information Education and Communication
IMD:	India Metrological Department
INCCA:	Indian Network for Climate Change Assessment
IPCC:	Intergovernmental Panel on Climate Change
km:	Kilometre
KTC:	Kadamba Transport Corporation
LDPE: Low	Density Polyethylene
MBR:	Master Balance Reservoir
MDR:	Major District Road

MLD:	Million Litres per Day
mm:	millimetre
MSW:	Municipal Solid Waste
NGO:	Non Government Organization
NGPDA:	North Goa Planning and Development Authority
NH:	National Highway
NOC:	No Objection Certificate
NUHM:	National Urban Health Mission
O&M:	Operation and Maintenance
PDA:	Planning Development Authority
PWD:	Public Work Department
SAPCC:	State Action Plan for Climate Change
SBM:	Swacch Bharat Mission
SCADA:	Supervisory Control and Data Acquisition
SLD:	Shared Learning Dialogue
sq m:	Square Meter
STP:	Sewerage Treatment Plant
TCP:	Town and Country Planning
TCPO:	Town and Country Planning Office
UCCR:	Urban Climate Change Resilience
UFW:	Unaccounted for Water
UGD:	Underground Drainage
UVA:	Urban Vulnerability Assessment
WRD:	Water Resource Department

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1. Background

1.1. Introduction

It is projected that over 60 percent of the world's population will be based in cities by the year 2030¹. As per a report by the Global Commission on Economy and Climate², Indian urban centres will house over 600 million of the country's population by this time. Due to high concentrations of people, infrastructure and resources, the most adverse impacts of climate change will likely be in these areas according to the World Bank³. In this context, it is of the utmost urgency that a city is able to increase climate resilience to avoid these impacts.

Climate resilience is defined as the capacity for a socio-ecological system to: (1) absorb stresses and maintain function in the face of external stresses imposed upon it by climate change and (2) adapt, reorganize, and evolve into more desirable configurations that improve sustainability of the system, leaving it better prepared for future climate change impacts⁴. Urban Climate Change Resilience (UCCR) is defined by Rockefeller Foundation as the capacity of cities (individuals, communities, institutions, businesses and systems) to survive, adapt, thrive in the face of stress and shocks, and even transform when conditions require it⁵.

There are a host of benefits for cities associated with building resilience as outlined in Table 1. Investing in resilience reduces losses and damages in the event of a disaster. However, even if the anticipated disaster does not occur for a long time, increased resilience will mean reduction in background risk and unlocking of economic development potential⁶.

Table 1: Potential Benefits of Resilience Building

Economic Benefits	Environmental Benefits	Social Benefits
Avoidance of runaway costs of climate change	Biodiversity conservation	Improved public health
Livelihood creation	Preservation of vital ecosystems and species	Decreased mortality
Higher savings by population, businesses and government	Conservation of water resources	Increased benefits to low-income households
Reduced risks associated with current climate variability	Improved practices for disaster risk reduction	Reduced damage and loss due to natural disaster
		Enhanced well-being of all social groups

1. United Nations. 2014. World Urbanization Prospects, the 2014 revision. UN Department of Economic and Social Affairs, Population Division.
2. The New Climate Economy. 2014. Chapter 2: Engines of National and Global Growth. Better Growth, Better Climate- Charting and new path for low-carbon growth and a safer climate. <http://2014.newclimateeconomy.report/>
3. World Bank. 2008. Climate Resilient Cities: A primer on reducing vulnerabilities to climate change impacts and strengthening disaster risk management in East Asian cities, Washington D.C.
4. Folke, C. 2006. Resilience: The emergence of a perspective for social-ecological systems analyses. Global Environmental Change. 16: 253–267.
5. The Rockefeller Foundation. 2015. Insights from the Asian Cities Climate Change Resilience Network: Urban Climate Change Resilience in Action: Lessons from Projects in 10 ACCCRN Cities.
6. Tanner, T.M. and Rentschler, J. 2015. Unlocking the 'Triple Dividend' of Resilience: Why investing in disaster risk management pays off. Interim Policy Note. Washington D.C.: GFDRR and London: Overseas Development Institute (www.odi.org/tripledividend).

1.2. Methodology

Panjim's CRS was formulated using the IAP. The process helped to identify fragile urban systems, major climate risks to urban systems and vulnerable areas and populations in the city, which were used to formulate resilience interventions.

Pioneered by the Rockefeller Foundation, the Asian Cities Climate Change Resilience Network (ACCCRN) supports practitioners to build inclusive urban climate change resilience in over 50 rapidly urbanising cities. To facilitate this initiative, the IAP toolkit was developed which targets city governments and helps them to develop their CRS with little or no external assistance.

1.2.1. Overview of ICLEI ACCCRN Process (IAP)

The IAP toolkit consists of a set of 16 tools which enables local governments to assess the climate risks of various systems in the city in context of urbanization and vulnerability, and plan resilience interventions corresponding to the fragilities identified. The IAP is designed in a step-by-step format, divided into following six phases as shown in Figure 1.

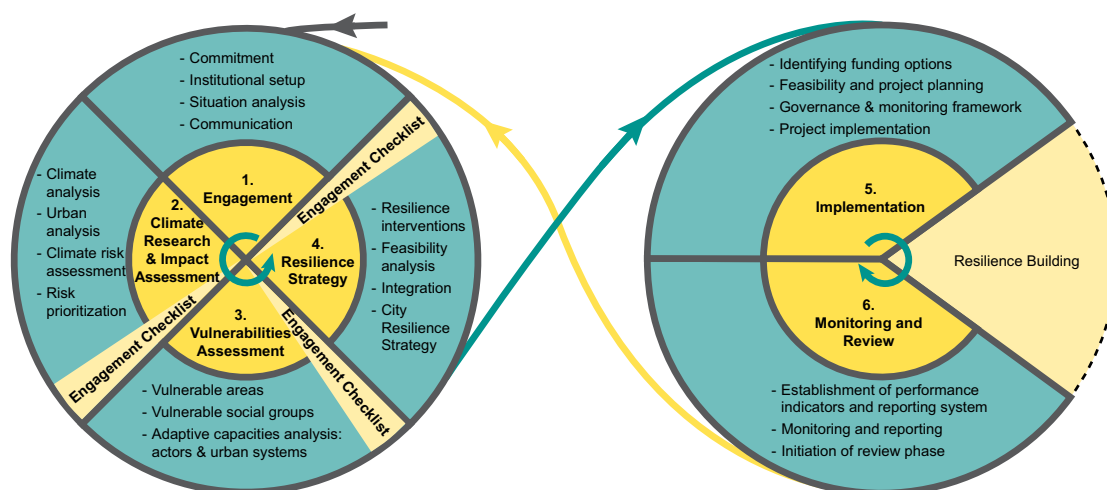


Figure 1: ICLEI ACCCRN Process

Phase 1 - Engagement: This phase begins with gaining political support in the city by formulating a Climate Core Team and a Stakeholder Committee. The Climate Core Team is responsible for the execution of project activities in the city and comprises of key officials from the city government. The Stakeholder Committee is formed with citizen representatives from various relevant institutions and organisations of the city. The Climate Core Team forms a communication plan for the city highlighting key messages to be conveyed to the public and the ways for doing so. This is followed by a scoping exercise which helps in gaining insight about the various city services and the problems faced by the city.

Phase 2 - Climate Research and Impact Assessment: This phase identifies the main impacts of climate change faced by city through SLDs with the Climate Core Team and Stakeholder Committee. An assessment of the past climate trends and future climate projections are conducted through secondary research. These are validated through analysis of city level data as well as local perceptions from city stakeholders. A risk assessment is conducted for fragile urban systems based on the likelihood and consequence of the climate risk statements for those systems.

Phase 3 - Vulnerabilities Assessment: This phase helps in identifying the key vulnerable areas with the fragile urban system and the vulnerable population for each system. This information is gathered in consultation with the stakeholder committee through SLDs. The adaptive capacity of the urban systems is also assessed in this phase.

Phase 4 - Resilience Strategy: In this phase, the city government uses the information and analysis from the previous phases to identify the relevant resilience interventions. These interventions are prioritised on the basis of their feasibility and applicability to the city. The resilience strategy is then developed and ratified through political support.

Phase 5&6 - Implementation and Monitoring & Review: After identifying the resilience interventions for the city, concrete project implementation plans can be prepared. Opportunities for financing and implementing these projects need to be explored. In all cases, monitoring and review remains a mandate of the city government, with active involvement of the Climate Core Team.

1.2.2. IAP in Panjim City

As part of the IAP in Panjim, a Climate Core Team (Annexure 2) was formed in the city. Panjim had collected information on its vulnerability through the UVA project with support of ICLEI South Asia. The climate threats and the impacts of the same on the various urban sectors have been documented. The results of the same were discussed in detail with the Climate Core Team and a total of seven urban sectors (water supply, health, transportation, sanitation, land, storm water and ecosystems) have been identified to be impacted by climate change. Through a SLD with a wide array of stakeholders constituted as a Stakeholder Committee, the climate risks and suggested interventions (along with their feasibility and impacts), for combating the same have been identified for each urban sector.

The climate risks were superimposed upon the fragile urban systems identified and a risk assessment was conducted identifying risks for all seven urban systems. The Stakeholder Committee also discussed consolidated potential resilience interventions for the climate risks that had been identified as being 'extreme' or 'high'. The interventions received were sector-wise along with their 'feasibility' (in terms of technical, political and cost feasibility) and 'impact' assessments.

ICLEI-South Asia discussed the resilience interventions with the Climate Core Team and identified the vulnerable wards. Additional resilience interventions were added as appropriate by (i) referring to past work undertaken in the city that is relevant to this initiative, (ii) inputs by the expert team, and (iii) by referring to good practice in other cities having similar contexts and facing similar challenges and risks. This information was collated and analyzed to develop the CRS for Panjim.

2. City Profile

Panjim city is located along the west coast of India along the Arabian Sea and is a part of the Tiswadi Taluka in the northern part of the State of Goa (Figure 2). The city is bound by the Arabian Sea along the South West, Mandovi River along the North and West and Zuari River towards the South East. It also has two Creeks: Querem Creek on the east and St. Inez Creek along the west. The city has a rich wealth of mangroves on the backwaters entering the Querem Creek, St. Inez Creek, Mandovi River and Zuari River.

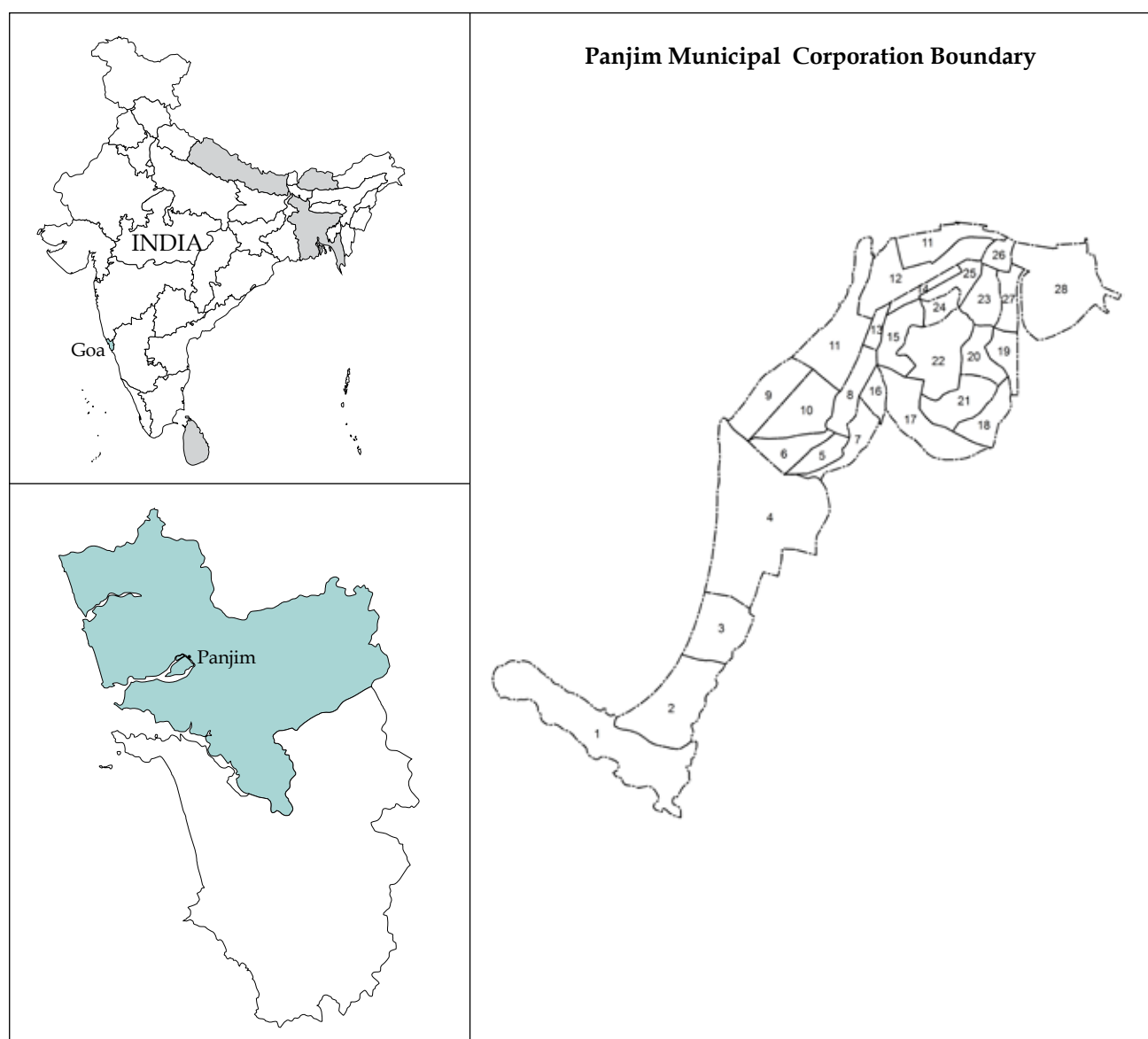


Figure 2: Location Map of Panjim

2.1. Demography

The population of Panjim accounts for 2% of the total urban population of the state and 16 percent of the district's urban population⁷. The city population growth has been fluctuating over the past five decades mostly due to the changes in the area under jurisdiction of the CCP. The total population that falls within the jurisdiction of CCP is 40,017 as per Census 2011 which shows decline of population from Census 2001 population of 59,066. This is due to exclusion of Taleigao and Durgawado, which were part of Panaji Municipal Council in Census 2001 and have been made outgrowths in Census 2011. However, the population as per the 2011 census for the entire metropolitan region is 114,759. The city also deals with a high influx of tourist population throughout the year. As per the tourist statistics for 2011, Tiswadi taluka received 1,136,861 tourists which comprised of 690,926 domestic tourists and 445,935 foreign tourists. Given that Panjim is the main tourist destination in the taluk, it can be assumed that the city receives maximum amount of taluk level tourist's arrivals throughout the year.

2.2. Economy and Employment

The main occupation in the city is based on tourism and agriculture. The state is famous nationally and internationally for coastal tourism. The key crops grown in Goa are paddy, cereals (millets/pulses and oil seeds), sugarcane, coconut, areca nut and cashew nut. Irrigation is largely through surface flow irrigation (3972 ha), dug wells (1867.91 ha) and canals (1149.40 ha). The table below provides a quick overview of the city of Panjim.

Table 2: General Information on Panjim⁸

District	North Goa
Area	8.12 sq. km.
No. of Wards	30
Height above mean sea level	7 meters
Distance to the sea	0 km
Demography	
Total Population	114,759
Male	59,305
Female	55,454
F/M ratio (per 1000)	935
Number of Households	10,158
Average household size	4
Population Density	1,334
Population of minority groups	6,293
Number of individuals immigrating into the city per year	11,530
Domestic tourist population (per annum)	6.90 lakh
International tourist population (per annum)	4.45 lakh
Literacy	
Average literacy rate	90.98%
Male literacy rate	93.52%
Female literacy rate	88.27%

7. Ministry of Urban Development and World Bank. 2015. Revised City Development Plan for Panaji- 2041. Supported under the Capacity Building for Urban Development project (CBUD). A Joint Partnership Program between Ministry of Urban Development, Government of India and The World Bank. Prepared by CRISIL Infrastructure Advisory.

8. Census of India. 2011. District Handbook of Statistics. Panaji Urban Region. Directorate of Census Operations. Government of India.

2.3. Municipal administration

The CCP administers the city. It regulates some of the civic function and services in the city. Panaji Corporation Act, 2002 has been enacted under the Goa Municipalities Act, 1968. The elected body of the Corporation is headed by the Mayor and consists of 30 councillors representing each ward. The Mayor and councillors are responsible for all policy decisions. The Municipal Commissioner is the head of administration and is responsible for the functioning of the council including tax collection, estates maintenance, projects, among other things. The Municipal Corporation provides and maintains services which include solid waste management, street lighting, and cleaning of sewerage and drains. It also controls, develops and maintains markets, streets and other city structures. Although CCP is primarily responsible for city governance in Panjim, there are other state level departments performing urban infrastructure provision and development functions (Table 3).

Table 3: Urban Infrastructure Service delivery institutions roles and responsibility

S. No.	Urban Infrastructure facilities in the city	State/CCP	Concerned Authority
1	Water supply	State	PWD (Div III Water Supply and Sewerage)
2	Sewerage	State	PWD (Div III Water Supply and Sewerage)
3	Solid waste management	CCP	CCP
4	Storm Water Drains	CCP	Design and laying of new drains done by WRD/ PWD but maintained by CCP
5	Roads	State and CCP	PWD and maintenance by CCP
6	Street lighting	State	Goa State Electricity Board
7	Public Transport	State	KTC
8	Traffic and Circulation	City	Traffic Police
9	Health facilities	State	Directorate of Health Services
10	Educational facilities	State	Directorate of Education
11	Fire Services	State	Fire Service Department
12	Parks, Open Spaces	State and CCP	CCP/ Forest department
13	Master Plan, Land Use, Building Bylaws	State	NGPDA / TCPO
14	Slum Development	CCP	CCP
15	Heritage Building Conservation	State	Archaeological Survey of India/State Tourism Board

3. Past Hazards and Climatic Events

Goa, especially North Goa is prone to natural disasters like earthquake, floods/ heavy rains, cyclones, landslides, tsunami. Goa is located in a moderate seismic zone in the country, namely, Zone IV of seismic zoning map of India. Though Goa has not directly witnessed any earthquake it was affected by tremors from devastating earthquakes from neighbouring state. During the monsoon of 2007 the Mapusa – Panjim NH-17 was struck by a landslide of high severity obstructing the vehicular traffic on this road for a month⁹. Tropical cyclones are considered to be the worst among all the natural hazards when viewed in terms of their severity, frequency of occurrence and areas of destruction. Panjim and Bicholim of the North Goa district were affected by floods caused due to the overflow of rivulets around the city in 2007. Although there were heavy damages to properties, there were no human casualties.

9. <https://www.mail-archive.com/goanet@lists.goanet.org/msg16859.html>

4. Climate Scenario in the City

4.1. Past Climate Data

The climate in Panjim is hot in the summer and mild in the winter. During summers (from March to May) temperatures reach up to 32°C and in winter (from December to February) it ranges from 20°C to 28°C. Goa receives an average annual rainfall of 2,932 mm, largely spread over the monsoon months (June to September).

In order to better understand the climate vulnerabilities of Panjim city the past and projected climatic data was analysed. The results of this analysis have been mutually agreed upon by the key stakeholders of the city through SLDs. Meteorological data from Indian Meteorological Department (IMD)¹⁰ was analysed. Annual temperature and rainfall data from 1901 to 1913 and from 1964 to 2000 was available. Due to the large data gap, time series data from 1964 to 2000 was used for the purpose of trend analysis. No major data gaps were observed in the selected data and any missing values that existed were filled using annual averages from other years for the same parameter.

The Figure 3 provides a consolidated analysis of the weather trends in terms of annual minimum and maximum temperatures as well as average annual rainfall. In the case of both temperature and rainfall the change in the 36 year period (1964 to 2000) shows a marginal increase.

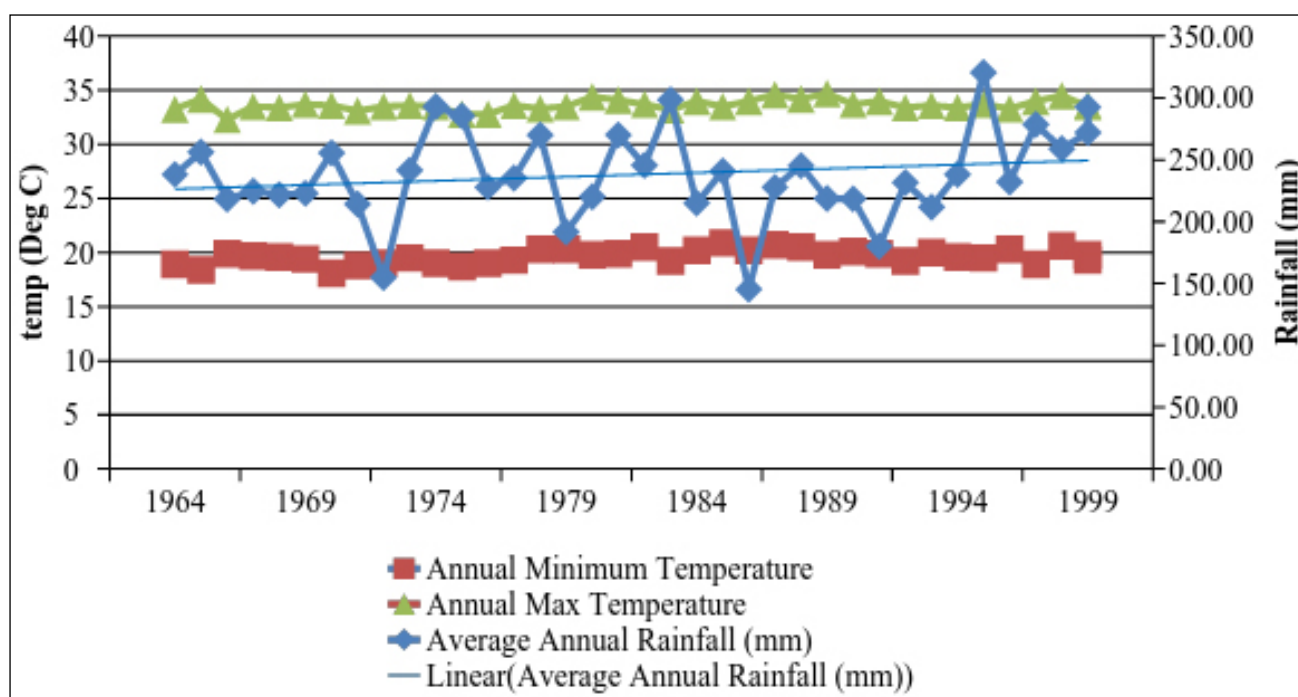


Figure 3: Trends in variation of temperature and rainfall in Panjim (1964-2000)

10. <http://www.imd.gov.in/>

4.2. Future Climatic Projections

In order to assess the future vulnerabilities of a city it was important to also understand the projected climatic trends for the area in which it is located. Climatic projections are mostly undertaken at a national or regional level. City level projections are most often not available, especially for cities in South and Southeast Asia. In the absence of such climatic projections for the city of Panjim regional projections have been used for this assessment. In this study the Government of India's 'Climate Change and India: A 4x4 Assessment' report¹¹ from 2010 has been referred to. The following are the projections made in this report for the Western Coast of India.

- **Precipitation change:** There is a high probability of an increase in average annual rainfall in the range of 69 to 109 mm in the Western Coastal Region by the year 2030. The projected change of an increase of 6% to 8%, is expected to show an average increase of 8mm rainfall in June, July and August; a decrease on an average by 19 mm in January and February; and a decrease in rainfall in March, April and May.
- **Temperature change:** There is a high probability of a rise in average annual temperatures by 1.5 to 2.2°C in the Western Coastal Region by the year 2030. The projected change is expected for all seasons, with the rainfall period of June, July, August and September showing the minimum rise amongst all seasons.

Table 4 summarises the climate scenario statements.

Table 4: Climate Scenario Statements

Changing Climate Conditions	Assessments	Climate Scenario Summary Statements
Temperature	Regional Assessment ¹¹	The mean annual temperature is projected to increase by 1.5°C to 2.2°C in the 2030s. The net increase in temperature ranges from 1.7°C to 1.8°C with respect to the 1970s. Temperatures also show a rise in all seasons.
Precipitation	Regional Assessment ¹¹	The annual rainfall in the Western coastal region is likely to vary between 935±185.33 mm to 1,794±247.1 mm. The projected precipitation is likely to increase by 6% to 8% in 2030s with respect to 1970s.

The projected climate trends broadly match the assessment of the past weather data as well as the general perceptions of the stakeholders: temperatures are increasing and are expected to increase in the near future; though rainfall has become erratic, there has not been a significant change in the amount of rainfall in the past and in the near future a significant increase is not expected.

Sea level rise is not perceived as a threat to the city of Panjim so far. However, if one examines the projected impacts of a 1 meter sea level rise in Panjim in terms of 'percentage of GDP at risk', 'number of people at risk of migration' and 'potential land loss' these are found to be significant – please see Figures 4, 5 and 6 below¹². The projections indicate that in the case of a 1 meter rise in sea level the GDP at risk in the Panjim area would vary in the range 4.58% - 12.47%, the number of people at risk of migration would range between approximately 19,000 and 64,000, and the hectares of potential land loss per administrative unit would be between 1,199 and 2,468 ha. These projected impacts are significant and therefore it emerged that there is a need to conduct a thorough study in order to understand the possibility and extent of a rise in sea level and the corresponding impacts.

12. These projections have been accessed from the *ci:grasp* website which '...performs as a climate information service and provides sound knowledge on current and projected climate stimuli, climate impacts and adaptation options at the national, sub-national and regional level.' This is an interactive platform that has been developed by the Potsdam Institute for Climate Impact Research (PIK) and GIZ on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. <http://ci:grasp.pik-potsdam.de/worldmap>

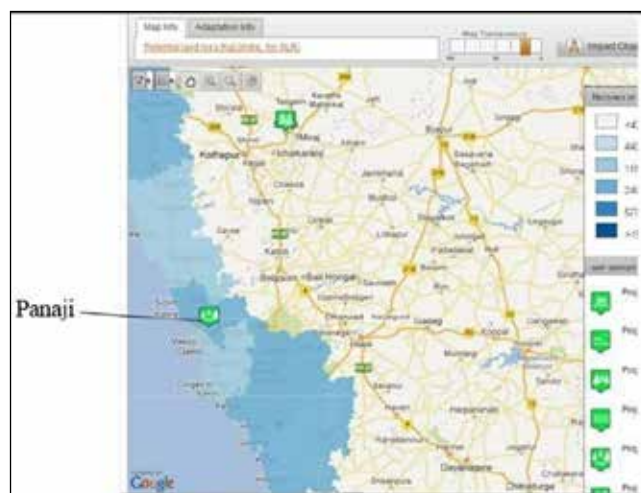


Figure 4: Potential land loss (in ha.) in the Panjim area due to 1m Sea-level Rise¹²



Figure 5: Percentage of GDP at Risk in the Panjim area due to 1m Sea-level Rise¹²

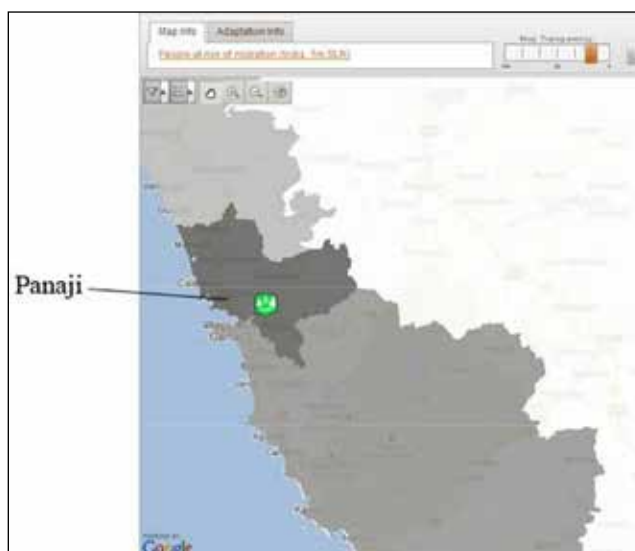


Figure 6: Number of people at Risk of migration in the Panjim area due to 1m Sea-level Rise¹²

5. Climate Impact Assessment

Climate impact assessment of urban systems helps to assess their fragilities with respect to the climate impacts identified earlier. These urban systems could include ‘core systems’ such as water, sewerage, transport which are essential for the running of the city, and ‘secondary systems’ such as health, education, sanitation which rely on the core systems. The urban system analysis identified seven fragile urban systems for Panjim through discussions in the SLDs.

- A. Water Supply
- B. Sanitation
- C. Storm Water Drainage
- D. Land Use
- E. Ecosystem
- F. Health
- G. Transportation

The current issues, the corresponding fragility caused as a result of these issues and finally the impact of climate on these systems are detailed henceforth.

5.1. Urban Systems Analysis¹³

5.1.1. Water Supply

Situation Analysis

In Goa, the state’s PWD undertakes the functions of provision of water supply to the city. Panjim city’s water supply source is River Khandepar which is a perennial source covered under the regional water supply scheme from Opa water works. The raw water capacity of River Khandepar is 123.0 MLD while the quantity drawn at present is 115.0 MLD. Further augmentation from this source is not feasible in future. The present gross water supply to the city region is 308 litres per capita per day (lpcd). However these estimates cannot be considered as accurate as the substantial portion of the water supplied to the region caters to the floating as well as the tourist population. The Opa scheme consists of four Water Treatment Plants (WTP) which are classified as per their capacity viz. 8 MLD plant, 12 MLD plant, 55 MLD plant and 40 MLD plant. The original 8 MLD capacity plant in Opa has been augmented with capacities of 12 MLD in 1967, and subsequently 55 MLD in 1972 with allocation of 35 MLD water for Ponda and 40 MLD of water for Tiswaditaluka.

The treated water from the treatment plant is collected in the underground reservoir of capacity 1350 m³ at Opa and pumped to master balancing reservoir (MBR) at Curti for distribution. Subsequently it flows by gravity to Altinho and to Panjim city. Panjim city consists of 14 storage reservoirs and the overall storage capacity of the existing reservoirs is 12800 m³. The city is divided into three water supply zones viz. Altinho, Ribandar and Taleigaon. The storage tanks at Altinho are in a dilapidated condition and require rehabilitation and repair works. Water is distributed to the service connections in the city by gravity. The present supply to the CCP is 15.0 MLD and 24.2 MLD for the city region. The coverage of water supply distribution pipeline network w.r.t. the existing road length in the city is 100% within the CCP area and presently 79% of the households within the CCP area are provided with House Service Connections.

13. Information in the section is compiled from the Revised City development Plan of Panaji, 2041 (2015) prepared by CRISIL supported under Capacity Building for Urban Development project (CBUD) A Joint Partnership Program between Ministry of Urban Development, Government of India and The World Bank and Panaji’s SMART city Proposal.

Considering the population of Panjim as per Census 20118, the daily water supplied of 198 lpcd is substantially high when compared with the service level benchmark of 135 lpcd as prescribed by the Central Public Health and Environmental Engineering Organisation (CPHEEO). The existing water distribution lines in the city are old, and comprise of asbestos cement or corroded galvanized iron (GI) pipes which are prone to leakage during other utility works in the vicinity. This leads to high water losses under Unaccounted for Water (UFW). As supply to households is through the means of gravitational force, pressure and duration of water supply varies across the city.

The improper water supply zoning has led to poor monitoring of the water supplied and transmission losses. Furthermore, the PWD staff performs most of their operations and maintenance functions manually which results in poor quality of database as well as consumes more time and manpower.

Fragility Statement and Climate Fragility Statement

Considering the present situation of water supply in Panjim, the fragility statement for this system is 'Current supply of water is 198 lpcd which is much more than the prescribed standard of 135 lpcd. Over extraction of water, high volumes of UFW and old infrastructure are putting enormous pressure on water sources.'

Overlaying the climate projections on the urban systems we are able to gauge their impacts on the fragility of each system. In the case of water supply, with an increase in temperature, the demand for water (domestic and drinking) will also increase. Given the current state of the system where there is already over extraction of water and supply is greater than demand, unsustainable management will lead to acute water scarcity in the future especially in the light of the increased temperature projection. As the pipes are corroded and there are many leakages in the system, the projected increase in precipitation which may lead to flooding will facilitate contamination of water.

Climate risk 1: Increased temperatures can lead to increased demand for water thereby posing additional stress on the supply system.

Climate risk 2: Increased precipitation would lead to increased flooding situation resulting in contamination of potable water.

5.1.2. Sanitation

Situation Analysis

The city's sewerage system dates back to 1967 and only covers the core city area. Ribandar, Taleigaon, Dona Paula, Caranzalem as well as the adjoining out growths lack any connections with the central sewerage system, although, some of the wards in the outer areas of the city are partially covered. The uncovered areas depend upon the system of individual soak pits/ septic tanks, direct discharge into the major drains and also open defecation to some extent. 87% of households have individual toilets, 7% use public/ community toilets while 0.6% resorts to open defecation. The households which have access to individual toilets are either connected to the existing sewerage system (42%) or have individual soak pits/ septic tanks (58%).

The sewerage network is divided into 12 sewage blocks and serviced by eight pumping stations. The sewage from the sewerage network is collected in three outfall drains which carry the sewage to the Sewage Treatment Plant (STP) located at Tonca area for treatment. The three outfall drains are located at following areas:

- Near Panjim Tourist Home (Northern part of Panjim)
- St. Inez
- Miramar (near Goa International Hotel)

In addition to the STP at Tonca, there are another two at EDC Patto with a capacity of 0.57 MLD and 2 MLD.

Toilet infrastructure: Situation Analysis

There are presently 29 public convenience systems with a total capacity of 171 seats located in various parts of the city. The public toilets are operated and maintained by Sulabh Sauchalaya. Out of these, 25 public toilets are connected to the underground drainage network while four are still connected to the septic tanks. With the increasing tourist influx in the city every year there is a need to provide adequate number of public toilets at major tourist destinations within the city as well as in the core city area. Apart from this, the existing public toilets need to be improved to meet international standards.



Figure 7: Slum toilets along the St. Inez Creek

Municipal Solid Waste: Situation Analysis



Figure 8: Solid waste lies discarded by the river side

The CCP manages the collection, transportation, treatment and disposal of Municipal Solid Waste (MSW) generated in Panjim. The CCP area on an average generates 47 tons of solid waste per day. Out of the 47 tons of waste collected per day 39 tons is received at the dumping yard of which only 33 tons is actually received and treated at the treatment plant. The per capita waste generation is 619 gm which is quite high which may be due to the high percentage of floating population in the city. Door to door waste collection takes place as well as collection from the community bins every day. Waste is segregated into wet waste which is transported to decentralized composting stations and dry waste is further segregated four ways (paper/card boards, glass, metal plastic),

stored in low density polyethylene (LDPE) bins. Only 60% of the residential complexes are covered under four-way dry waste segregation. Construction waste is quite high and amounts to approximately 25 tons on an average per day. There are 12 Municipal Solid Waste Management Zones within the city. 30 vehicles are used in the transportation of waste to the processing and the composting sites.

The key issues identified in the case of sanitation are the following:

The existing sewerage network is in poor condition and there is a lack of 100% coverage of the UGD system. Only 31.3% of the households out of the total households having access to water supply have sewerage connections. At present only 8.0 MLD (67%) of sewerage is being collected and treated in the existing STP at Tonca of 12.5 MLD. The major natural drains in the city receive solid and liquid waste water affecting the flow and discharging polluted water into the River. With the increasing tourist influx in the city every year there is a need to provide adequate number of public toilets at major tourist destinations within the city as well as in the core city area. According to a gap analysis conducted by CRISIL7, the city requires an additional sewerage network of 31.43 km and 8.73 MLD additional capacity of sewerage treatment plan by the end of 2041.

Insufficient composting units, insufficient land to set up new composting units, odour emanating from the units and difficulties in their management/monitoring is posing a problem in the processing of organic waste within the city. Sanitary workers involved in door-to-door collection, transferring of waste to the pick-up points and in the composting operation have not been provided with appropriate Personal Protective Equipment (PPE)s. The sorting centre currently used for non-biodegradable waste (dry waste) is not sufficient for the quantum of non bio-degradable waste received at the centre and not efficient, being completely

manual in operation. The biggest issue however remains that residents, the floating and tourist population have poor civic sense.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Sanitation in Panjim, the fragility statement for this system is 'An old sewerage system, inefficient service coverage, poor operation and maintenance (O&M) and lack of civic sense is impacting the sanitation of the city.'

In the past, leakages have led to contamination of piped as well as ground water. Water pollutants create a wide variety of problems when they enter the food chain, posing potential health hazards apart from foul taste or odour in drinking water. Open dumping of municipal solid waste also blocks sewers and drains resulting in flooding and insanitary conditions.

Climate risk 1: Increased precipitation would lead to unhygienic conditions and health hazards due to increased incidences of water borne diseases.

5.1.3. Storm Water Drainage

Situation Analysis

A majority of the area in the city of Panjim is made up of reclaimed low lying land and is only 7m above mean sea level making it highly prone to flood water from three sides i.e. Zuari river on the South, Mandovi river on the North and Arabian Sea in the West. The storm water drains within the city are mainly of two types, viz. major drains/ nallahs and roadside drains. The major drains are maintained by the WRD. The roadside drains are planned and laid by the PWD department while CCP maintains the roadside drains located within its jurisdiction. Based on the natural topography and the slope of the city all the storm water drains are laid flowing towards the Western area of the city. All the road side drains surface runoff water is let into major drains which is further discharged into River Mandovi. The present storm water drainage network for Panjim city was planned and implemented in the year 1938 by the Portuguese. The drains are closed, have no lining and are desilted every three months. The storm water drainage system can be divided into four major zones.



Figure 9: Sluice pipes choked with plastic

The total length of roadside drains in the city is 77 km (one sided) which covers the existing road network within the city. The storm water from here is channelized towards the River through major drains. However, with the scale of urbanization and silting of the major drains, the existing system of storm water drainage has been inadequate and insufficient to address the issues of the city which faces flooding every monsoon due to the natural process of the high tide in the River Mandovi. This has been a major challenge for the city which needs to be addressed in a systematic and effective manner. The present state of outfall drains is poor, choked with solid waste and lacks proper maintenance.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Storm Water drainage in Panjim, the fragility statement for this system is Panjim's storm water drainage system is quite old and prone to siltation.'

Increased rainfall will put more pressure on the city's drains which are already affected by siltation, blocked by solid waste and need replacing.

Climate Risk 1: Increased precipitation would lead to increased instances of flooding. Increased precipitation would also increase the chances of greater ‘knock-on’ impacts on human health and well-being.

5.1.4. Land Use

Situation Analysis

Panjim is bordered by the River Mandovi, the Ourém Creek and the Altinho hillock which form physical barriers to the city’s expansion. Therefore the initial growth of the city was along Miramar and Caranzalem. Consequently peripheral villages Taleigao, St. Cruz, Mercês and Bambolim were included in the natural expansion. Development of strong linkages in the form of bridges across the River Mandovi provided a setting for the induced expansion at Porvorim which became a major satellite of Panjim. Further commercial ribbon-development along the NH17 has taken place as well between Panjim and Mapusa.

Panjim is the administrative and economic hub of the district. Due to the high rates of urbanization and influx of tourists, the city is shifting from a residential to a commercial and institutional type. The residential areas in the city have expanded into the peri-urban outgrowths of the city. It is therefore important to plan the future development of these adjoining outgrowth areas along with the city area with the view of reducing the load on Panjim.

The city is located in the Coastal Regulation Zone (CRZ) and an ecologically sensitive zone. At present due to high urbanisation and land reclamation for development, the city’s ecosystem is threatened. This may lead to deterioration of the natural features and lower the city’s resilience to various natural disasters which will exacerbate as a result of climate change. This will not only affect the city infrastructure facilities but also the residents of the city.

The hills and hill slopes in and around Panjim, which were the aquifers absorbing rain water and thus recharging the ground water, today, are now concretized. The precipitation over Panjim city is no longer absorbed into the ground water body as in the past, but drains over the tarred roads. The city, which in reality is a reclaimed marshland of the nineteenth century, is today suffering from acute soil erosion. The silting of Mandovi river, unscientific constructions on hill slopes, encroachment and the reclamation of land near the T B Cunha School and the sports ground around housing Campal, has caused stagnation of rainwater leading to instances of flooding.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Land and Land use in Panjim, the fragility statement for this system is ‘Land degradation and encroachment is limiting land use options.’

As an indirect effect of increased temperature, demand for water will increase leading to an over extraction of ground water. This could in-turn lead to salt water ingress causing degradation of soil quality and even potentially cases of land subsidence. Increased precipitation will trigger water logging and flooding in reclaimed low lying areas. People living in these areas will be affected.

Climate Risk 1: In case of increased short duration-high intensity rainfall events, water logging and flooding situation in low-lying areas would only get worse, thereby reducing access to usable land.

5.1.5. Ecosystem

Situation Analysis

Reclaimed saline flood plains in Goa's tidal estuaries (below sea level at high tide) which comprise of mangrove areas are called the *Khazan* lands. An intricate system of bunds and sluice gates¹⁴, dykes, canals, and gates have allowed for its reclamation and for these floodplains to occupy an important role in agriculture and pisciculture. Mangrove vegetation provides an important, natural, anti-erosive barrier.

Mangroves act as wave breakers and reduce the net erosive energy of the tides. The biota of estuaries, mangrove swamps and forests, intertidal zones, mud flats, embankments, and the productive *Khazan* farms constitute very vulnerable elements of the system. These lands serve as emergency storm water receptacles. If this land is destroyed or filled up, flooding (in inland areas) is bound to occur. In present times, management of *Khazan* ecosystems are impaired by various factors, intensive agriculture and mining, and other socio-economic factors.

The planners of the Portuguese regime had designed and constructed drains, culverts and storm water pathways to channelize the water of the monsoon shower from the hills into the low lying areas around Miramar, Patto marshland, and an equilibration pond near Portais. They were fully aware that during the high tide, the waters from river Mandovi would rise above the ground level in Panjim and flood it. Hence the low lying areas, the water balancing ponds at Portais, the mangrove marshlands at Mercês, Santa-Cruz and around Patto Bridge were planned, and, used not only to receive and collect the river waters during high tide, but the rain waters during heavy monsoon showers as well.



Figure 10: State of the St. Inez Creek

The Ourém creek is located in the east of Panjim in an area called Fontainhas and is dominated by mangroves on both its banks. The creek extends to Mala and St. Cruz region. *Khazan* land is present along National Highway 4 near Kadamba bus stand and Ourém creek Salt pan at Ribandar Mangroves near Pattobridge. The St. Inéz Creek in Panjim opens up into the Mandovi River which further joins the sea at Miramar. The St. Inéz creek has now turned into a nallah since it has been receiving untreated sewage and garbage over the years. At present, the depth of the creek has been reduced and is found in the range of 1- 4.5 m along its course. The city garbage and floating litter stuck at various points along the length of the creek is observed.

This leads to flooding in some parts during monsoon. Urbanization and construction in the vicinity of the creek is exposing it to increasing pollution. New mega projects that are coming up near the creek would further aggravate the problem.

A stretch of about 4.5 km of sandy shore exists from Miramar, Carnazalem to Panjim town. Due to rapid urbanization and tourism, most of the dunes are destroyed. The mangrove forests and marshland around Santa-Cruz, Patto Plaza, and Mercês too are destroyed - reclaimed & transformed into housing complex and private garages and commercial units.

Fragility Statement and Climate Fragility Statement

Considering the present situation of the Ecosystem in Panjim, the fragility statement for this system is 'Large tracts of mangroves and sand dunes are being lost due to encroachment and conversion of land.'

14. Alvares. 2002. In: *Climate Resilient Infrastructure Services, Case Study Brief: Panaji* prepared by TERI funded by USAID, 2014.

The optimum mangrove leaf temperature for photosynthesis is believed to be between 28 and 32°C, while photosynthesis ceases when leaf temperatures reach 38–40°C^{15, 16}. Increases in temperature will not only affect the mangroves but also the species that depend on them. Increased surface temperature is expected to affect mangroves by changing species composition; changing phenological patterns (e.g., timing of flowering and fruiting); increasing mangrove productivity where temperature does not exceed an upper threshold; and expanding mangrove ranges to higher latitudes where range is limited by temperature, but is not limited by other factors¹⁷. Increased rainfall may be beneficial for mangroves resulting in increased growth rates and biodiversity, increased diversity of mangrove zones, and an increase in mangrove area, with the colonization of previously unvegetated areas of the landward fringe within the tidal wetland zone^{17, 18}. Areas with higher rainfall have been found to have higher mangrove diversity and productivity probably due to higher supply of fluvial sediment and nutrients, as well as reduced exposure to sulphate and reduced salinity^{19, 20, 21}.

Climate Risk 1: Increased temperature would impact the fundamental functioning of the ecosystem by bringing about changes in pollinators, migratory species and seed dispersers' behaviour. Increased temperatures can affect mangrove survival.

5.1.6. Health

Situation Analysis

Panjim is well equipped with good health facilities. A number of private multi-specialty hospitals, clinics and dispensaries cater to the city's present need. The Goa Medical College hospital is the government hospital which is located in Bambolim adjacent to the CCP area. There is an urban health centre maintained by the Directorate of Health Services which receives on an average 80 to 100 patients per day. Apart from this, there is one medical laboratory at Campal. The health facilities in the city are mainly located in the areas adjoining the core city area towards the Northern part of the city. The Northern part of the city is equipped with major city level health amenities and remains accessible for the city as well as the adjoining urban centres and rural areas due to good connectivity.

Cases of various vector borne diseases have been reported in Panjim. Breakdowns in urban systems functions like that of sewerage, water supply and drainage further lead to health issues. Cases of E. coli in ground water have been reported in the city⁷. The key diseases affecting the citizens of Panjim are – Malaria, Dengue, Chikungunya, and Filaria .

Fragility Statement and Climate Fragility Statement

Considering the present system of Health the fragility statement for this system is 'Due to a breakdown of functions of urban systems like water supply, sanitation and drainage system, the disease risk in the city is increasing.'

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15. Clough, B.F., Andrews, T.J., Cowan, I.R. 1982. *Physiological processes in mangroves*. In: Mangrove Ecosystems in Australia: Structure, Function and Management. Clough, B.F. (Ed.). Australian National University Press, Canberra.
 16. Andrews, T.J., Clough, B.F., Muller, G.J. 1984. *Photosynthetic gas exchange properties and carbon isotope ratios of some mangroves in North Queensland*. In: Physiology and Management of Mangroves, Tasks for Vegetation Science, Teas, H.J. (Ed.). The Hague.
 17. Field, C. 1995. Impacts of expected climate change on mangroves. *Hydrobiologia* 295, 75–81
 18. Duke, N.C., Ball, M.C., Ellison, J.C. 1998. Factors influencing biodiversity and distributional gradients in mangroves. *Global Ecol. Biogeogr* 7, 27–47.
 19. McKee, K. 1993. Soil physiochemical patterns and mangrove species distribution reciprocal effects. *J. Ecol.* 81, 477–487.
 20. Ellison, J. 2000. How South Pacific mangroves may respond to predicted climate change and sea level rise. In: Climate Change in the South Pacific: Impacts and Responses in Australia, New Zealand, and Small Islands States. Gillespie, A., & Burns, W. (Eds.). Kluwer Academic Publishers, Dordrecht, Netherlands.
 21. <http://www.nhm.goa.gov.in/nhm-components/national-disease-control-programmes/national-vector-borne-disease-control-programme-nvbdcnp>

The projected climate risks would have indirect impacts on health by creating flooding and increased unhygienic conditions (as discussed above) that could lead to greater incidences of vector and water borne diseases.

Climate Risk 1: Increased temperature can lead to heat stress and increased morbidity and illness.

Climate Risk 2: Increased precipitation would lead to water logging/flooding which will increase chances of water/vector borne communicable diseases.

5.1.7. Transportation

Situation Analysis

Goa has a total length of 269 km under National Highways and two National Highways pass through it. The NH-17 runs along west coast and links Goa to Mumbai in the north and Mangalore to the south while NH-4A runs across the state connecting Panjim to Belgaum (Karnataka) in east. The State Highways, Major District Roads (MDR) and the city roads are maintained by the state government under PWD. The CCP presently is not involved in the O&M and laying of roads within the city. Total road coverage in the city is only 5.45% of the total city area which is highly inadequate in comparison to the Urban and Regional Development Plan Formulation and Implementation (URDPFI) guidelines of 14-15%. Roads within the CCP are 100% surfaced with bituminous topped (BT) roads. The major issue which is faced by the city administration is regular resurfacing of the roads which are subjected to frequent wear and tear due to high vehicular traffic movement. The road surface is also damaged during the period of monsoons due to heavy rain and flooding in some parts of the city.

Goa is endowed with 253 km of navigable inland waterways. Ferry transport is a significant transport mode in Panjim. A substantial number of people use the ferry system operated by River Navigation Department as it is affordable and less time consuming to go across the River Mandovi. There are three jetties from which ferries transport people and vehicles across the River Mandovi. They operate from Panjim to Betim, Ribandar to Choraio and Divar jetty to St. Pedro.

The existing transportation infrastructure of the city includes the Kadamba Transport Corporation (KTC) bus terminal and the Ferry transport node. The KTC and private bus operators run buses within Panjim and Goa State. There are total 433 buses in the state. Apart from this, there is water transport facility transporting people and goods from Panjim across to other bank of River Mandovi. There are three jetties from which ferries transport people and vehicles across the river Mandovi. There is no direct railway link or airport facility within or surrounding the city limits.

One of the biggest issues in Panjim is the inadequacy of the public transport system. Public transport only accounts for 15% of the total trips in the city. Public transport routes are not comprehensive and do not cover all areas of the city. The existing bus services in the city are insufficient and inadequate. While a few regions are well served, like KTC to Miramar beach, other areas have little to no bus services. This is especially true of private buses which only ply on certain major routes in the city. The public transport system has not been effective to serve the mobility pattern of city. This has led to an increasing number of private vehicles over the years elevating traffic congestion. The parking area is highly inadequate, not regularized and presently not charged. All the major roads have on-street parking, which reduces the effective right of way and adds to on-road congestion. There is lack of efforts to promote pedestrian and other environment friendly mode of transportation in the city. The city bus stand lacks good passenger and tourist facilities.

Fragility Statement and Climate Fragility Statement

Considering the present situation of Transportation in Panjim, the fragility statement for this system is ‘High vehicular volume leads to congestion and increased emissions, threatening the micro climate.’

Higher temperatures can deform road surfaces and create rutting and potholes, particularly on roads with a heavy traffic load and can also affect bridge joints. In addition, higher temperatures coupled with poor public transport and a large number of tourists will lead to an increase in vehicular traffic due to more number of cars on the road. This will disrupt smooth flow of traffic creating more congestion and increase emissions. Apart from this, heavy rains cause flooding and landslides which will further damage the roads.

Climate Risk 1: Increased temperature would impact micro climate; therefore leading to an increased use of private vehicles, AC usage in cars, more GHG emissions.

Climate Risk 2: Increased precipitation would lead to flooding situation leading to congestion and in extreme cases loss of connectivity/access.

5.2. Risk Assessment

The climate risks associated with the fragilities of these systems were calculated through a risk assessment exercise conducted by the stakeholder group during an SLD. The fragile urban systems with the highest risks as per the assessment were investigated further.

The risk score for each climate fragility statement is defined as a combination of the likelihood of an event to occur and the consequences faced if the event occurred.

The process followed for risk scoring is detailed in Annexure 1. Table 5 shows the risk status of the climate fragility statements.

Table 5: Risk Assessment of Climate Fragility Statements

Urban System	Impacts of Climate Change	Risk Status
Water Supply	Increased temperatures can lead to increased demand for water thereby posing additional stress on the supply system.	High
	Increased precipitation would lead to increased flooding situation resulting in contamination of potable water.	
Sanitation	Increased precipitation would lead to unhygienic conditions and health hazards due to increased incidences of water borne diseases.	High
Storm Water Drainage	Increased precipitation would lead to increased instances of flooding. Increased precipitation would also increase the chances of greater ‘knock-on’ impacts on human health and wellbeing.	High
Land	In case of increased short duration-high intensity rainfall events the water logging and flooding situation in low-lying areas would only get worse, thereby reducing access to usable land.	High
Ecosystem	Increased temperature would impact the fundamental functioning of the ecosystem by bringing about changes in pollinators, migratory species and seed dispersers’ behaviour. Increased temperatures can affect mangrove survival.	High

Urban System	Impacts of Climate Change	Risk Status
Health	Increased temperature can lead to heat stress and increased morbidity and illness.	High
	Increased precipitation would lead to water logging/flooding which will increase chances of water/vector borne communicable diseases.	
Transport	Increased temperature would impact micro climate; therefore leading to an increased use of private vehicles, AC usage in cars, more GHG emissions.	Medium
	Increased precipitation would lead to flooding situation leading to congestion and in extreme cases loss of connectivity/access.	High

Based on this risk assessment, all the fragile urban systems show high risk. As the risk of the impacts of increased temperature only showed medium risk in the transportation urban system, this was put on a lower priority than the others.

6. Vulnerability Assessment

6.1. Overview

In order to build resilience there is a need to understand the extent of vulnerability of the city to climate change. This vulnerability depends upon the geographical location, demography, infrastructure, socio economic condition, ecological condition of the city. The Intergovernmental Panel on Climate Change (2007) defines vulnerability as a function of three parameters of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

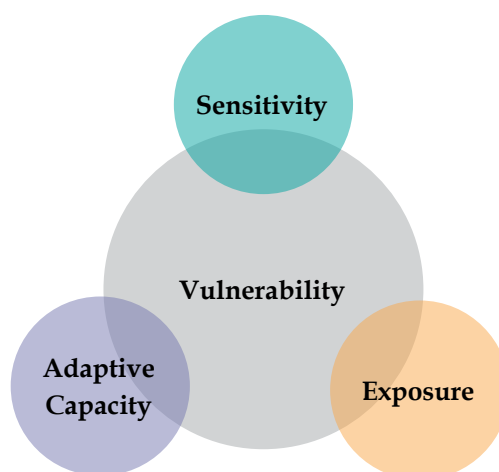


Figure 11: Vulnerability Constituents²²

Vulnerability assessment through the IAP consists of identification of vulnerable areas and actors for all the prioritized climate fragility statements of the fragile urban systems and analysis of the adaptive capacities. Vulnerability assessment of Panjim was carried out in consideration of the following elements:

1. **Identification of Vulnerable Places:** Highly vulnerable areas in context of identified fragile urban system of the city were identified and mapped to arrive at vulnerable hotspots affected by maximum number of fragile urban systems.
2. **Identification of Vulnerable actors and their adaptive capacity:** In each of the vulnerable areas, the actors that play a critical role towards building urban resilience were identified and assessed in terms of their capacity to organize and respond to threat or disruption, access to resources necessary for response (manpower, technology, funds) and access to information necessary to develop effective plans and actions and to improve responses to disruptions. These determine the adaptive capacity/resilience of the identified actors for a particular fragile system.
3. **Assessment of Capacities of Urban Systems:** Adaptive capacity of urban systems is its capacity to absorb and respond to shocks that determines their resilience. The adaptive capacity was determined in the context of economy, technology/infrastructure, governance, social systems and ecosystems.

The sections below identify the vulnerable areas, vulnerable actors and adaptive capacity of the fragile urban systems using the climate fragility statements developed in consultation with the Stakeholder Committee.

22. IPCC. 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Annex I., M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK.

6.2. Identification of vulnerable areas of Fragile Urban Systems

6.2.1. Water Supply: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Increased temperatures can lead to increased demand for water thereby posing additional stress on the supply system.	Core areas of Fort Kochi and Matancherry, ward 61 and ward 62 (Figure 4).

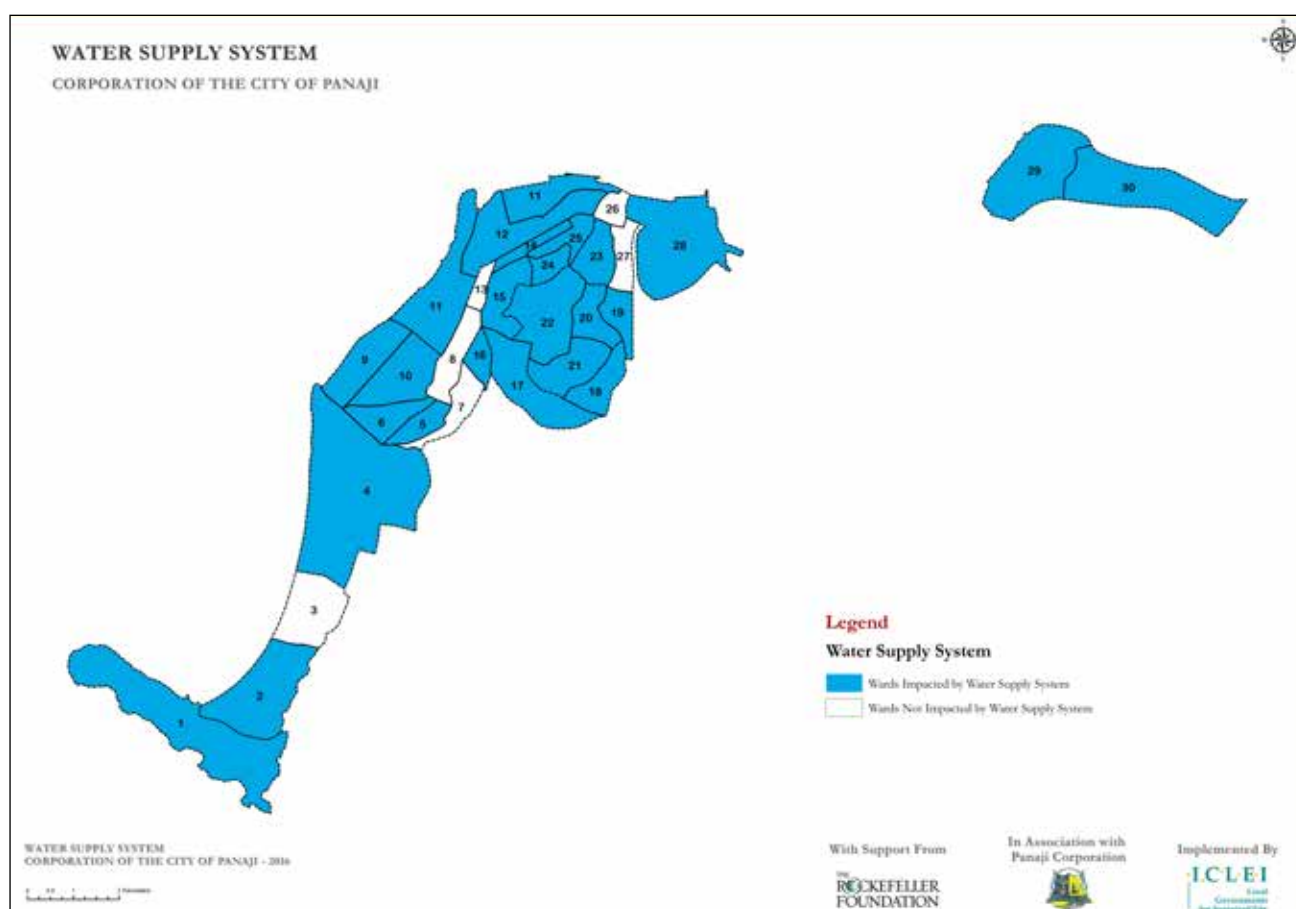


Figure 12: Wards in Panjim city vulnerable to the climate risks for water supply

6.2.2. Sanitation: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Increased precipitation would lead to unhygienic conditions and health hazards due to increased incidences of water borne diseases.	St. Inez band area, pockets at Mala area; Parts of Bhatulem ; Sea beach in Avivao Sea beach in Dando, Caranzalem; Forest/ plantation area/ vacant lots near Dhempe Higher Secondary School of Arts and Science; Forest/ plantation area in Valice Bhat, Storm water drains near Lopez Bar/ Tamdi Mati Bus Stop (Figure 13).

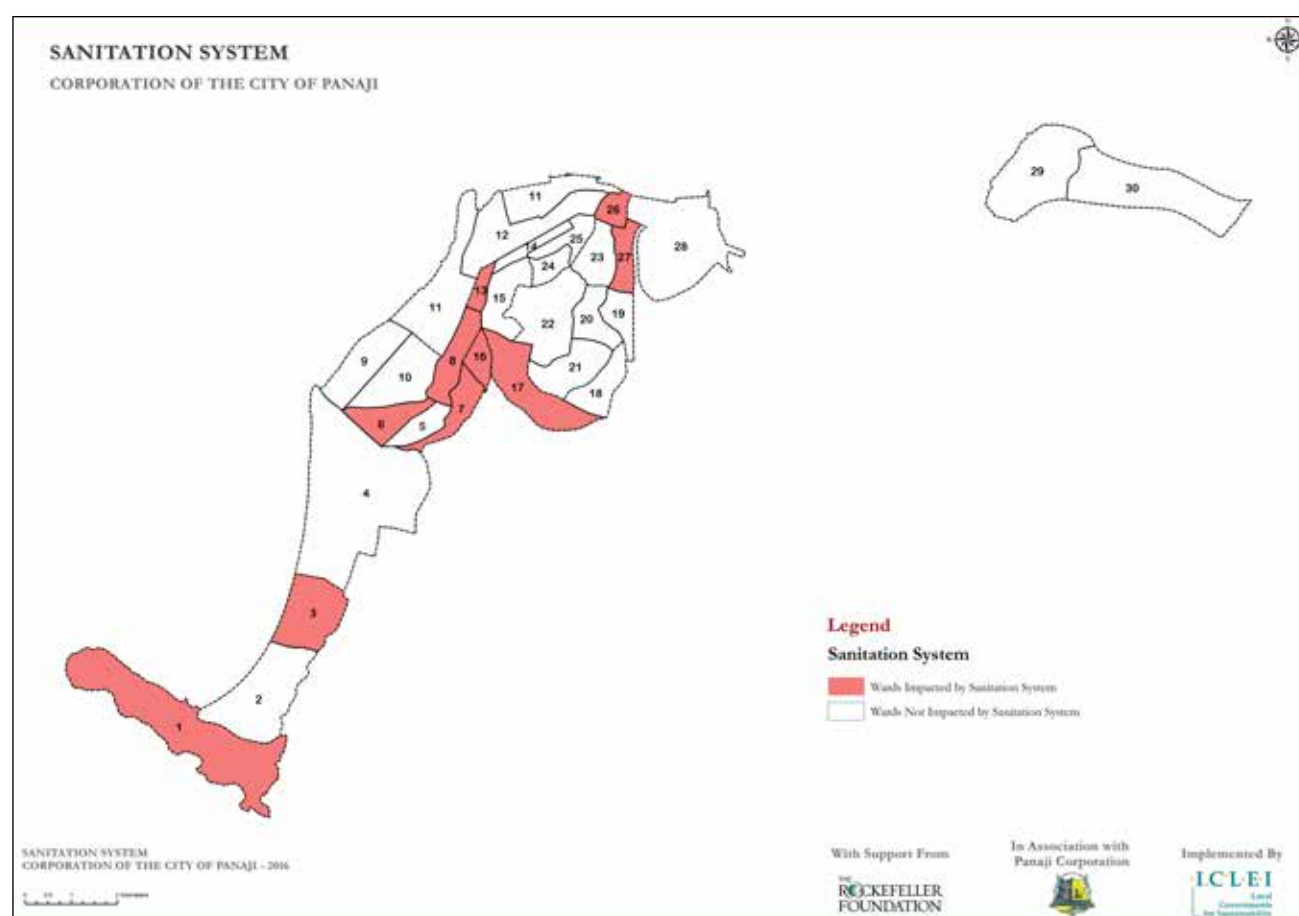


Figure 13: Wards in Panjim city vulnerable to the climate risks for Sanitation

6.2.3. Storm Water Drainage: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Increased precipitation would lead to increased instances of flooding. Increased precipitation would also increase the chances of greater 'knock-on' impacts on human health and wellbeing.	Dr. Pissurlekar road (near CCP); MG road; KTC; Avenida Dom Joao de Castro; Mala Area; 18th June Road; Near Don Bosco's campus road; DB road; Atmaram Borkar road, Swami Vivekanand road; Dr. Shivgaonkar road; St. Inez Road; Ward 6 (St. Inez); Mira mar circle road; Rua de Ourém creek road; Carazalem road (Figure 14).

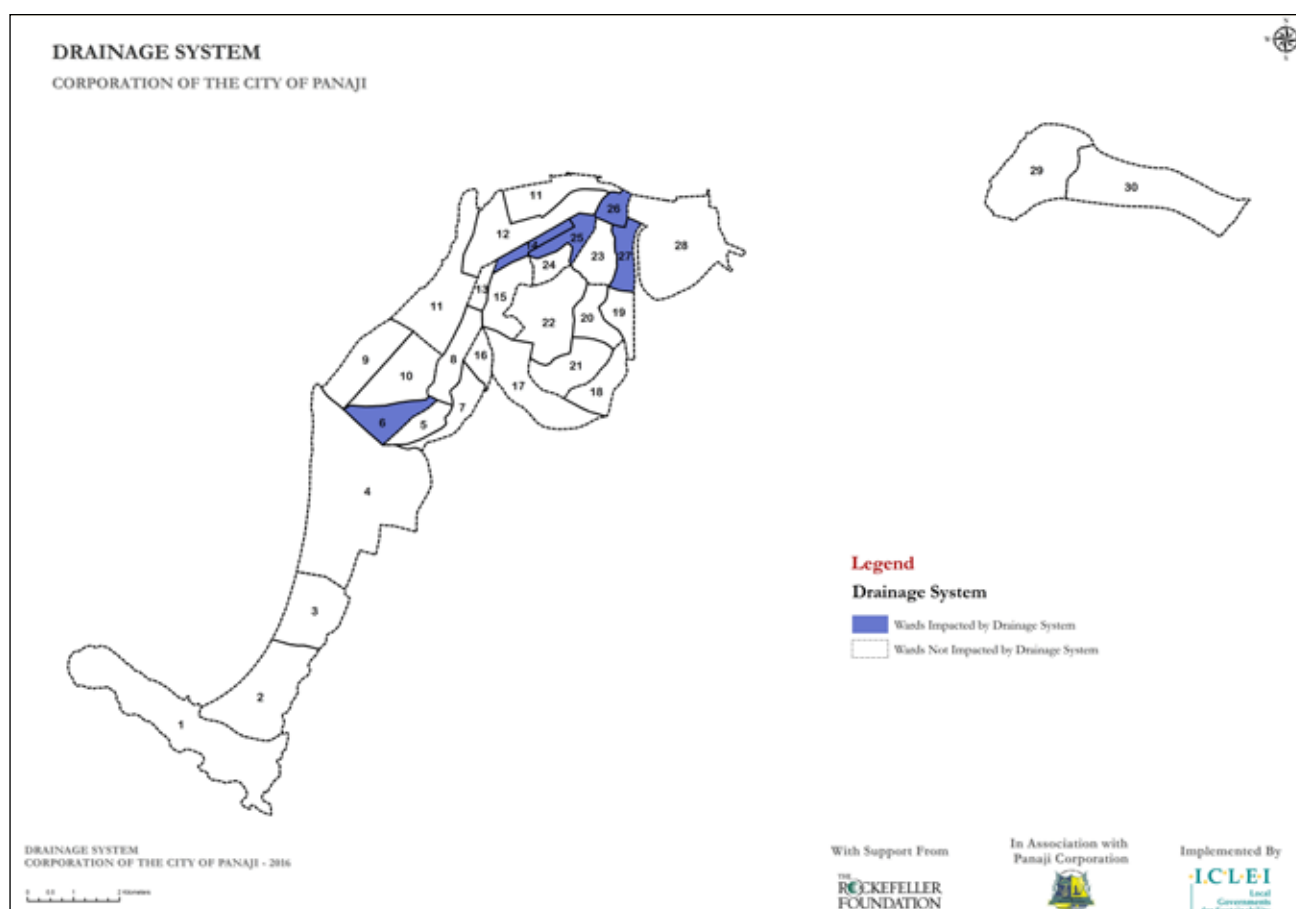


Figure 14: Wards in Panjim city vulnerable to the climate risks for Storm Water Drainage

6.2.4. Land Use: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
In case of increased short duration-high intensity rainfall events the water logging and flooding situation in low-lying areas would only get worse, thereby reducing access to usable land.	Mala Area; Ward 6 (St. Inez); St. Inez Road; Rua de Ourém creek road (Figure 15).

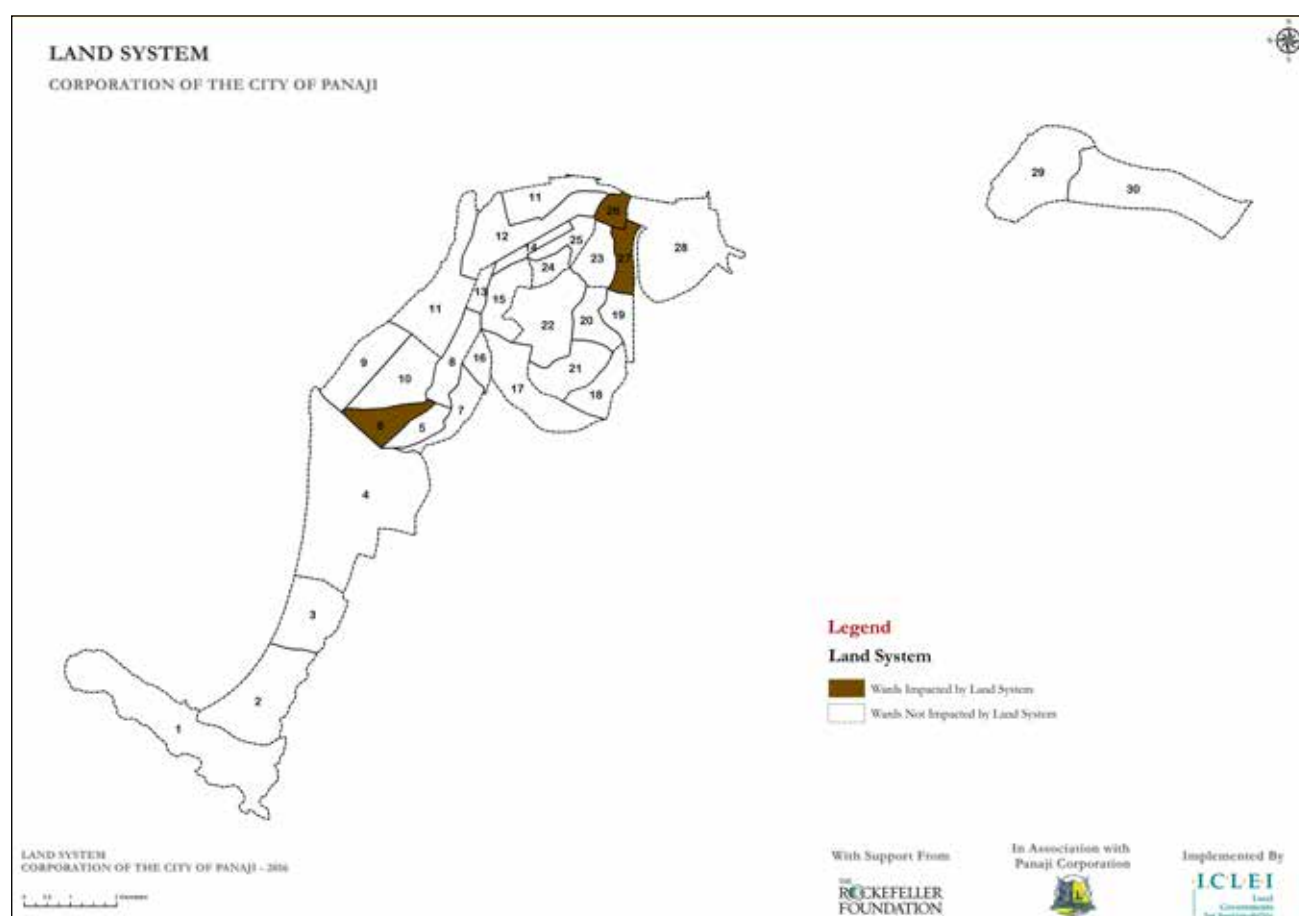


Figure 15: Wards in Panjim city vulnerable to the climate risks for Land

6.2.5. Ecosystem: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Increased temperature would impact the fundamental functioning of the ecosystem by bringing about changes in pollinators, migratory species and seed dispersers' behaviour. Increased temperatures can affect mangrove survival.	Mala areas, along St. Inez creek; along causeway (salt pans and mangroves) (Figure 16).

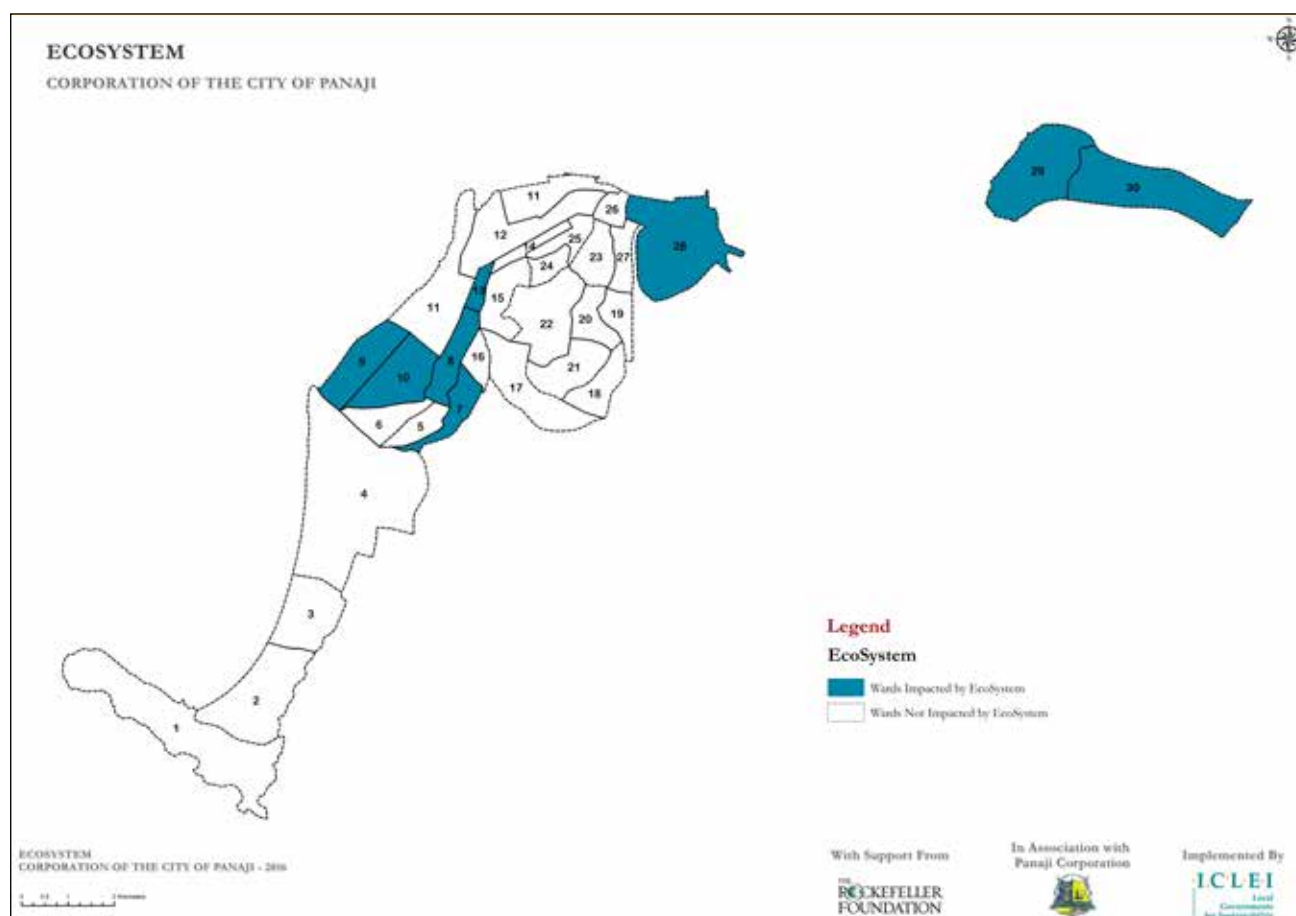


Figure 16: Wards in Panjim city vulnerable to the climate risks for Ecosystem

6.2.6. Health: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Increased temperature can lead to heat stress and increased morbidity and illness.	Pockets of Mala Area; St. Inez Band; Parts of Bhatulem (Figure 17).
Increased precipitation would lead to water logging/flooding which will increase chances of water/vector borne communicable diseases.	

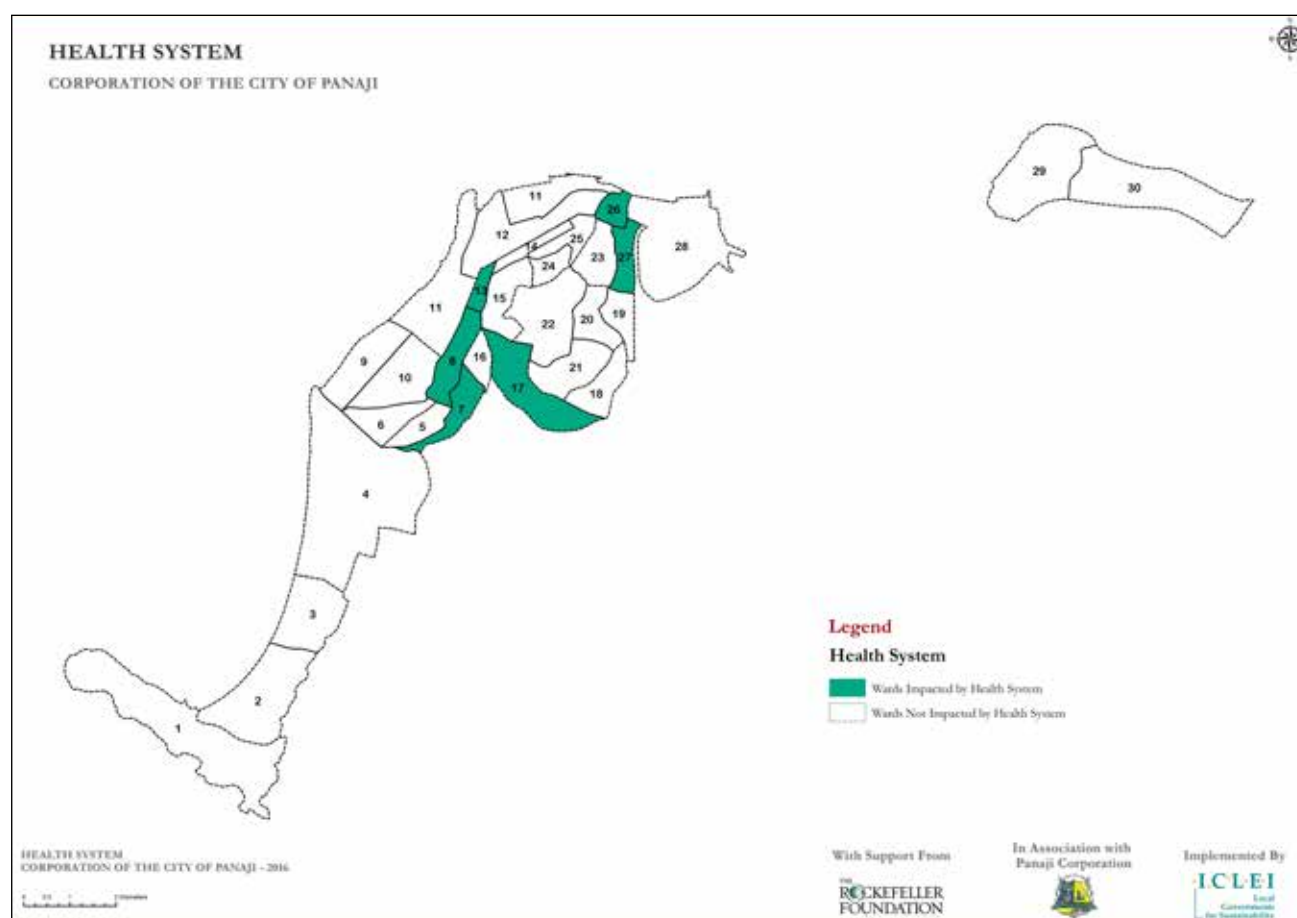


Figure 17: Wards in Panjim city vulnerable to the climate risks for Health

6.2.7. Transportation: Vulnerable Areas

Climate Fragility Statements	Area/ward most vulnerable
Increased precipitation would lead to flooding situation leading to congestion and in extreme cases loss of connectivity/access.	Central Business District (CBD) area (Figure 18).

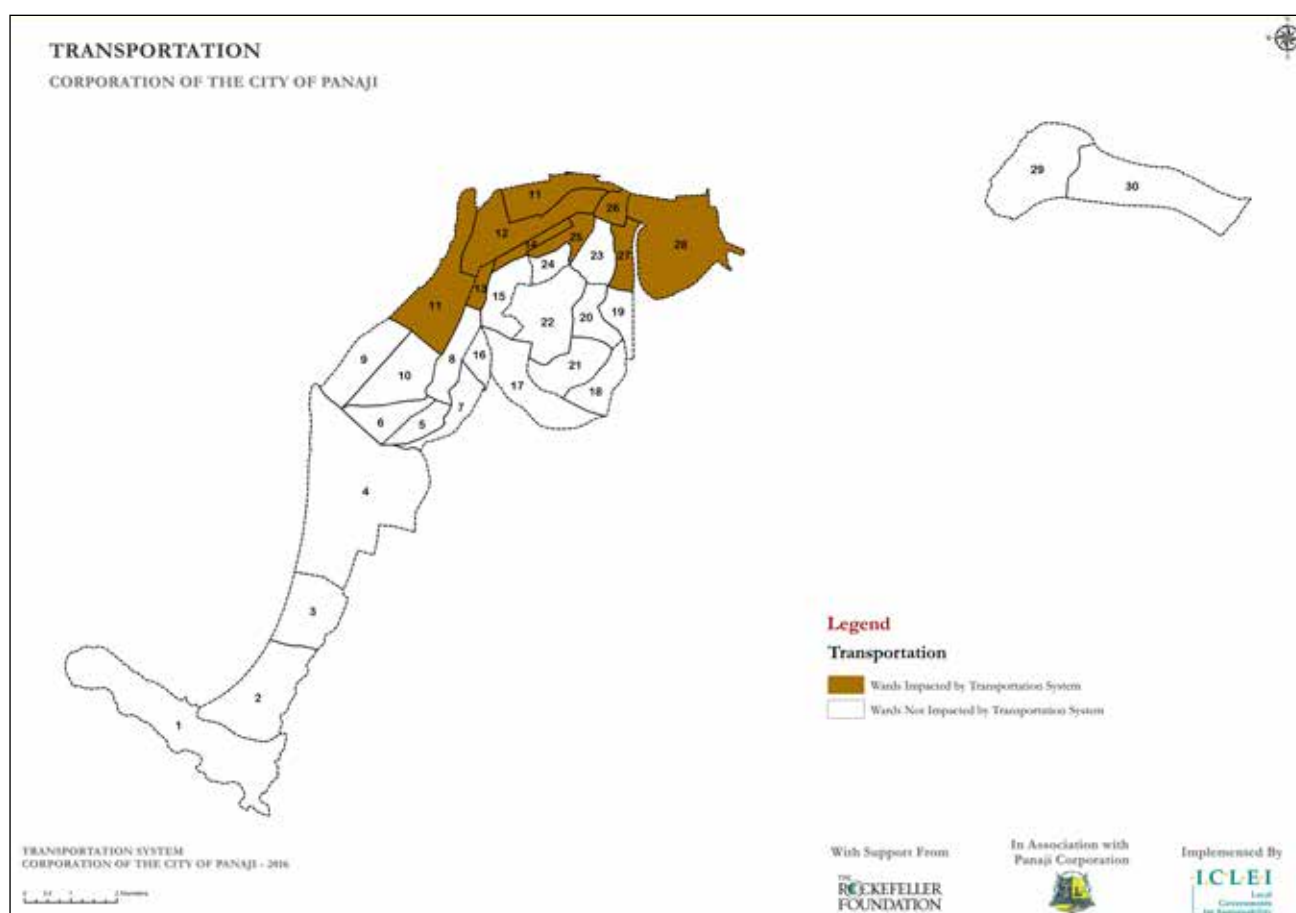


Figure 18: Wards in Panjim city vulnerable to the climate risks for Transportation

Through these assessments, the areas that were found to be most vulnerable are wards 26 and 27 which are vulnerable to six fragile urban systems, while ward 13 is vulnerable to five fragile urban systems. Wards 26 and 27 have very poor levels of infrastructure, a substantial slum population and are inundated annually following heavy rainfall. Ward 13 also has a large slum population on private land and due to issues with ownership of the land, is extremely poor in basic services.

The Vulnerability hotspot map (Figure 19) helps to identify the wards which must be focused on for future interventions to build resilience that are identified in later chapters.

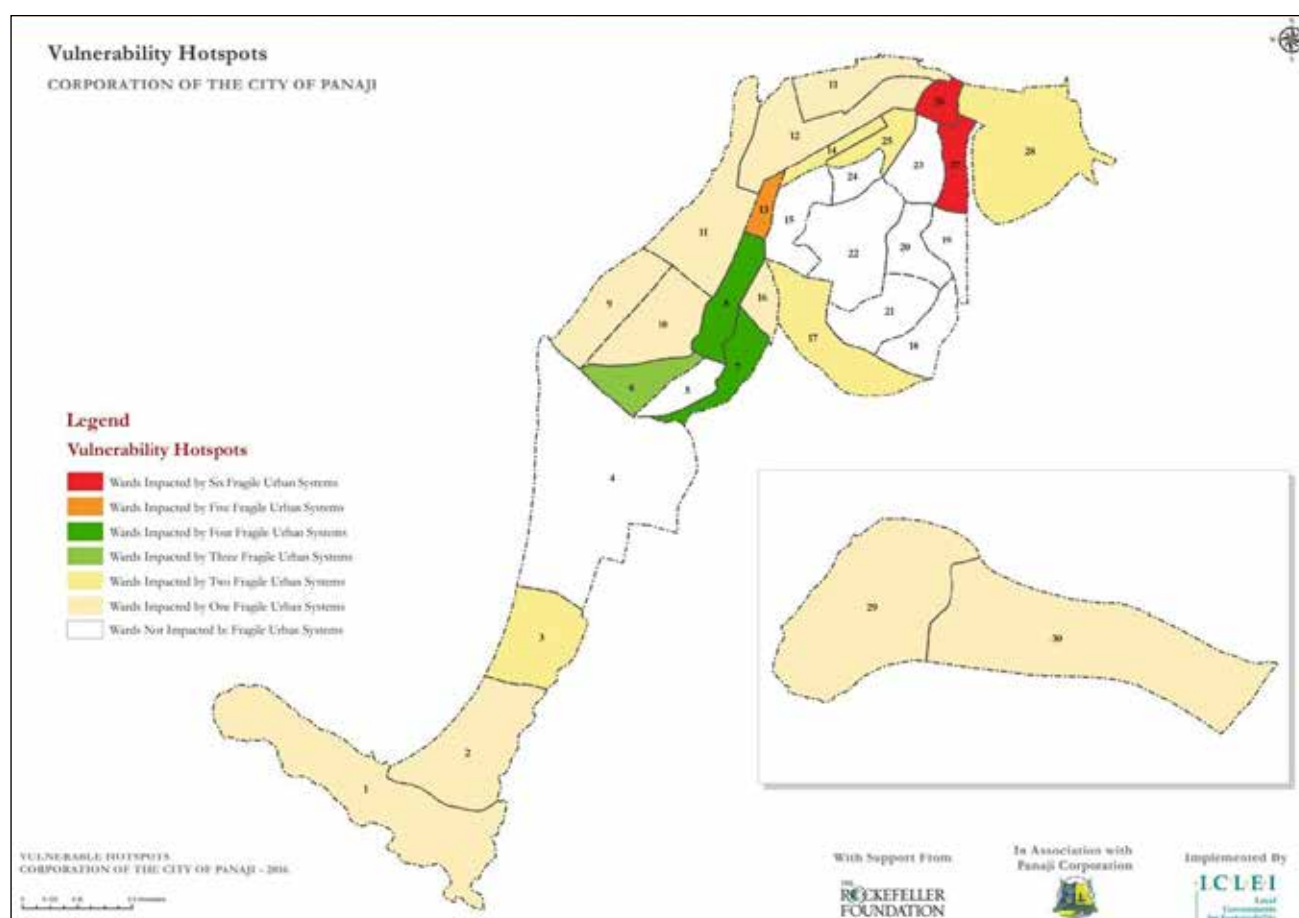


Figure 19: Vulnerability Hotspot Map of Panjim City

6.3. Actor Analysis

An analysis of actors across the different urban systems revealed low levels of adaptive capacities across the seven urban systems. CCP is a vulnerable actor across all the fragile urban systems except in the case of sanitation where it emerged as a supporting actor with a medium score. Parastatal bodies like the PWD, WRD, Forest Department, Biodiversity Board also scored low across the different urban systems. CCP and other departments may be able to address present issues, however, in terms of disaster preparedness, planning needs to be initiated. Furthermore capacities will also need to be developed. The traffic police department scored high in the assessment of the transportation urban system and can contribute towards building urban resilience in the city. The department has an emergency response plan where they have considered multiple scenarios, especially ones which may require the city to be evacuated.

Table 6 below shows the adaptive capacities of the actors for each fragile urban system.

Table 6: Analysis of the adaptive capacities of local actors identified

Fragile Urban System	Climate Fragility Statements	Area/ ward	Actors	Level of Adaptive Capacity
Water Supply	Increased temperatures can lead to increased demand for water thereby posing additional stress on the supply system. Increased precipitation would lead to increased flooding situation resulting in contamination of potable water.	Dando (Carazalem), St. Inez Band, pockets of Mala area; Parts of old Latin localities of Bairo Portais, and Bhatulem; Includes a few heritage structures namely Maruti Temple, Portais Chapel, Panjim Inn etc.	Citizens/Residents	Low
			Floating Population	Low
			Unorganized Societies/ Slum Population	Low
			PWD	Low
			WRD	Low
			Educational Institutions	Low
			Private Corporations	Low
			CCP	Low
Sanitation	Increased precipitation would lead to unhygienic conditions and health hazards due to increased incidences of water borne diseases.	St. Inez band area, pockets at Mala area; Parts of Bhatulem; Sea beach in Avivao Sea beach in Dando, Caranzalem; Forest/ plantation area/ vacant lots near Dhempe Higher Secondary School of Arts and Science; Forest/ plantation area in Valice Bhat, Storm water drains near Lopez Bar/ Tamdi Mati Bus Stop.	CCP	Medium
			PWD (sewerage)	Low
			Unorganized Societies/Slum Population	Low
			Private Corporations	Low
			Residents/ Households/Citizens	Low
			Floating Population	Low

Fragile Urban System	Climate Fragility State-ments	Area/ ward	Actors	Level of Adaptive Capacity
Storm Water Drainage	Increased precipitation would lead to increased instances of flooding. Increased precipitation would also increase the chances of greater 'knock-on' impacts on human health and well-being.	Dr. Pissurlekar road (near CCP); MG road; KTC; Avenida Dom Joao de Castro; Mala Area; 18th June Road; Near Don Bosco's campus road; DB road; Atmaram Borkar road, Swami Vivekanand road; Dr. Shivgaonkar road; St. Inez Road; Ward 6 (St. Inez); Mira mar circle road; Rua de Ourém creek road; Carazal-em road	Residents/ Citizens	Low
			CCP	Low
			Unorganized Societies/ Slum Population	Low
			Educational institutions	Low
			WRD	Low
			Private Corporations	Low
Land Use	In case of increased short duration-high intensity rainfall events the water logging and flooding situation in low-lying areas would only get worse, thereby reducing access to usable land.	Mala Area; Ward 6 (St. Inez); St. Inez Road; Rua de Ourém creek road	Residents/ Households	Low
			CCP	Low
			Unorganized Societies/ Slum Population	Low
			TCP	Low
			NGPDA	Low
Ecosystem	Increased temperature would impact the fundamental functioning of the ecosystem by bringing about changes in pollinators, migratory species and seed dispersers' behaviour. Increased temperatures can affect mangrove survival.	Mala areas, along St. Inez creek; along causeway(salt pans and mangroves).	WRD	Low
			Residents/ households	Low
			Unorganized societies/ Slum Population	Low
			Forest Department	Low
			Goa State Biodiversity Board	Low
			Department of Science and Technology	Low
			Fishermen	Low
			CRZA	Low

Fragile Urban System	Climate Fragility State-ments	Area/ ward	Actors	Level of Adaptive Capacity
Health	Increased temperature can lead to heat stress and increased morbidity and illness. Increased precipitation would lead to water logging/flooding which will increase chances of water/vector borne communicable diseases.	Pockets of Mala Area; St. Inez Band; Parts of Bhat-ulem.	Residents/ House-holds	Low
			Unorganized Socie-ties/ Slum Popula-tion	Low
			Floating Population	Low
			NGOs	Low
			Health Department	Low
			Educational Institu-tions	Low
			Private Hospitals	High
Transporta-tion	Increased precipitation would lead to flooding situation leading to con-gestion and in extreme cases loss of connectivi-ty/access.	CBD area.	Private Corporations	Low
			Floating Population	Low
			Transport Depart-ment	Low
			Traffic police	High
			CCP	Low
			Residents	Low
			Educational Institu-tions	Low

6.4. Adaptive Capacity of Fragile Urban Systems

The adaptive capacities of the seven fragile urban systems were assessed during the SLD against the five parameters of economy, technology, governance, societal and ecosystem services. Overall, participants rated the adaptive capacities of the urban systems as medium except in the case of land which scored low on all parameters (Table 7).

None of the urban systems had high capacity when assessed with regard to the five parameters. All the systems had two-three parameters falling under the low category and the rest falling under the medium category. Overall, all the urban systems in the city need to build resilience due to old infrastructure, increasing floating and residential population, along with rapid urbanisation. The city needs to develop better governance, infrastructural and economic systems in order to improve the adaptive capacity of all the seven fragile urban systems.

Table 7: Consolidated vulnerability analysis of Fragile Urban Systems identified for Panjim city

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive capacity of the system		
			Vulnerable	Potential Supporting	Low	Medium	High
Water Supply	Increased temperatures can lead to increased demand for water thereby posing additional stress on the supply system.	Core areas of Fort Kochi and Matancherry	● Citizens ● Hotels ● Fisheries Industries / Fisherman Community	● KMC ● KWA	● Economic ● Technology/ Infrastructure ● Governance ● Societal	● Eco-system Services	
Sanitation	Increased precipitation would lead to unhygienic conditions and health hazards due to increased incidences of water borne diseases.	St. Inez band area, pockets at Mala area; Parts of Bhatulem; Sea beach in Avivao Sea beach in Dando, Caranzalem; Forest/ plantation area/vacant lots near Dhempe Higher Secondary School of Arts and Science; Forest/ plantation area in Valice Bhat, Storm water drains near Lopez Bar/ Tamdi Mati Bus Stop	● Citizens/Residents ● Floating Population ● Unorganized Societies/ Slum Population ● Private Corporations ● PWD	● CCP	● Societal ● Ecosystem	● Economic ● Technological/Infrastructural ● Governance	

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive capacity of the system		
			Vulnerable	Potential Supporting	Low	Medium	High
Storm Water Drainage	Increased precipitation would lead to increased instances of flooding. Increased precipitation would also increase the chances of greater 'knock-on' impacts on human health and wellbeing.	Dr. Pissurlekar road (near CCP); MG road; KTC; Avenida Dom Joao de Castro; Mala Area; 18th June Road; Near Don Bosco's campus road; DB road; Atmaram Borkar road, Swami Vivekanand road; Dr. Shivgaonkar road; St. Inez Road; Ward 6 (St. Inez); Miramar circle road; Rua de Ourém creek road; Carazalem road	• Citizens/Residents • Floating Population • Unorganized Societies/ Slum Population • Educational Institutions • Private Corporations • CCP • WRD		• Economic • Technological/Infrastructural • Ecosystem	• Governance • Societal	
Land Use	In case of increased short duration-high intensity rainfall events the water logging and flooding situation in low-lying areas would only get worse, thereby reducing access to usable land.	Mala Area; Ward 6 (St. Inez); St. Inez Road; Rua de Ourém creek road	• Citizens/Residents • Floating Population • Unorganized Societies/Slum Population • WRD • CCP • NGPDA • TCP		• Governance • Technological/Infrastructural • Ecosystem	• Economic • Societal	

Fragile Urban System	Climate Fragility Statements	Vulnerable Areas	Urban Actors		Adaptive capacity of the system		
			Vulnerable	Potential Supporting	Low	Medium	High
Ecosystem	Increased temperature would impact the fundamental functioning of the ecosystem by bringing about changes in pollinators, migratory species and seed dispersers' behaviour. Increased temperatures can affect mangrove survival.	Mala areas, along St. Inez creek; along causeway(salt pans and mangroves).	● Citizens/Residents ● Unorganized Societies/ Slum Population ● Fishermen ● CRZA ● Forest Department ● Department Of Science And Technology ● Goa State Biodiversity Board		● Economic ● Technological/Infrastructural ● Societal	● Governance ● Ecosystem	
Health	Increased temperature can lead to heat stress and increased morbidity and illness. Increased precipitation would lead to water logging/flooding which will increase chances of water/vector borne communicable diseases.	Pockets of Mala Area; St. Inez Band; Parts of Bhatulem.	● Citizens/Residents ● Floating Population ● Unorganized Societies/ Slum Population ● Educational Institutions ● NGOs ● Health Department	● Private hospitals	● Societal ● Ecosystem	● Economic ● Technological/Infrastructural ● Governance	
Transportation	Increased precipitation would lead to flooding situation leading to congestion and in extreme cases loss of connectivity/access.	CBD area.	● Private Corporations ● Floating Population ● Citizens/Residents ● Educational Institutions ● CCP ● Transport Department	● Traffic police	● Governance ● Ecosystem	● Economic ● Technological/Infrastructural ● Societal	

7. Resilience Interventions

Possible adaptation interventions were identified for the seven fragile urban systems in Panjim on the basis of their climate risks and vulnerabilities, the vulnerable areas and the vulnerable actors to adapt to the possible impacts of climate change on these systems. Once the interventions were determined, their resilience score was calculated as high, medium, average and low on the basis of their resilience potential assessed in terms of their redundancy, flexibility, responsiveness and ability to increase access to information. If the interventions improved only one indicator mentioned above, their score was low, if they addressed two, their score was average, if they addressed three, their score was medium and if they addressed all four, their score was high. The climate resilience interventions were also assessed qualitatively for their technical, financial and political feasibility. The overall feasibility was calculated as an average of the qualitative feasibility for all three indicators. Finally their impact on the overall resilience of the city (short, medium or long term) was considered to assess the average time taken for the impacts to be felt on the resilience of the city.

These interventions were linked to existing city plans and schemes so as to determine whether the required interventions can be integrated with little or no additional resources into existing departmental programs or projects.

A total of 38 resilience interventions have been identified in the process as listed in Table 8. The interventions are grouped by fragile urban system and as infrastructural or non-infrastructural measures. The overall resilience score, overall feasibility and impact on the resilience of the city is given in the table. The table also gives an indicative duration for implementing the intervention as short (0-3 years needed), medium (3-5 years needed) or long term (more than 5 years needed) and an indicative cost requirement for the intervention as high (requiring substantial financial support), medium (requiring partial financial support) or low (can be covered by city budget). Each intervention's possible co-benefits are also outlined in the table.

Table 8: Prioritised Resilience Interventions against Resilience Indicators

Prioritised Resilience Interventions	Overall Resilience score	Overall Feasibility	Time taken for Impact on Resilience of City	Duration of Implementation Short/ Medium/ Long term	Indicative Cost (Low/ Medium/ High)	Potential Co-benefits
Water Supply						
Infrastructural Measures						
Rain water harvesting as an alternative source as well as for ground water recharge.	Medium	High	Short term	Short term	Medium	
Use of sensors for control of overflow of Over Head Tanks.	Medium	High-Medium	Short term	Short term	Low	
Reuse of treated waste water by using waste water recycling systems fitted into new commercial and residential buildings.	Medium	Medium	Long term	Long term	High	Leads to reduced pollution of water sources.
Innovation to control leakage and wastage of water using technologies like Zonescan alpha which is a permanent network monitor or automated SCADA based monitoring.	Medium	Medium	Short term	Short term	High	Better water governance.
Prevention of contaminants from entering river source through the implementation of source protection plans on a watershed basis.	High	Medium	Long term	Long term	High	Long term impact on health of citizens and ecosystem.
Policy/Non-Institutional Measures						
Restrictions placed on usage of water (timings, quotas, activities).	Average	Medium	Short term	Short term	Low	Can help to save money for consumers.
Introducing a cap on commercial extraction of water and an increase in the rate for the same.	Medium	Medium	Short term	Short term	Low	Can help generate revenue for municipal corporation.
Awareness generation to reduce wastage of water.	Medium	High	Long term	Long term	Medium	Can be used to create awareness on multiple issues.

Prioritised Resilience Interventions	Overall Resilience score	Overall Feasibility	Time taken for Impact on Resilience of City	Duration of Implementation Short/ Medium/ Long term	Indicative Cost (Low/ Medium/ High)	Potential Co-benefits
Regular monitoring of water quality parameters in water treatment plants and pipelines.	Medium	High	Short term	Short term	High	Can be used for health notifications.
Sanitation						
Infrastructural Measures						
At source composting of wet organic waste.	Medium	High-medium	Short term	Short term	Medium	Can engage community to build participation.
Revamp and retrofit sewerage / drainage system in places where the system is rundown.	Average	Medium	Long term	Medium term	High	Improve health conditions.
Decentralized Sewage Treatment Plants (STPs) in new colonies that are not linked to the sewerage system.	High	Medium	Long term	Medium term	High	Reduce health risks.
Regular cleaning and dredging of St Inez Creek.	Medium	Medium	Medium term	Medium term	High	
Sluice gates and control system for nallahs.	Medium	High	Short term	Short term	High	
Policy/Non-Institutional Measures						
Awareness generation on segregation at source.	High	High	Long term	Long term	Medium	Can be used for multiple issues together.
Heavy fine for litter offenders.	Medium	High	Short term	Short term	Low	Can generate revenue for Municipal Corporation.
Drainage						
Infrastructural Measures						
Revamp of storm water drainage system.	Average	Medium	Medium term	Medium term	High	Can reduce health risks.
Installing water level gauges to mark sea level rise.	Low	High	Short term	Short term	High	Can help in forecasting.

Prioritised Resilience Interventions	Overall Resilience score	Overall Feasibility	Time taken for Impact on Resilience of City	Duration of Implementation Short/ Medium/ Long term	Indicative Cost (Low/ Medium/ High)	Potential Co-benefits
Policy/Non-Institutional Measures						
Implement automated SCADA based monitoring of drainage system.	Medium	High-Medium	Short term	Short term	High	
Planning drainage infrastructure considering future sea level rise especially around vulnerable areas.	High	Medium	Long term	Short- Medium term	Medium	
Land						
Infrastructural Measures						
Increased Green cover, especially mangroves.	Medium	High	Long Term	Long Term	Medium	Can prevent water pollution from sewerage, and act as sinks for drainage.
Providing bunding system to prevent water inflow and salinization of land.	High	Medium	Long term	Short term	High	
Policy/Non-Institutional Measures						
Decentralized planning (ward mapping).	High	High-Medium	Long term	Long term	High	Sustainable development of the city.
Planning Development Authority (PDA) to seek No Objection Certificate (NOC) from departments monitoring parameters.	Medium	High	Short term	Short term	Low	
Policy of no-construction on steep slopes and near water bodies.	High	High	Long term	Long term	Low	Reduce life risks.
Ecosystem						
Infrastructural Measures						
Tree plantation including replanting of mangroves and maintenance of existing wetlands.	Medium	High	Medium-long term	Medium-long term	Medium	Can support better drainage in the city.

Prioritised Resilience Interventions	Overall Resilience score	Overall Feasibility	Time taken for Impact on Resilience of City	Duration of Implementation Short/ Medium/ Long term	Indicative Cost (Low/ Medium/ High)	Potential Co-benefits
Manual cleaning of beaches.	Medium	High-Medium	Short term	Short term	Medium	Can involve citizens to instil pride in their city.
Maintenance of sand dunes by planting vegetation, using wooden sand fences, creating crosswalks and pedestrian footpaths.	Medium	High-medium	Short term	Short term	Medium	
Revitalisation of water sources eg; Mala lake, Boca de vaca, Fonte Phoenix.	Medium	Medium	Medium-long term	Medium term	High	Soil conservation.
Policy/Non-Institutional Measures						
Proper planning on biodiversity conservation and ecosystem management through an integration of biodiversity conservation into urban planning; development of people's biodiversity register, labelling of trees; inventorization so that Rare, Endangered and Threatened (RET) species are not under further threat due to urbanisation.	Medium	High	Short term	Short term	Medium	
Legal protection of Khazan lands.	Medium	High	Medium term	Medium term	Low	
Health						
Policy/Non-Institutional Measures						
Health department to be reinforced and equipped to handle epidemics through training and capacity building.	High	Medium	Short term	Long term	High	Improved healthcare for citizens.
Early warning system.	High	High-Medium	Short- medium term	Short- medium term	High	
Awareness generation on Health Issues and safety.	High	High	Short term	Short term	Medium	Can be used for multiple issues for raising awareness.
Awareness generation on breeding of mosquitoes.	High	High	Short term	Short term	Medium	Can be used for multiple issues for raising awareness.

Prioritised Resilience Interventions	Overall Resilience score	Overall Feasibility	Time taken for Impact on Resilience of City	Duration of Implementation Short/ Medium/ Long term	Indicative Cost (Low/ Medium/ High)	Potential Co-benefits
Transportation						
Infrastructural Measures						
Provision of smaller/eco-friendly public transport (bus service) options with increased frequency.	High	High-medium	Short- medium term	Short- medium term	High	Supplementary income generating opportunities.
Clean fuel alternatives like CNG, LPG.	Medium	High-medium	Long term	Short term	High	
Policy/Non-Institutional Measures						
Restriction of commercial/ tourist vehicles during peak hours.	Medium	Low	Short- medium term	Short- medium term	Low	Cleaner air, less congested roads.

7.1. Integration into City Plans

Current programmes and public works currently being taken up in the city are financed chiefly by four missions: the SMART Cities Mission, AMRUT, The National Urban Health Mission (NUHM), and the SBM.

Under the Smart Cities Mission a number of resilience interventions can be funded based on the implementation plan designed by the city. In a bid to practice integrated urban water management, SCADA based monitoring is proposed to be implemented into the water supply framework along with smart metering. Mala lake, Boca de Vaca and Fonte Phoenix are being revived, a new STP at Patto and wastewater recycling is proposed. Furthermore a plantation drive of 5,000 trees is also proposed.

To expand upon existing services, sewerage, storm water, public toilets and road infrastructure is going to be augmented within Mala Fontainhas zone and the CBD area. There will also be an increase to public transport options with 20 additional mini buses proposed within the CBD area.

Under the Special Purpose Vehicle, GIS mapping of the city will be undertaken.

The AMRUT scheme will finance the improvement of the drainage and sewerage network, development of watershed plans as well as co-finance improved public transport.

Health interventions like the awareness generation programmes and early warning system development can be taken up under the NUHM while the SBM can fund provision of toilets and awareness generation and IEC materials on sanitation.

The newly introduced Nagar Van Udyan Yojana aims to develop at least one city forest in each city having a Municipal Corporation and funds available here can be used to plant more mangroves and trees in the city.

A summary of the issues, climate impacts, vulnerable areas and resilience actions sector wise is given below.

7.1.1. Water Supply

Issues:	- The water is distributed to the service connections in the city by gravity which leads to varying pressure and duration of water supply across the city. - The existing water distribution lines in the city are old, and comprise of asbestos cement or corroded galvanized iron (GI) pipes which are prone to leakage during other utility works in the vicinity leading to high UFW. - The daily water supply of 198 lpcd is substantially high when compared with the service level benchmark of 135 lpcd as prescribed by the CPHEEO. - The improper water supply zoning has led to poor monitoring of the water supplied and transmission losses.		
Some Existing / Planned Measures:	SCADA based monitoring is proposed to be implemented into the water supply framework along with smart metering.		
Potential Climate Impacts:	- Increased temperatures can lead to increased demand for water thereby posing additional stress on the supply system. - Increased precipitation would lead to increased flooding situation resulting in contamination of potable water.		
Potentially Impacted Prabhags / Areas:	Dando (Carazalem), St. Inez Band, pockets of Mala area ; Parts of old Latin localities of Bairo Portais, and Bhatulem; Includes a few heritage structures namely Maruti Temple, Portais Chapel, Panjim Inn etc.		
Risk Status:	High		
Actors:	<table border="1"> <tr> <td> Vulnerable - Citizens/Residents - Floating Population - Unorganized Societies/ Slum Population - Private Corporations - Educational Institutions - WRD - PWD - CCP </td><td> Supporting </td></tr> </table>	Vulnerable - Citizens/Residents - Floating Population - Unorganized Societies/ Slum Population - Private Corporations - Educational Institutions - WRD - PWD - CCP	Supporting
Vulnerable - Citizens/Residents - Floating Population - Unorganized Societies/ Slum Population - Private Corporations - Educational Institutions - WRD - PWD - CCP	Supporting		

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Introducing a cap on commercial extraction of water and an increase in the rate for the same.	Introduction of policy at local level, cost of meetings.	INR 2 lakhs
Infrastructural Measures		
Rain water harvesting as an alternative source as well as for ground water recharge.	Per unit cost can range from INR 3-5 lakhs.	INR 5 lakhs per unit

7.1.2. Sanitation

Issues:	• Ribandar, Taleigaon, Dona Paula, Caranzalem as well as the adjoining outgrowths (OG) lack any connections with the central sewerage system. • Inadequate number of toilets to cater to the floating population. • At present only 8.0 MLD (67%) of sewerage is being collected and treated in the existing STP at Tonca of 12.5 MLD. The major natural drains in the city receive solid and liquid waste water affecting the flow and discharging polluted water into the River. • Residents, the floating and tourist population have poor civic sense and litter indiscriminately. • Water pollutants create a wide variety of problems when they enter the food chain, posing potential health hazards apart from foul taste or odour in drinking water. • In the past, leakages have led to contamination of piped as well as ground water. • Open dumping of municipal solid waste also blocks sewers and drains resulting in flooding and insanitary conditions. • High precipitation events will facilitate the spread of disease.	
Some Existing/Planned Measures:	• New STP at Patto and wastewater recycling is proposed. • Sewerage, and public toilet infrastructure is going to be augmented within Mala Fontainhas zone and the CBD area through the AMRUT programme.	
Potential Climate Impacts:	• Increased precipitation would lead to unhygienic conditions and health hazards due to increased incidences of water borne diseases.	
Potentially Impacted Areas:	• St. Inez band area, pockets at Mala area; Parts of Bhatulem ; Sea beach in Avivao Sea beach in Dando, Caranzalem; Forest/ plantation area/ vacant lots near Dhempe Higher Secondary School of Arts and Science; Forest/ plantation area in Valice Bhat, Storm water drains near Lopez Bar/ Tamdi Mati Bus Stop	
Risk Status:	High	
Actors:	Vulnerable • Citizens/Residents • Floating Population • Unorganized Societies/ Slum Population • Private Corporations • PWD	Supporting • CCP

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Awareness generation on segregation at source.	Cost of meetings, hoardings, leaflets, and other IEC materials.	INR 5 lakhs
Infrastructural Measures		
Decentralized Sewage Treatment Plants (STPs) in new colonies.	Civil construction, system costs.	INR 80 lakhs per MLD sewage

7.1.3. Storm Water Drainage

Issues:	- Storm water drainage has been inadequate and insufficient to address the issues of the city which faces flooding every monsoon due to the natural process of the high tide in the River Mandovi. - Siltation of drains regularly occurs. - Drains are choked with solid waste. - Increased rainfall will put more pressure on the city's drains which are already affected by siltation, blocked by solid waste and need replacing. - The city's risk to flooding will only increase impacting health, damaging property and endangering lives.	
Some Existing / Planned Measures:	- Mala lake, Boca de Vaca and Fonte Phoenix are being revived. - Storm water infrastructure is going to be augmented within Mala Fontainhas zone and the CBD area.	
Potential Climate Impacts:	Increased precipitation would lead to increased instances of flooding. Increased precipitation would also increase the chances of greater 'knock-on' impacts on human health and wellbeing.	
Potentially Impacted Areas:	Dr. Pissurlekar road (near CCP); MG road; KTC; Avenida Dom Joao de Castro; Mala Area; 18th June Road; Near Don Bosco's campus road; DB road; Atmaram Borkar road, Swami Vivekanand road; Dr. Shivgaonkar road; St. Inez Road; Ward 6 (St. Inez); Mira mar circle road; Rua de Ourém creek road; Carazalem road.	
Risk Status:	High	
Actors:	Vulnerable - Citizens/Residents - Floating Population - Unorganized Societies/ Slum Population - Educational Institutions - Private Corporations - CCP - WRD	Supporting

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Planning drainage infrastructure considering future sea level rise especially around vulnerable areas.	Cost of consultants.	INR 10 lakhs
Infrastructural Measures		
Revamp of storm water drainage system.	Cost depends on materials, type of land, etc.	INR 200 lakhs per km.

7.1.4. Land Use

Issues:	• The city is highly dense and will keep growing over the years putting pressure on the land use. • Unplanned expansion of the city into ecologically sensitive zones is threatening the resilience of the city. • Concretization of a majority of the area is leading to poor percolation of water into the ground. • The silting of Mandovi River, unscientific constructions on hill slopes, encroachment and the reclamation of land near the T B Cunha School and the sports ground around housing Campal, has caused stagnation of rainwater leading to instances of flooding. • As an indirect effect of increased temperature, demand for water will increase leading to an over extraction of ground water. This could in-turn lead to salt water ingress causing degradation of soil quality and even potentially cases of land subsidence. • Increased precipitation will trigger water logging and flooding in reclaimed low lying areas.	
Some Existing / Planned Measures:		
Potential Climate Impacts:	• In case of increased short duration-high intensity rainfall events the water logging and flooding situation in low-lying areas would only get worse, thereby reducing access to usable land.	
Potentially Impacted Prabhags / Areas:	• Mala Area; Ward 6 (St. Inez); St. Inez Road; Rua de Ourém creek road.	
Risk Status:	High	
Actors:	Vulnerable • Citizens/Residents • Floating Population • Unorganized Societies/ Slum Population • WRD • CCP • NGPDA • TCP	Supporting

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Policy of no-construction on steep slopes and near water bodies.	Cost of meetings, cost of making policy.	INR 5 lakhs
Infrastructural Measures		
Regular cleaning of drains especially before the monsoons.	Staff costs, material costs.	INR 15 lakh per km

7.1.5. Ecosystem

Issues:	- Management of <i>Khazan</i> ecosystems are impaired by various factors, intensive agriculture and mining, being one of them. - The St. Inéz creek has now turned into a <i>nallah</i> since it has been receiving untreated sewage and garbage over the years. The city garbage and floating litter getting stuck at various points along the length of the creek is being observed. This leads to flooding in some parts during monsoon. - Urbanization and construction in the vicinity of the creek is exposing it to increasing pollution. Increased temperatures can affect mangrove survival. - Due to rapid urbanization and tourism, most of the dunes are destroyed. The mangrove forests and marshland around Santa-Cruz, Patto Plaza, and Mercês too are destroyed - reclaimed & transformed into housing complex and private garages and commercial units.	
Some Existing / Planned Measures:	Plantation drive of 5,000 trees is proposed.	
Potential Climate Impacts:	Increased temperature would impact the fundamental functioning of the ecosystem by bringing about changes in pollinators, migratory species and seed dispersers' behaviour. Increased temperatures can affect mangrove survival.	
Potentially Impacted Prabhags / Areas:	Mala areas, along St. Inez creek; along causeway (salt pans and mangroves).	
Risk Status:	High	
Actors:	Vulnerable - Citizens/Residents - Unorganized Societies/ Slum Population - Fishermen - CRZA - Forest Department - Department of Science and Technology - Goa State Biodiversity Board	Supporting

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Legal protection of Khazan lands.	Cost of meetings, cost of making the policy.	INR 5 lakhs
Infrastructural Measures		
Tree plantation including replanting of mangroves.	Costs of trees cost of plantation, maintenance.	INR 10 lakhs per annum.

7.1.6. Health

Issues:	• Cases of various vector borne diseases have been reported in Panjim city. • Cases of E. Coli in ground water have been reported in the city. • Breakdowns in urban systems functions like that of sewerage, water supply and drainage further lead to health issues.	
Some Existing / Planned Measures:		
Potential Climate Impacts:	• Increased temperature can lead to heat stress and increased morbidity and illness. • Increased precipitation would lead to water logging/flooding which will increase chances of water/vector borne communicable diseases.	
Potentially Impacted Prabhags / Areas:	• Pockets of Mala Area; St. Inez Band; Parts of Bhatulem	
Risk Status:	High	
Actors:	Vulnerable • Citizens/Residents • Floating Population • Unorganized Societies/ Slum Population • Educational Institutions • NGOs • Health Department	Supporting • Private Hospitals

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Health department to be reinforced and equipped to handle epidemics by training and capacity building.	Per training costs, materials, logistics.	INR 2 lakhs per training.

7.1.7. Transportation

Issues:	• The major issue which is faced by the city administration is regular resurfacing of the roads which are subjected to frequent wear and tear due to high vehicular traffic movement. • The road surface is also damaged during the period of monsoons due to heavy rain and flooding in some parts of the city. • Public transport only accounts for 15% of the total trips in the city. Public transport routes are not comprehensive and do not cover all areas of the city. • The parking area is highly inadequate, not regularized and presently not charged adding to congestion on the roads. • Higher temperatures can deform road surfaces and create rutting and potholes, particularly on roads with a heavy traffic load and can also affect bridge joints. • Increased temperature would impact micro climate; therefore leading to an increased use of private vehicles, AC usage in cars, more GHG emissions. • Heavy rains cause flooding and landslides which will further damage the roads.	
Some Existing / Planned Measures:	• Road infrastructure is going to be augmented within Mala Fontainhas zone and the CBD area. There will also be an increase to public transport options with 20 additional mini buses proposed within the CBD area.	
Potential Climate Impacts:	• Increased precipitation would lead to flooding situation leading to congestion and in extreme cases loss of connectivity/access.	
Potentially Impacted Prabhags / Areas:	• CBD Area	
Risk Status:	High	
Actors:	Vulnerable • Private Corporations • Floating Population • Citizens/Residents • Educational Institutions • CCP • Transport Department	Supporting • Traffic Police Cell

Prioritized Actions

Type of Measures	Cost per unit and description	Cost Estimate
Policy and Institutional Measures		
Restriction of commercial/tourist vehicles during peak hours.	Cost of meetings, cost of policy.	INR 5 lakhs
Infrastructural Measures		
Provision of smaller/eco-friendly public transport (bus service) options with increased frequency.	Cost of vehicles, registration policy.	INR 100 crores

8. Conclusion

Climate change in the city of Panjim is among the primary drivers of vulnerabilities and it remains a realistic threat, especially in terms of sea level rise. Although climate change impacts are not well perceived within the city as they are slow onset changes, stakeholders recognize that there has been an increase in temperature over the years. Regional projections for rainfall indicate that an increase in the average annual rainfall can be anticipated, and the general perception is that there has not been a significant change in the rainfall in the past 30 odd years. Sea level rise is not perceived as a threat but projections of this event by scientific institutions show that there would be significant social, economic and environmental impacts.

An assessment of the city's urban systems that were fragile and would become even more vulnerable to climate change was conducted identifying seven systems- water supply, sanitation, drainage, land, ecosystem, health and transportation. It found that each of these would be further impacted, either directly or indirectly, by anticipated climate threats for the region and the impacts were categorized by stakeholders as high risk. The vulnerable areas were then identified to arrive at the vulnerability hotspots. Ward 26 and 27 were the most vulnerable wards in the city.

Finally potential resilience building measures were arrived at that can be undertaken and towards whom these actions should be targeted – thereby providing a clear roadmap for the CCP. The city can use this assessment while undertaking planning development activities across different sectors and to build climate resilience. For each urban system, hard and soft measures were identified. The most important measures include awareness generation activities for better sanitation, conservation of water and improved waste management; capacity building for better locally available healthcare; planning and policy measures for better land use, protection of *Khazan* lands, and non-motorised transportation in the soft measures. Improvements in water supply systems, sanitation and drainage systems, decentralised management systems for waste and waste water, plantation and dune management for protection of ecosystems, provision of non-motorised infrastructure for public transit were identified among infrastructural measures. A number of government schemes like the AMRUT scheme, the SBM, the Smart Cities Mission can be used and leveraged to provide funding for these interventions.

Annexure 1 : Climate Change and Impact Assessment

A. URBAN SYSTEM: LAND

1. Risk Assessment

Impacts (Existing and Potential)	Group 1		Group 2		Group 3		Group 4		Average		Overall	
	LH	CON	LH	CON	LH	CON	LH	CON	LH	CON	Risk Score	Risk Status
Land reclamation	5	5	5	5	3	2	4	4	4.25	4	16	High
Increased water logging in low lying areas due to increased precipitation	5	4	4	3			4	4	4.33	3.66	16	High
Degradation of soil quality due to salt water ingress and even potential cases of land subsidence (seen in ward 5 and 6)	3	2	4	2	2	2	4	3	3.25	2.25	6	Medium
Disruption of services and destruction of assets due to sea level rise	2	2	2	5			3	3	2.33	3.3	6	Medium

LH: Likelihood, CON: Consequences

2. Resilience Interventions

2.1. Climate Risk: Increased Temperature (High Probability) – By 2030

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Increased Green cover	High	High	Medium	Long Term
Decentralized planning	Medium	Low	High	Long Term
Outline development plan for next ten years	High	High	Low	Long Term

2.2. Climate Risk: Increased Precipitation – in monsoon months (Decreased frequency with increased intensity) – By 2030

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Policy on no-construction on steep slopes and near water bodies	High	Low	Low	Long Term
Planning Development Authority (PDA) to seek No Objection	High	High	Low	
Certificate (NOC) for departments monitoring parameters	High	High	Low	

2.3. Climate Risk: Sea Level Rise – By 2100

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Legal protection of <i>Khazan</i> lands	High	Low	Low	Long Term
Providing bunding system	High	High	High	
Proper planning on biodiversity conservation and ecosystem management	High	High	Low	

B. URBAN SYSTEM-SANITATION

1. Risk Assessment

Impacts (Existing and Potential)	Group 1		Group 2		Group 3		Group 4		Average		Overall	
	LH	CON	LH	CON	LH	CON	LH	CON	LH	CON	Risk Score	Risk Status
Increased chances of fire hazards due to drier conditions	2	2	3	3			2	2	2.33	2.33	4	Low
Unhygienic conditions and health hazards due to increased incidences of water borne diseases due to increased precipitation	5	4	5	4			3	2	4.33	3.33	12	High
Disruption of services and destruction of assets due to sea level rise	4	4	2	4			4	5	3.33	4.33	12	High
Increased impact of green house gases like methane					4	2			4	2	8	Medium

LH: Likelihood, CON: Consequences

2. Resilience Interventions

2.1. Climate Risk: Increased Temperature (High Probability) – By 2030

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Awareness generation on segregation at source of Solid Waste	High	Low	Medium	
At source composting of wet organic waste	High	Low	Low	

2.2 Climate Risk: Increased Precipitation – in monsoon months (Decreased frequency with increased intensity) – By 2030

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Revamp sewerage drainage system	High	Medium	Medium	
Decentralized Sewage Treatment Plants (STPs) in new colonies	High	Low	Medium	
Solid waste treatment with modern processing facilities	High	Low	High	
Heavy fine for litter offenders	High	Low	-	

2.3 Climate Risk: Sea Level Rise – By 2100

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Regular cleaning and dredging of St. Inez Creek	High	Low	High	
Sluice gates and control system	High	Low	High	
Develop new Panjim to reduce stress on Panjim city	Low	High	High	

C. URBAN SYSTEM: STORM WATER

1. Risk Assessment

Impacts (Existing and Potential)	Group 1		Group 2		Group 3		Group 4		Average		Overall	
	LH	CON	LH	CON	LH	CON	LH	CON	LH	CON	Risk Score	Risk Status
Siltation of storm water drains leading to flooding (especially ward 24)	3	3	5	2			4	4	4	3	12	High
Greater knock on impacts on human health and well-being due to increased precipitation	4	4	4	3			3	3	3.66	3.33	12	High
Service disruption and destruction of assets due to sea level rise	4	4	2	3			4	5	3.33	4	12	High
Slopes of existing storm water drains affected									0	0		

LH: Likelihood, CON: Consequences

2. Resilience Interventions

2.1. Climate Risk: Increased Precipitation – in monsoon months (Decreased frequency with increased intensity) – By 2030

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Revamp of storm water drainage system	High	Medium	Medium	
Monitoring of drainage system	High	High	High	

2.2. Climate Risk: Sea Level Rise – By 2100

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Planning infrastructure considering future sea level rise	High	High	Medium	
Installing water level gauges to mark sea level rise	High	High	Medium	

D. URBAN SYSTEM: TRANSPORTATION

1. Risk Assessment

Impacts (Existing and Potential)	Group 1		Group 2		Group 3		Group 4		Average		Overall	
	LH	CON	LH	CON	LH	CON	LH	CON	LH	CON	Risk Score	Risk Status
Increased congestion and loss of connectivity in extreme cases due to increased precipitation	3	3	4	4	4	4	3	3	3.5	3.5	16	High
Destruction of assets and disruption of services due to sea level rise	4	5	2	4			3	3	3	4	12	High
Increased temperature would impact micro climate	3	4	4	3			3	3	3.33	3.33	9	Medium

LH: Likelihood, CON: Consequences

2. Resilience Interventions

2.1. Climate Risk: Increased Temperature (High Probability) – By 2030

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Improve public transport	High	Low	High	
Clean fuel	High	Medium	High	

E. URBAN SYSTEM: HEALTH

1. Risk Assessment

Impacts (Existing and Potential)	Group 1		Group 2		Group 3		Group 4		Average		Overall	
	LH	CON	LH	CON	LH	CON	LH	CON	LH	CON	Risk Score	Risk Status
Increase in health issues	4	3	4	3			4	3	4	3	12	High
Increased temperature can lead to heat stress and increased morbidity	3	3	4	3			4	3	3.66	3	12	High
Increase in water borne diseases due to increased precipitation	5	4	4	3	4	4	4	4	4.25	3.75	16	High
Destruction of assets and disruption of services due to sea level rise	5	4	2	3			3	2	3.33	3	9	Medium
Increased breeding of mosquitoes due to increased precipitation					4	4			4	4	16	High

LH: Likelihood, CON: Consequences

2. Resilience Interventions

2.1. Climate Risk: Increased Temperature (High Probability) – By 2030

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Health department to be reinforced and equipped to handle epidemics	High	High	Medium	
Alarm system for informing public	High	High	Low	
Awareness generation on Health Issues and safety	High	Medium	Low	

2.2. Climate Risk: Increased Precipitation – in June, July and August months (Decreased frequency with increased intensity) – By 2030

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Awareness generation on breeding of mosquitoes	High	High	Medium	
Improvement in sewer network and drainage system	High	High	High	

F. URBAN SYSTEM: WATER SUPPLY

1. Risk Assessment

Impacts (Existing and Potential)	Group 1		Group 2		Group 3		Group 4		Average		Overall	
	LH	CON	LH	CON	LH	CON	LH	CON	LH	CON	Risk Score	Risk Status
Beach Formation	3	2	3	2			3	3	3	2.33	6	Medium
Salt water intrusion	5	3	5	3			4	4	4.66	3.33	15	High
High water table	4	3	4	3			2	3	3.33	3	9	Medium
Contamination of river water	5	4	5	4			4	4	3.5	4	12	High
Increased flooding due to increased precipitation leading to contamination of potable water (especially ward 12)	4	5	4	3			3	2	3.66	2.5	12	High
Increased demand for water due to increased temperature			4	4					4	4	16	High
Ground water depletion					5	4			5	4	20	Extreme

LH: Likelihood, CON: Consequences

2. Resilience Interventions

2.1. Climate Risk: Increased Temperature (High Probability) - By 2030

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Greener buildings with natural ventilators	High	Medium	High	
Tree plantation/terrace garden/kitchen garden	High	High	Low	
Control on car wash	Low	Medium	Low	
New constructions to use sensors for control of overflow of OHTs	High	Medium	High	
Policy for capping commercial extraction of water	High	Low	Low	

2.2. Climate Risk: Increased Precipitation – in monsoon months (Decreased frequency with increased intensity) – By 2030

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Rain water harvesting for ground water recharge	High	High	Low	Long Term
Awareness generation to reduce wastage of water	High	High	Low	
Monitoring and implementation of policy and regulation	High	Low	Low	Long Term
Reuse of treated waste water	High	Medium	High	Long Term
Introduction of appropriate water treatment measures	High	High	High	
Regular monitoring of water quality parameters	High	High	High	
Increase in rate for commercial extraction of water	High	Low	Low	
Innovation to control leakage and wastage	High	High	Medium	

2.3. Climate Risk: Sea Level Rise – By 2100

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Preventing contaminants from entering river source	Medium	High	Medium	
Data gathering	High	Low	Low	Long Term

G. URBAN SYSTEM: ECOSYSTEM

1. Risk Assessment

Impacts (Existing and Potential)	Group 1		Group 2		Group 3		Group 4		Average		Overall	
	LH	CON	LH	CON	LH	CON	LH	CON	LH	CON	Risk Score	Risk Status
Loss of sand dunes	3	2	3	2			3	2	3	2	6	Medium
Mangrove survival effected due to changes in pollinators and migratory species and seed dispersers due to increased temperatures	5	4	4	2			5	4	4.66	3.33	15	High

Impacts (Existing and Potential)	Group 1		Group 2		Group 3		Group 4		Average		Overall	
	LH	CON	LH	CON	LH	CON	LH	CON	LH	CON	Risk Score	Risk Status
Back water ecosystems negatively impacted due to sea level rise (breeding ground of fish impacted leading to impact on entire food chain)	5	4	2	3			4	4	3.66	3.66	16	High
Khazan lands impacted					4	3			4	3	12	High
Slum ecosystem impacted					3	3			3	3	9	Medium

LH: Likelihood, CON: Consequences

2. Resilience Interventions

2.1. Climate Risk: Increased Temperature (High Probability) – By 2030

Interventions	Feasibility			Impact
	Technologically	Politically	Cost	
Tree plantation	High	Medium	Medium	
Replanting mangroves considering its impact on development *	High	High	Low	
Manual cleaning of beaches	-	-	-	
Maintenance of sand dunes	Low	Low	Medium	

*though suggested as a possible intervention during the participatory exercise, this intervention does not seem feasible.

Annexure 2: Climate Core team & Stakeholder Committee

Climate Core Team

	Name	Designation	Email	Office Phone	Cell Phone
1	Mr.Shubham Chodankar	Mayor	mayor@ccpgoa.com	91-832-2223339 / 2422736 +91-832-2426998	
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3	Mr. John Abreu	Municipal Engineer			9403687465
4	Mr. Sachin Ambe	Assistant Engineer	ambe.sachin@yahoo.com		9403687478
5	Mr.ShrikantLawande	Asst. Engineer	office@ccpgoa.com		9403687475
6	Mr.GajananArabekar	Accounts Taxation Officer			9422579095

Stakeholder Committee

	Name	Designation	Email	Office Phone	Cell Phone
1	Mr.ShubhamChodankar	Mayor	mayor@ccpgoa.com	91-832-2223339 / 2422736 +91-832-2426998	
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6	Mr. Richard Dias	Businessperson, Goa			9764447491
7	Mr.Ruturaj Parikh	Director, Charles Correa Foundation.	ruturaj.parikh@gmail.com	0832-2220058 / 59	9925025458
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APPENDIX 11: IDENTIFYING ECOSYSTEM SERVICE OPPORTUNITIES IN KOCHI

Identifying Ecosystem Service Opportunities in Kochi

Technical scoping report for the INTERACT-Bio Project

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INTRODUCTION

INTERACT-Bio (Integrated Action on Biodiversity) is a 4-year project designed for improving the utilization and management of nature within fast-growing cities and the regions surrounding them. India is one of the three project countries, and Kochi is the first Indian city where the project is working.

For the scoping process in Kochi, we apply the Ecosystem Service Opportunities (ESO) framework, focusing on Steps 2 and 3 of the step-by-step guidelines (Rode and Wittmer 2015, see also Rode et al 2016). The structure and materials used reflect a modified version of the framework, which was adapted based on recent application experiences in several countries (Mexico, South Pacific, etc.).

Vision and aims of the INTERACT-Bio project in Kochi

The broad mission of the project is to provide expanding of urban communities in Global South with nature-based solutions and associated long-term benefits. It aims to integrate biodiversity considerations in city-region planning by 1) connecting national and subnational government decision makers, 2) strengthening the city-regions to integrate biodiversity and nature-based solutions into land use, infrastructure and development planning, 3) to develop supporting policy instruments, and 4) mainstreaming biodiversity considerations across sectors at the subnational and national level.

Broad aims / Mission statement		
We want to address... (current management issues/ threat of ..., in relevant area...that is arising because of...)	We want to contribute to the broader/long-term goals of... (what kind of biodiversity, ecosystem service and/or development outcomes we want to set in place)	We want to achieve the specific/short-term goals of ... (how we want to reduce the issue/threat by using appropriate policy instruments)
Kochi is home to mangrove bird sanctuary and Vembanad lake, the largest Ramsar wetland in South India. These biodiversity sites are facing challenges from rapid urbanization and unplanned growth, clogging and blocking of natural canals due to waste and lack of coordination (ICLEI-INDIA). The environmental issues also cause severe problems for the population in terms of health, loss of livelihoods, and quality of life.	Very broadly, the project intends to provide urban communities in the Global South with nature-based solutions and associated long-term benefits. For Kochi, the following goals turned out as relevant based on stakeholder consultations, • Improved resilience • Reduction in pollution • Improved water supply • Greening of environment • Awareness generation • GIS based Land use (land cover map of the city)	The focus will be on two ecosystems: Mangalavanam, Vembanad (Kerala backwaters, including Kochi lake) <i>The more specific aims and desired outcomes will be a result of this scoping.</i>

UNDERSTANDING THE LOCAL CONTEXT

The ICLEI-team is preparing a comprehensive scoping report for the setting of India and the specific situation in Kochi. The present section of this report is unlikely to add new elements to the ICLEI analysis. It was primarily intended to provide UFZ with a basic understanding of the situation prior to the first visit and before engaging in the more specific scoping of “ecosystem service opportunities” (see section 3) via workshop and expert consultations. The information of this section is based on several reports made available by ICLEI, notably Thomson (2002) and DTCP (2010).

Stakeholders

The project started out with Kochi Municipal Corporation as the main partner and stakeholder. For the consultation process as well as the first and second workshop, stakeholders in the sense of actors with an interest in broader environmental issues in and around Kochi were identified. They consisted of scientists, NGOs, and representatives of local authorities. A systematic stakeholder mapping should be conducted once a more specific thematic focus has been agreed (e.g., mangrove conservation). The ESO guidelines propose the following template structure for stakeholder mapping, which could be adapted to the local purpose.

Template: Stakeholder Mapping Table				
Stakeholder name/group	Attitude to the relevant conservation goals	Conflicts with other stakeholders [with whom, in what sense?]	Collaboration with other stakeholders [with whom, in what sense?]	Current status of engagement and person(s) to contact

Environmental context

Kochi is a leading city in the South east coast of India, in Ernakulam district of the state Kerala. It is the sea mouth of seven major rivers draining into the Arabian sea and so known as the ‘Queen of Arabian Sea’. It is built on a cluster of islands and peninsulas. The city has two main seasons, dry and wet season and the average temperature is between 22°-32°C. It experiences a tropical climate with intense solar radiation and abundant precipitation causing very high humidity throughout the year. The rainfall is mainly from the Southwest and Northeast monsoon. Kochi is crisscrossed by a network of canals. The city landscape is mainly composed of backwaters and wetlands. The wetlands are covered during rainy season when Pisciculture is carried out, and during the summer they are dry and favors paddy cultivation (Pokkali farming).

Mangalavanam

Mangalavanam is located at the heart of Kochi, is a symbolic relict of the original ecological set up of Kochi. The ecologically sensitive area covers up to 2.74 hectares. It contains various mangrove species and areas with trees, shrubs and vines that thrive in brackish water and also found in river estuaries. The plants, animals and microorganisms are adapted to live in tropical inter-tidal zone. It is a bird sanctuary and home to many native and migratory birds. Marine and freshwater aquatic organisms are found in abundance. A small population of butterflies and vertebrates are also found here. It serves as a main roosting site for flying foxes. Mangalavanam is known to be functioning as 'the green lungs of the city', important in stabilizing the land along the coast and backwaters. It is situated in the middle of the city surrounded by the Bharat petroleum campus in the northeast, old Ernakulam railway station on the south and the National institute for Oceanography (NIO) and the Central Marine Fisheries Research Institute(CMFRI) on the west. The once dominant Mangrove is now disappearing, mainly because of dredging, filling, silt build-up, and waste dumping (mainly solid waste-plastics) clogging the water bodies as well as continued construction around the core area.

Vembanad

Vembanad had the second largest lagoon in India, a 900 kilometres long intricate network of lagoons, lakes, canals, estuaries and deltas of several rivers that flow into the Arabian Sea. It runs through several districts; the area around Kochi it is called the Kochi lake. The waterbody is separated from the Sea by barrier islands. The crisscrossed canals are used for navigation (as a national waterway) and they play a vital role in the socio-economic and environmental situation of the city. The backwater ecosystems help in controlling floods, preventing salinity intrusion, ground water recharge and serves as a breeding, feeding and nursing place of shrimps and fishes. It is home to 20,000 waterfowls and an ideal habitat for shrimps. It hosts about 100 native bird species and a lot of migratory birds in the seasonal time. It is also now a favorite tourist destination.

The backwaters are facing serious anthropogenic pressures due to the developmental activities. The city does not hold enough land space for all the development activities which are increasingly moved to areas outside the city borders. Changes in land use, water and air pollution, improper disposal of wastes, conventional sewage system, development of slums, and reduction of green spaces are the major cause of environmental degradation. Another challenge in the city is salt-water intrusion due to rising sea level. Percolation of effluents from septic tanks and dispersion trenches pollute the ground water. Air pollution is caused by emissions from vehicles, adulteration of fuel, violation of emission norms, poor maintenance of roads, and unfiltered emissions from the industries (mainly outside the city).

According to DTCP (2010), the existing sewage treatment plant serves only 1% of the urban population and the rest of the sewage enters into the backwaters. It contains organic and inorganic pollutants causing diseases and fecal contaminants. Most of the industries (over 50 large and medium sized firms) are located outside the city limit alongside the backwaters between Angamaly and Kochi. Most of the trade effluents from the industries are dumped into the river, making the water highly polluted with toxins and acidic with ammonia, fluorides and phosphates. The effluent and sewage discharge increase the nutrient content of the water causing eutrophication. This leads to the loss of wet land plants and other aquatic organisms, reducing their ability to release oxygen content through the roots and to resolve metals and arsenic. Pollutants released from the surrounding industries severely reduced the productivity in fishing, aquaculture and paddy cultivation. Dredging of the bottom of backwaters by commercial sand mining has caused severe ecological imbalance and development projects such as the harbor development, construction of new bunds and bridges, building new road ways, etc. are converting ecosystems and reducing biodiversity. Sedimentation, dumping of silt from rivers, soil erosion, and construction activities have caused water logging and reduced the water holding capacity of the ecosystem. These issues also prevent ground water recharge affecting the water supply.

Socio-economic and cultural context

A large part of the city population originally depended on the water bodies for food and livelihood, as farmers and fishermen. More and more of the agricultural land is now converted into residential and industrial area. The city of Kochi is becoming a leading industrial city with a boom in the IT, tourism, banking and finance sectors as well as increased port activities. It is the industrial capital of Kerala and in the process of becoming one of the major Indian cities (so called METRO city). Recently the metro rail has been laid in the city which is hoped to meet the increased transportation demands. Large investments in the industry come from foreign investors, mainly from the Middle East. The Cochin international port, the harbor and cargo terminal serve as a trade point for Southern India. The industries around are mainly producing chemical and petrochemical products, pesticides, rubber, fertilizer and leather. There are also a number of refineries found around the city.

Culturally, the state is known for its environmental beauty and called “GOD’S OWN COUNTRY”. The state was initially colonized by the Portuguese, followed by the Dutch and then the British. Kochi is the second most populated city in the state. The main language spoken here is Malayalam. Mostly people are following their traditional ethnic life style.

Kochi has witnessed serious land use change in the past decades. Commercialization of the backwaters accelerated the industrialization in Kerala. There was a huge amount of public and private investors in the backwaters. Pokkali rice agriculture is the major economic activity of the rural communities in the low-

lying wetlands. Many traditional Pokkali farmers have changed or stopped their practices. Some of them sold their lands to private investors who build residential and tourist housing. Due to ecological problems (in particular low water quality) in the backwaters around Kochi, the tourism industry has already started moving south.

Traditionally people highly value their environment, yet the increasing population and development demands pose enormous challenges and have started to change traditional values and practices. Political and social movements in Kochi have existed for a long time. Strikes, protests and marches for or against many issues have been ubiquitous in Kerala because of the comparatively strong presence of labour unions. However, there is a lack of awareness on issues around conservation and use of natural resources, so that social movements have so far not addressed these topics.ⁱ

Political, institutional, and policy context

The institutional setting for sustainable development and environmental policy involves responsibilities at many levels, from national level (e.g., Ministry of Environment, Forest and Climate change), Kerala state level, local district level, and the level of the municipality (Kochi municipal corporation, Cochin Environmental Protection Agency). Besides governmental authorities, NGOs and research organizations play an important role, such as the National ecological training institute-NETI, Central Marine Fisheries Research Institute-CMFRI, Kerala Forest Research Institute-KFRI, Salim Ali Centre for Ornithology and Natural History.

Thomson (2002) argues that the unsustainable development path and irrational use of resources is mainly caused institutional and government failures, weak political and social mobilizations, loopholes in the policies, no proper implementation or monitoring of policies. The structure of property rights, customary rights, fishing rights, rights on wetlands, etc. is not managed well. For example, in Mangalavanam, the ownership of the region is split among Southern railways, Kerala forest department, the city corporation of Cochin, police department, revenue department and Bharat petroleum as well as small areas under private ownership. This creates confusion and no proper maintenance of the region. In Vembanad, uncontrolled mining of shells from lake beds, sewage effluents and heavy load of organic material released by industries, tourism causing commercialization and disturbing the lives and livelihood of the people, fishermen using illegal nets affecting the breeding of fishes, garbage from households disposed into backwaters, etc. are some of the issues affecting the ecosystem of the backwaters. Various laws and policies are already put forth by the governments, but they are not sufficiently complied with nor adequately enforced or monitored.

Policy and planning on land use and development follows a large number of framework and legal instruments, which are again functioning at different governance

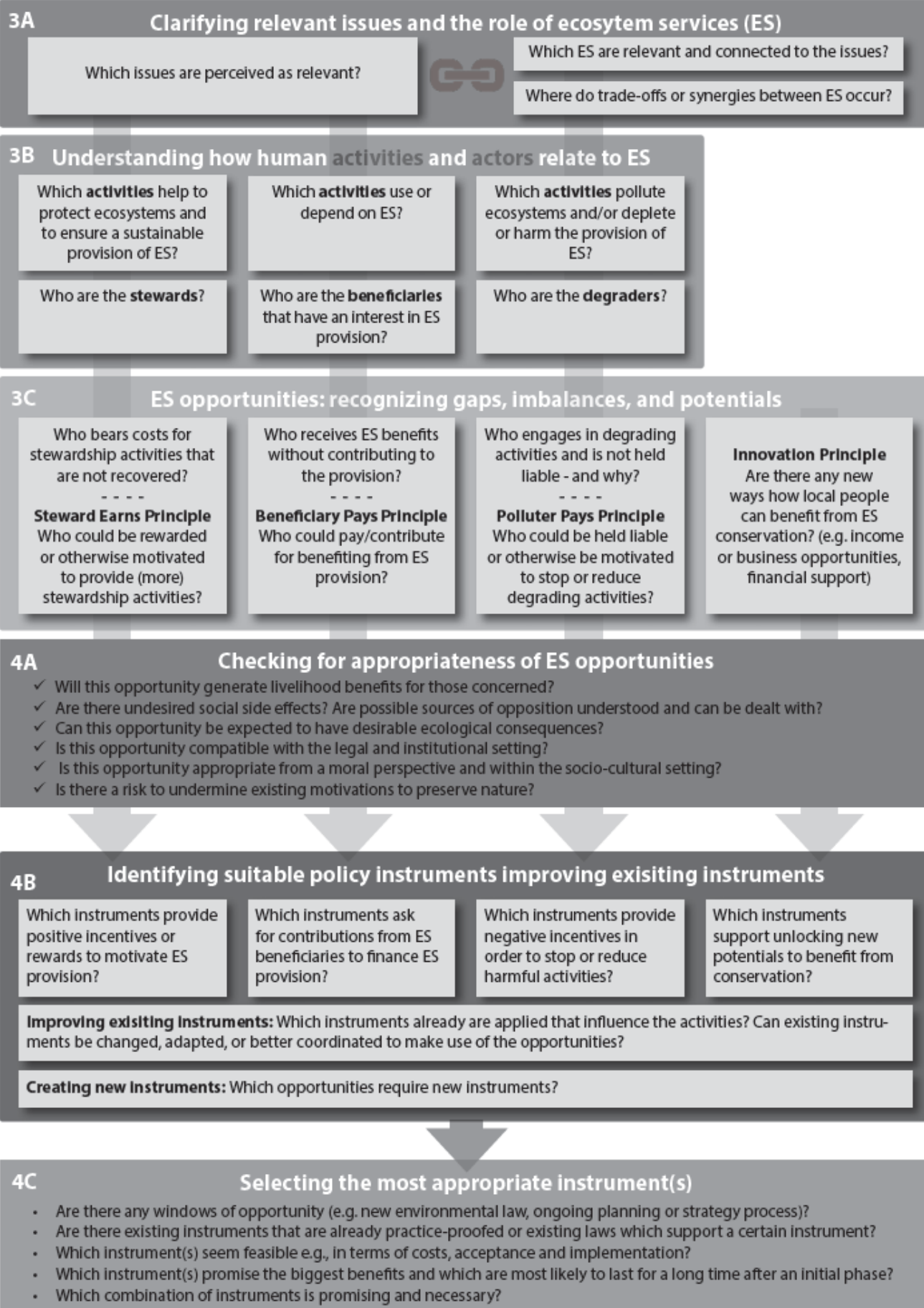
levels. The following table provides a non-exhaustive overview of relevant policy and management laws and guidelines from the national, state, and municipal level.

National level	State level (Kerala)	Municipal level
National Land Utilisation Policy	Kerala State Policy for Compensation and Transparency in Land Acquisition, 2015	Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines
National Urban Housing and Habitat Policy	Draft Land Policy 2009, Kerala	Model Regional and Town Planning and Development Law
The right to Fair Compensation and Transparency in Land Acquisition Rehabilitation Resettlement Act, 2013	Kerala conservation of paddy land and wetland act,2008 (and amendment bill)	Model Municipal Law (MML), 2003
National slum policy,2001	Industrial policy for kerala	Urban/Metropolitan Planning/ Development Act, Improvement Trust Act, Industrial Development Act, Cantonment Board Act, Major Ports Act
National Policy for inland water transport,2001, ministry of shipping, government of India	Kerala Town and Country Planning Act, 2016	Cochin port trust
National environmental policy 2006, Ministry of environment and forest	Kerala Building Rules	Smartcity,2016
National urban housing and habitat policy,2007	Kerala Municipality Building rules – 1999, Amendment Rules, 2013	The City development plan, Municipal Corporation of Kochi
National wetland conservation programme,2009	Kerala Port Policy	Centre for heritage, environment and development, Kochi
The green India mission	Tourism policy of Kerala	
Biodiversity Act,2002	Kerala Housing and Habitat Policy 2007	
Action plan on climate change,2008	Kerala Parks, Playfields and Open Spaces Act	
The wildlife protection act,1972	Kerala land conservancy act,1957	
National forest policy, 1998	Kerala state environment policy,2009	
National Water policy,2002	Kerala coastal zone management-CRZ	

SCOPING ECOSYSTEM SERVICE OPPORTUNITIES

This section covers the core part of the UFZ scoping. Figure 1 presents the scoping framework, based on an adapted version of Rode and Wittmer (2015). The questions raised in Steps 3A and B were answered within group work sessions during the stakeholder workshop on March 28, complemented by information from discussions with the Cochin Municipal Corporation and consultations with KFRI scientists. This information is presented in sections 3.1 and 3.2. The actual “ecosystem service opportunities” as defined in Step 3C of the framework were not assessed with stakeholders. For now, some opportunities will be included as part of the “ideas how to improve the situation”, as reported in Section 3.3 (which again resulted from the workshop and expert consultations). More specific opportunities for selecting and planning suitable policy instruments (Step 4A-C) could be assessed more systematically with stakeholders in a follow-up workshop setting.

The ecosystem service opportunities framework



Relevant issues and ecosystem services

Mangalavanam and other mangrove patches within Kochi jurisdiction

A. Clarifying relevant issues and the role of ecosystem services (ES)			
What are the important issues? Few mangrove patches remaining in and around Kochi, remaining ones tend to be degraded/polluted Mangalavanam as well-known piece of nature in city center is increasingly polluted and disturbed	Which ecosystem services are relevant and connected to the issues? • education (birds, biodiversity): nature interpretation center, education camps • recreational use: nature walks (locals and tourists) • aesthetic and inspiration for arts • pollination through insects, birds and bats • biological control of predator activities • provision of food, raw material, fresh water and medicinal resources • carbon sequestration • prevention of erosion • buffer against flood events • prevent salt water intrusion • local climate regulation and reduction of heat stress • improve air quality • water purification • biodiversity habitat • maintenance of genetic diversity		
	Where do trade-offs occur and how? Most trade-offs between polluting activities and ecosystem services	Where do synergies occur and how? Many synergies between the ecosystem services provided by healthy mangroves	

Vembanad Lake (Backwaters)

A. Clarifying relevant issues and the role of ecosystem services (ES)			
What are the important issues? • Pollution of the lake and canals (oil spills, waste, toxics from commercial activities and construction, sewage) harming biodiversity and human health • Siltation from dredging / removal of silt by port harming backwater fisheries (access of fishers to the fishing ground) and aquatic ecosystem is distracted (microorganisms die) – no baits for fishing and as food source	Which ecosystem services are relevant and connected to the issues? • clean/fresh water provision (BUT drinking water for Kochi is coming from other source); • provision of food: fish, grains, prawn, crabs, mollusks • provision of raw materials: clam, sand, gravel, clay, calcium-carbonate, timber, fuel wood • provision of medicinal resources, germ plasm, cosmetics and fertilizers • Water purification (reduced by too much pollution, close to tipping point) & phytoremediation of heavy metals • Mangroves as wind break protects local agriculture (paddy) • Mangroves prevent erosion and hold soil together • Mangroves provide storm and flood protection • Mangroves as breeding/spawning ground for fish • Carbon sequestration • Tourism: bird watching, boat tours, agricultural tourism picking up • Biodiversity habitat (incl. migratory species) and gene pool, RAMSAR site • Birds and insects as pollinators for paddy • Birds and frogs as pest control		
	Where do trade-offs occur and how? • Between polluting activities and ES • Between intensive agri-/aquacultural production and non-provisioning services • Between non-ecological aspects of tourism (e.g., oil spills, too high capacity) and habitat		Where do synergies occur and how? • Fishing and Pokkali benefits from water purification and healthy mangroves (windbreak, breeding and spawning ground) • Eco-tourism benefits from aesthetic value and habitat function

Relationship of human activities and actors with ecosystem services

Mangalavanam and other mangrove patches within Kochi jurisdiction

B. Understanding how human activities and actors relate to ecosystem services

Which activities contribute to the provision of ES? (by conserving biodiversity or managing ecosystems) Who are the actors?		Which activities benefit from or rely on ES? Who are the actors that use or depend on ES and have an interest in their provision?		Which activities degrade or pollute ecosystems and/or deplete or harm the provision of ES? Who are the responsible actors?	
activities	actors	activities	actors	activities	actors
mangrove management	- coastal zone authority / Indian coast guard / navy (national) - protected areas managed by forest department	fishing (mangrove for breeding and nursery)	- fisherman and communities consuming fish - fishing industry - boat tour operators	- Cochin shipyard port activities - Kochi LNG (liquid natural gas) terminal construction for offshore storage and transport destroy mangroves	- households with sewage - constructors - Indian navy (dredging) - Indian coast guard (dredging) - Indian national railways (cut down mangroves)
Management and protection of Mangalavanam	- Kerala Forest Department - Kochi Municipal Corporation	Leisure trips, including boat tours (for pleasure, recreation, physical & Mental Health)	- Public visitors - Tourism operators - morning walkers	Incompatible land use in surrounding area (with high buildings)	- Corporation GCDA - Railway - Developers - High court - KMC - Govt. of Kerala - Private builders
Eco-friendly tourism	- DTPC - Private Agencies	Nature Camps and education activities	- Students - general public - neighborhood - KFD	Light and noise pollution in surrounding area	- Local public and households - high court building - traffic
Research	- KFRI - CUSAT - SACON - Colleges	Climate protection efforts	- Agencies responsible for climate protection - Global community	Improper drainage system and destruction of natural drainage	- Govt. bodies - Local bodies
Buffer zone protection	Kerala State	birdwatching	- bird watchers - tourism operators	Introduction of exotic plants and predators	- Forest Department - Natural invasion
Controlling pollution (5890)	- Kerala state pollution control board - KMC			Waste disposal: toxic, solid and liquid	- general public - KMC - Businesses (for instance fishing net factory)
Regulations (CRZ/ RAMSAR agreement / Coastal zone management rule)	- Govt. of India - United Nations			siltation of surrounding blocking tidal activities	- public works Dept. - KMC
good railway stations (stopped)	Indian railways				

Vembanad Lake (Backwaters)

B. Understanding how human activities and actors relate to ecosystem services					
Which activities contribute to the provision of ES? (by conserving biodiversity or managing ecosystems) Who are the actors?		Which activities benefit from or rely on ES? Who are the actors that use or depend on ES and have an interest in their provision?		Which activities degrade or pollute ecosystems and/or deplete or harm the provision of ES? Who are the responsible actors?	
activities	actors	activities	actors	activities	actors
mangrove conservation, management (potentially also restoration, but not yet happening)	- coastal zone authority - Indian coast guard / navy (national) - forest department - private land owners - Forest Dept. - KCZMA - LLMC	tourism relies on attractive landscapes (boat tours), bird population (bird watching), clean water	- boat tour operators - bird watchers	crude oil transportation: oil spills from pumping and leakage	Cochin shipyard port (port activities)
Ecological agriculture (mainly traditional Pokkali)	- Farmers - Agriculture Dept. (via promotion and subsidies)	- Agriculture / food: production and consumption (local and export) - Paddy farming depends on pollinators	- Fishermen - Farmers - Local communities - consumers - Government authorities responsible for fisheries	Overfishing and destructive fishing (fishnet mesh size)	Fishermen relying on the practices
Community work on sustainable practices for clam and rejuvenated fish population	Community-led enterprise-based conservation (ATREE)	Eco-consumption	traditional Pokkali farmers	(Overuse of) chemical fertilizer and pesticides	Farmers relying on the practices
Policies and legislation	Govt.	Fishing (subsistence, commercial, game fishing)	- Fishermen - Game fishing organizers	Aquaculture monoculture (also with antibiotics)	Fish farmers
Social Forestry (Mangrove)	Forest/ BMC local	Germ plasma conservation		Industrial discharge (incl. toxic waste)	- industries - new commercial activities at city outskirts
manual dredging	LSGD	Industrial operations in the Kochi outskirts		waste dumping and sewage disposal	- general population - industries - local authorities
Waste Management	LSGD	biodiversity conservation efforts	Environmental authorities and NGOs	shipping and dredging	- port trust - ship yard - tourism boats

• Bank protection	• LS GD	• Industrial extractive activities (how do they benefit?)	Cement and construction industry	• Legislation without scientific vision • Lack of clarity and violation of law	• Govt. • Policy makers • general public
• Wetland area monitoring	• Local level monitoring committee	• recreation	• local population and tourists	• dredging	• Indian navy • Indian coast guard
• Legal monitoring of CRZ area	• Secretary of LSG • District Collector	• Coir geo textile	• LS GD	• Mangroves destruction	• Indian national railways • Kochi LNG liquid natural gas terminal
• Mangrove monitoring and research	• KUFOS • CUSAT • CWRDM	• Medicinal resources	• pharmaceutical industry • public health	• oil spilling	• tourism boat operators
• Water quality enhancement	• SPCB • CPCB • CUSAT • NIO • NGOs • Academic institutions			Construction on the shores causing erosion ; conversion and filling	• private companies • private individuals • constructors
				• Sand mining	• Local population
				• Un-authorized construction	• Govt. of India
				• Depletion of ground water	

Ideas how to improve the situation

The following ideas were generated during the workshop and expert consultations.

Idea	How to implement	Who could implement	Time frame
General			
Better waste management of solid, liquid, hazardous and biomedical waste	Decentralized management of organic waste at ward level; Insitu filtration effluent treatment plant at ward level; Amendment in Municipal Building rule, e.g. management system mandatory for shopping mall, buildings, hospital, industry	Govt of Kerala KMC SPCB Interact Bio Project	2 years
Monitoring & evaluation of wetland ecosystems and biodiversity hotspot (GIS based)	To identify ecologically fragile area and integrated to GIS platform; Regular monitoring surveillance using GIS mobile app or cloud; Establishment of a permanent monitoring station; Formation of task force	KMC Academic research platform, Cochin corporation, PCB state wetland authority, universities, fisherman communities	2 years - long-term
Policies to conserve and to	Mapping and monitoring of green spaces/trees inside Kochi;	KMC, NGOs, Research	Long term

restore green areas / trees in city	relate to heat stress and air pollution; awareness raising; find out which areas real estate are planning to buy and convert; discuss with builders the benefit of green spaces	Institutes, Residents, Builders, Interact Bio Project	
Increase environmental awareness / literacy creation from students to policy makers	Enhance capacity building, education & participation & awareness, including at all school levels, utilize ICT (effective) educational tools etc.	Govt India, Govt of Kerala, KMC, Community groups Local groups, NGOs, Research Institute, Interact Bio project	1 year – long-term
Zero waste disposal and discharge to the estuarine system	Proper implementation of waste collection and sewage treatment system	KMC, PCB	Long term
Ecosystem service assessment	Multi-disciplinary team conducted study	KMC lead (Support by ICLEI, etc)	2 – 3 years
Formulate and implement “green/sustainability” criteria for public buildings	Build on the “green audit” requirement for universities; check options to include criteria for all public buildings (schools etc.); check “green protocol” developed by KMC	KMC	1 year
Cleaning/desilting of canals and restoration of banks		INTERACT-Bio project, with KMC	1 year
Related to Backwaters (Vembanad Lake)			
Better support Pokkali paddy cultivation	Policy implementation and financial assistance for Pokkali farmers	Farmers, SHGs	Long-term
Management and action plan for policy formulation regarding Backwaters	Participatory process for shared vision, strategy, and action plan; Implementation through Acts, Rules, Notifications	KMC	1 year
Related to Mangroves			
Mapping of mangrove areas in and around Kochi, including ownership of land.		INTERACT-Bio project with KMC, KFRI, other research partners	3 months
Create network of mangrove landowners	Core group of mangrove stakeholders	KMC and other stakeholders	
Policies for protection of Mangroves	Bann cutting of mangroves through different legal and incentive measures	KMC, SHGs, Interact Bio Project	Long-term
Acquire private mangroves/ wetland area by state govt.	Implement GO (RT) 166/06/ forest dated 25 – 03 - 2006 Check exact content of legislation and amount of compensation ; contact Wildlife Trust of India on good practice experiences	Govt. of Kerala; KFRI	2 years
Specifically related to Mangalavanam			
Buffer zone and expansion of Mangalavanam protected area	Reclaim 7 hectares from housing corporation & add 10 h of marshy land	Legal notice Declaration	1 year
Stop Sewage flow into ecosystem	Sewage treatment plant at source; connect to other canals	KMC	Six months
Stop light and noise pollution	Antiglare windows and walls in all high rise buildings near to mangrove ; Establishing honking free zone	KMC	Three months

LESSONS AND RECOMMENDATIONS FOR THE INTERACT-BIO PROJECT

Based on the conversations with the Kochi Municipal Corporation and experts, the workshop results as well as internal discussions among the INTERACT-Bio team, UFZ would like to share some concluding thoughts, lessons and recommendations with respect to further project activities.

UFZ was impressed by the strong support from and close relationship with the Kochi Municipal Corporation (KMC) provides great enabling conditions for the project. It is also an excellent window of opportunity – and already a noteworthy success of the project – that several biodiversity-related aspects were included in the recent KMC budget. It is understood that the project is now expected to deliver a first quick and tangible/visible outcome, and various options have been considered during the UFZ visit (e.g., desilting a canal and planting trees to stabilize the bank, a butterfly garden). UFZ understands and acknowledges this need for a visible outcome, and would be glad to participate and advise in the decision process if this helps.

We would like to support two lines of action (see below). As institutional basis for both of them, the advice from KFRI experts to build a **core advisory group** of influential stakeholders seems promising. This core group will be able to help identify and ensure the participation of actors who are particularly relevant for advancing targeted actions within 1 and 2. It was mentioned that CMFRI, Cochin University, Kerala Forest Department, district administration (district collector), and the Kochi municipality opposition leader could be part of this core advisory group.

1. Building a network, action agenda, and communication material for mangrove conservation in the Greater Cochin Area

One focus of the project can be mangroves conservation. In that case, however, it is advisable to not only focus on Mangalavanam, which is a very small area with limited potential impact of conservation activities from an ecological – and ecosystem services – point of view. Mangalavanam without doubt also has some cultural and emblematic value for the city. And yet, there is a risk that a focus on the area ends up primarily as public relations campaign that could even defer more effective action to conserve biodiversity and ecosystem services in and around Kochi. We therefore support the idea to frame mangrove conservation efforts more broadly, with Mangalavanam as a sort of “light house” for mangrove advocacy and education. Since mangrove patches within narrow city boundaries seem limited and characterized by strong development pressures, the scope could be set to include all remaining mangrove forest in the Greater Cochin Area.

As discussed in the project team, a first task to that end includes a detailed mapping and identification of land owners for these areas. Then, the project can initiate and facilitate a network formation of mangrove landowners, for sharing knowledge, good management practices, and ideas for conservation. Stakeholders to participate in the process should include relevant public authorities (e.g. Forest department) and knowledge holders from research and practice. For instance, KFRI can share data on “ecologically fragile land” policy, and the Wildlife Trust of India can share experiences on mangrove conservation and restoration in other parts of India.

To support these efforts, the project can further involve professors from Kochi University or colleges and discuss potential collaborations for further studies and capacity building. This includes biodiversity experts for baseline assessments and monitoring activities as well as environmental/ecological economists. The project can also develop targeted information material to popularize and make the case for mangrove conservation, aimed primarily at City counselors and public authorities (policy brief) but also wider audiences. This could be done based on the novel IPBES framework of “multiple values for Nature” (Pascual et al 2017), including appropriate communication of ecosystem service values, and relying on latest knowledge on biodiversity communication strategies (e.g. from South Africa).

UFZ can offer to provide the technical backstopping/supervision for the concept and implementation of such a communication approach and material (e.g., a brochure). ICLEI /UFZ will need to clarify how to organize this task and who could provide resources for the more time-consuming research activities and/or research assistance. This may also be an opportunity to build relevant capacity in India.

2. Supporting KMC in developing a management and action plan for Sustainable Backwaters

Building on the interest of the Kochi Municipal Corporation (KMC) and the inclusion in the current budget, the project should help KMC prepare a management and action plan for the Backwaters. This will involve identifying the relevant stakeholder groups in order to take an inclusive, participatory approach. The results of the second exercise of the April workshop on “human activities and actors related to ecosystem services” provide a good starting point for further specification of possible actions and policies for a sustainable development and ecosystem conservation in the backwaters. One option is that a targeted group of stakeholders takes this thinking forward based on Steps 3C to 4C of the “ecosystem service opportunities” guidelines (Rode and Wittmer 2015), for instance in a workshop setting. It was mentioned during the consultations that there is a large amount of knowledge available on the ecological status, threats, and conservation options for the backwater ecosystems. The project should build on this knowledge by including the relevant knowledge holders (and potentially also with a literature review). The management and action plan

should specify concrete implementable management activities and policy options, (some of) which could be included in the 2019 budget for implementation.

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ANNEX 1: TEMPLATE WITH GUIDING QUESTIONS FOR SECTION 2

Environmental context

- **What are the general environmental conditions of the area of interest? e.g.**
Land use, land cover and habitat types
Other natural features (hydrological, geological, etc.)
Habitats and species with special conservation significance
Current and historical trends in land use/cover
Current and historical trends in land, air and water quality
Location of environmental hotspots, sensitive or threatened areas.
- **What are the main pressures on and threats to ecosystem conservation? What are their causes (e.g. impacts of particular economic activities)? To what extent are the causalities (scientifically) verified (e.g. contamination through pesticides)?**
- **What conservation activities are already in place? What are the main objectives and measures of already existing conservation plans? Are the objectives appropriate and are the measures being implemented? If not, what are the barriers?**

Socio-economic and cultural context

- **Current level of development and infrastructure and development potential in the area**
- **Current land use (including potential environmental impacts)**
- **Sources of income and employment (economic sectors, main activities)**
- **Important public and private investments**
- **Distribution of wealth and income across the population (including the poverty line)**
- **Cultural characteristics of the local population (demography, language, class structure, ethnicity, religion, relevant traditions)**
- **Education (literacy level, school system)**
- **Status of community involvement - Is it participatory? Are women, minorities, poor people, et al. represented? Are there networks to assist communication and stakeholder coordination?**
- **How do people perceive their environment and what is their attitude towards conservation measures? Which conservation measures are contested and by whom?**
- **Is there important traditional knowledge of natural resource use? Who has the rights of access to traditional knowledge and its application?**

Political, institutional, and policy context

- **Who is in charge at local level, in particular of environmental management? Which organisational structures govern environmental protection and ecosystem conservation? What influential political institutions are there and who leads them (formally and informally)?**
- **Are there important national or international policies that influence local development and conservation objectives?**
- **What is the local system of land tenure, ownership (property rights, resource use rights) - both formal and customary/ de facto?**
- **Which policy instruments for ecosystem conservation exist already?**
 - **Legal instruments (conservation laws, protected areas, land use restriction, etc.)**
 - **Economic instruments (payments, tax reductions, etc.)**
- **Which local, regional or sectoral development plans and policies are relevant for conservation? (e.g. policies for regional economic, agricultural or infrastructure development, "perverse" subsidies with negative effects on biodiversity conservation)**
- **What local political support is there for biodiversity conservation? Which international, national and local actors are involved in conservation? Are there currently any conflicts over policies or laws?**
- **Are there currently any "windows of opportunity" to improve environmental policies? (e.g., formulation of a sustainable development plan, ongoing policy reform, public debate)**

APPENDIX 12: PILIKULA NISARGA DHAMA

Pilikula Nisarga Dhama (Pilikula) is an eco-education and tourism development project promoted by the District Administration of Dakshina Kannada in Mangaluru. It comprises an integrated theme park with attractions of cultural, educational and scientific interest. The park is spread over an area of 370 acres and comprises of a tropical forest and Pilikula Lake. The project presently includes a Biological Park, an Arboretum, a Science Centre, a Lake Park with Boating Centre, a Water Amusement Park, a Heritage Village, an Ayurveda Health Therapy Centre, Tourist Cottages and a Golf Course. The Biological Park, Arboretum and Aquarium were setup with the intention to conserve the unique wildlife and plant species of the Western Ghats and act as an ex-situ conservation effort. The biological park houses 400 animals (mammals, birds and reptiles) and is the only breeding centre for king cobras. The arboretum comprises 6,000 plants represented by 235 endangered species. The plant nursery in the arboretum distributes plants at nominal rates to encourage gardening and tree plantation. A bamboosetum having 28 species of bamboos is also located in the complex. The aquarium which is found within the lake park runs a native endemic fish conservation programme. Presently over 20 species of which 15 fall under various IUCN categories viz; vulnerable (*Hyselobarbus jerdoni*, *Dawkinsia assimilis*, *Barilius ardens*, *Osteochilus nashii*, *Hyselobarbus dobsoni* and *Hyselobarbus carnaticus*), threatened (*Hyselobarbus kureli* and *Garra biconata*), endangered (*Hyselobarbus lithopidos*, *Hyselobarbus thomasii*, *Biotia striata*, *Sahyadria denisoni*, *Etroplus canarensis* and *Dawkinsia exclamatio*) and critically endangered (*Neolisochilus wayanadensis*) are housed within the aquarium.

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