

# URBAN WETLAND/WATER BODIES MANAGEMENT GUIDELINES

A TOOLKIT FOR LOCAL STAKEHOLDERS



NATIONAL MISSION FOR CLEAN GANGA

January 2021  
Volume I



SCHOOL OF PLANNING &  
ARCHITECTURE, NEW DELHI



# URBAN WETLAND/WATER BODIES MANAGEMENT GUIDELINES

VOLUME I

Image Credit: Rajeev Chauhan





जल शक्ति मंत्री  
भारत सरकार  
Minister for Jal Shakti  
Government of India



## Message

The value of wetlands especially in urban settings, is evidenced through our history where water bodies were respected and valued by all communities creating a sense of belonging and ownership towards them. Water bodies within an urban precinct, including smaller ones, form vital ecosystems supporting local livelihoods, with social, economic, ecological and aesthetic benefits. Their value as part of an extensive food chain and biological diversity is immense. For a city, they can provide a wide range of important resources and ecosystem services such as food, water, groundwater recharge, water purification, flood moderation, erosion control, climate regulation and rainfall sinks. They are an important part of our natural wealth and liquid assets.

Sustainable urban water body management encapsulates the linkages between functioning of water cycle and river rejuvenation guided by ecosystem approaches. Government of India's Jal Shakti Abhiyan also recognizes this need and accords high priority to conservation and wise use of wetlands in our country. National Mission for Clean Ganga has made significant inroads by initiating multiple projects and regulatory frameworks to support State Governments for integrated management. Conservation of wetlands would also go a long way in achieving Hon'ble Prime Minister's dream of 'Nal Se Jal' in each household.

This toolkit has been envisioned in a strategic step towards increasing the capacity of city urban wetland managers. I am happy to note that the progress made in this direction has been documented through these volumes, as a step by step guidance framework. I am sure the toolkit will inspire cities to re-imagine their urban wetlands as part of the integrated vision for the city and process of urban planning. The Ministry looks forward to working with the State Governments and concerned citizens to secure these natural assets.

(Gajendra Singh Shekhawat)



जल शक्ति  
और सामाजिक न्याय एवं अधिकारिता राज्य मंत्री  
भारत सरकार  
MINISTER OF STATE FOR  
JAL SHAKTI AND SOCIAL JUSTICE & EMPOWERMENT  
GOVERNMENT OF INDIA



## Message

Wetlands are life support systems for urban cities, ensuring effective functioning of the water cycle. They help recharge groundwater aquifers, cleanse polluted waters and act as sponges to mitigate floods. Especially for river basins, urban wetlands play a multi-layered role of not only supporting the rivers but also provide ecosystem services to a city. Urban wetlands serve as special attributes contributing to the cultural heritage, and have deep connections with a city's ethos. The value of wetlands in securing local livelihoods through activities such as fishing, farming and tourism, is incomparable. They are indeed an important part of a city's natural wealth and "liquid assets".

The Ministry of Jal Shakti holds the conservation and rejuvenation of urban wetlands in high priority. We are initiating long-term actions for conserving wetlands in the Ganga basin, build the momentum for their revival and to make it a people's movement.

In a strategic step towards increasing the capacity of urban wetland managers in integrated and holistic management of wetlands, a toolkit has been developed for local stakeholders, as Urban Wetland Management Guidelines. This toolkit will be beneficial for all to systematically approach, prioritize and plan for urban wetland management.

The Ministry looks forward to working with State Governments, experts, NGOs, private sector and concerned citizens from all walks of life to restore and revive urban wetlands.

(Rattan Lal Kataria)



## *Foreward*

The National Mission for Clean Ganga (NMCG) under its 'Namami Gange' program has taken up an initiative to conserve the wetlands in Ganga River Basin. The wetlands are highly productive ecosystems supporting rich biodiversity that protect the environment in various ways including supply of water, aiding in its purification and waste assimilation. The wetlands play a crucial role in recharging groundwater, increasing the base flow of rivers and helping in erosion control. Several wetlands on the Ganga basins are home to key flora and fauna, including migratory species. The National Environment Policy 2006, recognised the ecosystem services provided by wetlands and emphasized the need to set up a regulatory mechanism for all wetlands so as to maintain their ecological character and ultimately support their integrated management.

India is a signatory to the Ramsar Convention on Wetlands and is committed to conservation and wise use of all wetlands within its territory. The Ramsar Convention in its 10th meeting of the Conference of the Contracting Parties (COP 10) in 2008 adopted Resolution X.27 on 'Wetlands and Urbanization' and expressed concern that many wetlands in urban and peri-urban environments are or are becoming degraded through encroachment of surrounding populations, pollution, poorly managed waste and infilling or other developments, and that these activities have diminished both the ecosystem services that urban wetlands can provide. It recognized the crucial role of capacity building in enabling local governments, including municipalities, to ensure the conservation and wise use of wetlands, in urban and peri-urban areas, under their jurisdiction.

The foundation of NMCG as an authority is structured on an underlying principle of managing an integrated ecosystem of river Ganga, its tributaries, associated wetlands and ground water. It is imperative to look at the bigger picture of River-sensitive sustainable urbanization. Properly managed wetlands, especially lakes, in urban areas have an important role as a source of water supply, controlling runoff and groundwater recharge. River and river flood plains are water rich areas but the cities on these floodplains are still facing water scarcity. Instead of the wetlands giving water to the base-flow of the river, they are now actually pulling the water. This is the issue that needs to be tackled.

The water bodies are to be maintained to give life to the river. The 'Jal Shakti Abhiyan' of Government of India brought wetlands into the focus of various government bodies when it recognized this need for rejuvenation of wetlands and brought out a list of water bodies for priority work. NMCG has been closely working with the experts, stakeholders and with line departments such as, State Wetland Conservation Authorities, Wetland Division of MoEF&CC and Wetland International India to take forward the cause of wetland conservation in Ganga Basin. Land and water, two major ecological constituents of wetland ecosystems, are enlisted as State subjects as per the Constitution. As such the State Governments and Union Territory Administrations need to take into account the wetland ecosystem services and biodiversity values likewise within their developmental programming and economic well-being. The functions of wetlands are widely known. However, when it comes to managing these functions, the municipal bodies are lagging behind. The "Urban Wetland Management Guidelines – A Toolkit for Local Stakeholders" prepared in collaboration with the School

of Planning and Architecture, Delhi aims to educate the local stakeholders on the management plan to maintain the urban floodplain wetlands, including mapping the city information, mapping wetlands/ water bodies & their attributes to cover the information gap, identifying their link with the groundwater dynamics (ground water status and the level at which it is maintained), urban development alongside the wetlands and land suitability analysis (demarcating the zone of influence), looking at the impact of development and trends in the city Master Plans and identification of critical wetlands, and accordingly finalization of the action plan.

This Toolkit has been tested for the city of Bhagalpur, which is downstream to river Ganges and is a water rich area. It was found that these urban wetlands are interwoven with settlement pattern and economic activities including agriculture, rearing of fish, among others. Apart from scientific and community engagement, the Toolkit also strives to acknowledge traditional knowledge which should also be made a part of water management within the cities.

This Toolkit represents NMCG's efforts towards establishing urban wetlands as part of the city's water fabric, conserving and nourishing them to become public spaces as well as a valuable contribution to local environment. It is our fervent hope that urban municipal bodies and local stakeholders find the Toolkit useful and it will motivate them towards the common goal of River Rejuvenation.

**Rajiv Ranjan Mishra**  
**Director General**  
**National Mission for Clean Ganga**





# Preface

India's wetlands/water bodies are extraordinarily diverse-ranging from lakes and ponds to marshes, mangroves, backwaters and lagoons -and play a vital role in maintaining water balance, flood prevention, support biodiversity and food security and livelihoods. Wetlands/Water bodies are systematically converted into "real estate" by vested interests or simply used as a dumping ground for sewage and garbage and are receptacles for toxic waste. While community and court actions are in process across the country, the lack of enforcement of legal instruments has hampered any real progress in many of these cases.

Urban areas have flourished around water, be it river, lake, springs or a steady availability of ground water. What was earlier identified as source to sustain urban development is increasingly being transformed as a sink for waste- both solid and liquid. In the rapid pace of urbanization we have overlooked the role of water bodies, with the plans of many cities not even indicating their existence on the map. This has led to their rapid encroachment and degradation. Today we do not have an inventory of water bodies of all urban settlements whereas it is available at state for wetlands of greater areas. For the capital city of Delhi data has been provided by the Delhi Parks and Gardens Society (DPGS), which state that there are over 1000 water bodies in the city. However, almost 30% of these are untraceable and area under water bodies has reduced by 7% from 1999 to 2002, The ownership and maintenance of water lie with multiple agencies, however in recent years, there has been increased awareness about the importance of rejuvenating water bodies to enhance water security and an initiative of reviving 201 bodies is underway in the capital.

Wetlands/ Water bodies are a essential for human well-being, economic security and climate change mitigation and adaptation. The multiple benefits provided by wetlands are essential in achieving Sustainable Development Goals. Forming an integral part of the hydrological cycle, properly managed wetlands/water bodies in urban areas have an important role as a source of water supply, controlling run-off and recharging groundwater. For prevention of pollution, conservation and restoration of wetlands, the government has come up with different policies and acts which needs to be taken forward for implementation at local levels. The present toolkit puts forth a methodology to assess the role of water bodies, prioritize them for conservation/rejuvenation and mainstreaming conservation of wetlands/water bodies in the development/planning process.

**Prof. Dr. PSN Rao**

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## **ACKNOWLEDGMENT**

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The study would not have been completed without the support from the officers from Bhagalpur District and City, Bihar; which was taken up to develop and test the toolkit - Ms. Vandana Kini, IAS, Commissioner, Bhagalpur division, Shri Pranav Kumar IAS, Collector Bhagalpur District, Smt Seema Saha, Mayor, Municipal Commissioners - Shri Meena ( upto 10th July 2019 ) and Smt J. Priyadarshini (from 11th July 2019 onwards) and officers of Bhagalpur Municipal Corporation, Ward Councilors , NGOs and local people of the city of Bhagalpur.

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## ABBREVIATIONS/ ACRONYMS

AAI: Airport Authority of India	NDZ: No Development Zone
CCA: Culturable Command Area	NEERI: National Environmental Engineering Research Institute
CETP: Common Effluent Treatment Plant	NGO: Non Governmental Organization
CGWA: Central Ground Water Authority	NHAI: National Highways Authority of India
CGWB: Central Ground Water Board	NMCG: National Mission for Clean Ganga
CPCB: Central Pollution Control Board	NOC: No Objection Certificate
CZMA: Coastal Zone Management Authority	NPCA: National Plan for Conservation of Aquatic Ecosystems
DPAP: Drought Prone Area Programme	PERT: Program Evaluation Review Technique
DEM: Digital Elevation Model	PMKSY: Pradhan Mantri Krishi Sinchai Yojana
DPR: Detailed Project Report	PWD: Public Works Department
EC: Environmental Clearances	RCZ: River Conservation Zone
FTL: Full Tank Level	RWH: Rain Water Harvesting
GIS: Geographical Information System	SLUSI: Soil and Land Use Survey of India
HFL: High Flood Level	STP: Sewage Treatment Plant
IWDP: Integrated Wasteland Development Programme	SWM: Solid Waste Management
IWMP: Integrated Watershed Management Programme	TCPO: Town and Country Planning Organization
JSA: Jal Shakti Abhiyan	ULB: Urban Local Bodies
MLD: Million Litres Per Day	UT: Union Territory
MOEFCC: Ministry of Environment, Forest and Climate Change	USGS: United States Geological Survey
MOWR, RD & GR: Ministry of Water Resources, River Development and Ganga Rejuvenation	WUA: Water Users Association
NBC: National Building Code	ZOI: Zone of Influence
NDMA: National Disaster Management Authority	

## DEFINITIONS

**WETLAND:** “Wetland” means an area of marsh, fen, peatland or water; whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters, but does not include river channels, paddy fields, human-made water bodies/tanks specifically constructed for drinking water purposes and structures specifically constructed for aquaculture, salt production, recreation and irrigation purposes. {Wetlands (Conservation & Management)Rules, 2017}

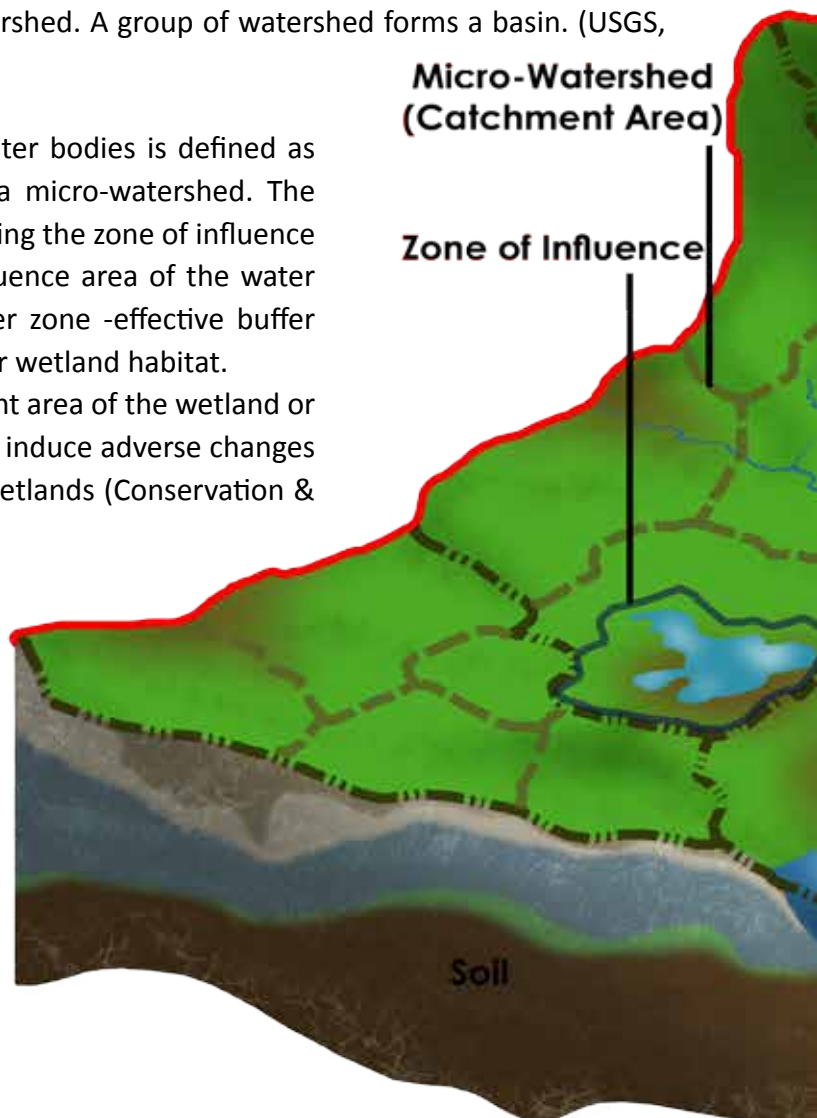
**WATERSHED:** A Watershed is an area of land that drains all the streams and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel. The word ‘watershed’ is sometimes used interchangeably with drainage basin or catchment. Ridges and hills that separate two watersheds are called the drainage divide. The watershed consists of surface water - lakes, streams, reservoirs and wetlands - and all the underlying groundwater. Larger watersheds contain many smaller watersheds.

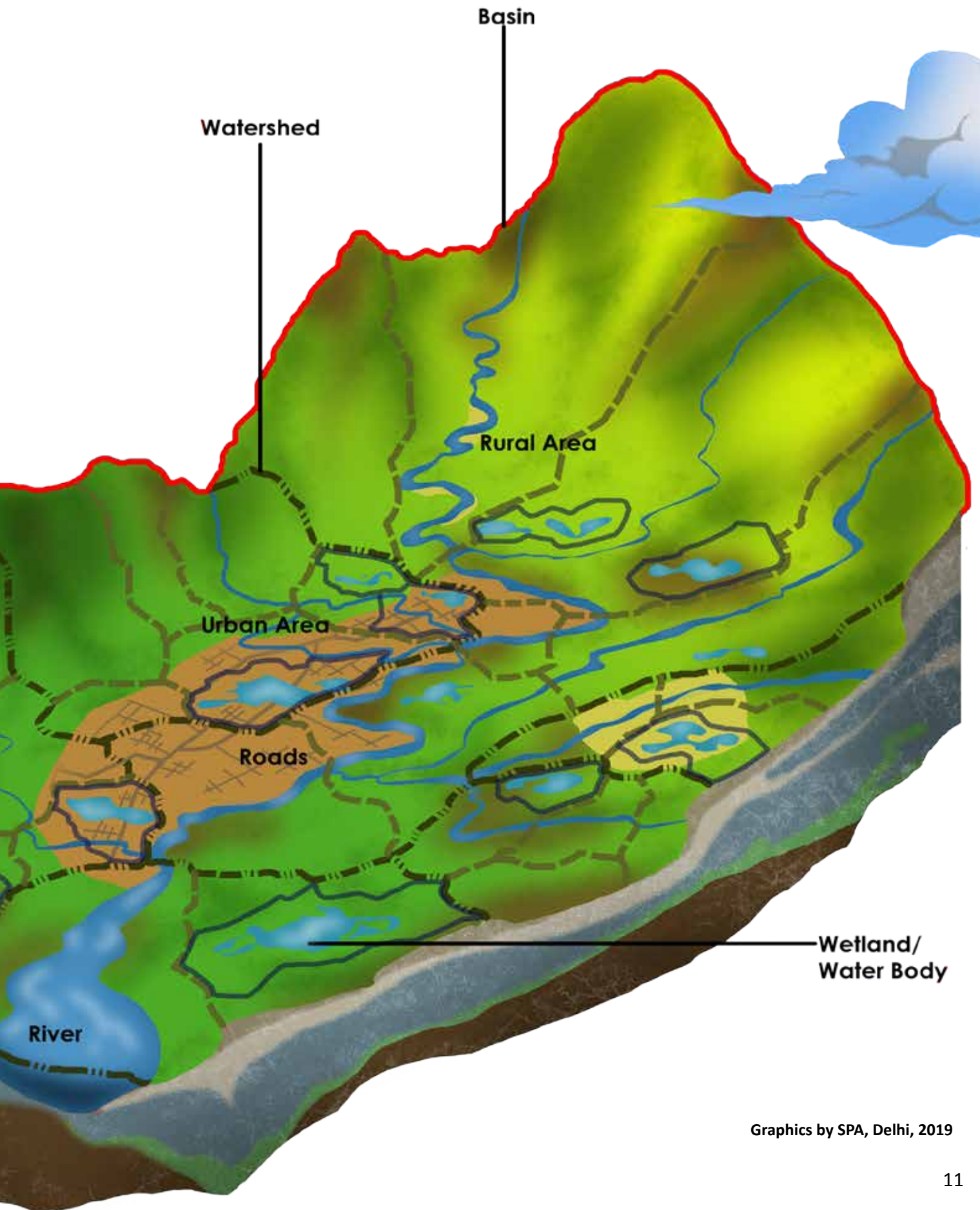
Watershed is a natural hydrologic entity governed by the terrain topography from where runoff is drained to a point. The term watershed is a general phenomenon thus its size and area depends on the scale of the base map used for delineation and codification. (Soil and Land Use Survey of India)

**CATCHMENT AREA:** The Catchment area of wetlands/ water bodies is defined as the hydrological unit that governs the water flow within wetlands/ water bodies. In case of urban areas, the micro-watershed delineated from larger watershed boundaries forms the catchment area of urban wetlands/water bodies. Often micro-watershed is also referred to as sub-watershed. Two or more catchment area forms a sub-watershed. A group of sub-watersheds form a watershed. A group of watershed forms a basin. (USGS, NASA)

**ZONE OF INFLUENCE:** The Zone of Influence of water bodies is defined as the lowest level of drainage surface area within a micro-watershed. The catchment area of water bodies will help in delineating the zone of influence of water bodies which also signifies the direct influence area of the water bodies. The Zone of Influence will cover the buffer zone -effective buffer space for water quality and effective buffer space for wetland habitat. “Zone of Influence” means that part of the catchment area of the wetland or wetland complex, developmental activities in which induce adverse changes in ecosystem structure, and ecosystem services. {Wetlands (Conservation & Management)Rules, 2017}

**BUFFER SPACE:** The Buffer Space of wetlands/water bodies is defined as the land adjacent to wetland/ water body areas designated for maintaining water quality and wetland/water body habitat. Wetland buffers in urban areas are particularly important in moderation of the impacts of altered hydrological regimes and flooding. (Planners Guide to Wetland Buffers for Local Governments, March 2008, Environmental Law Institute)





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## INTRODUCTION

The fast pace of urbanization has been placing tremendous pressure on urban areas to provide a good quality of life for majority of human kind. India is one of the two countries slated to possess maximum number of urban dwellers (404 million by 2014, as per UN estimates of 2014). This population will reside in the numerous towns, cities and metropolitan regions ranging from size of 5000 to more than 2 million. Coupled with the variation in size is the diversity of physiographic regions - plains, plateau, coasts, deserts and mountains presenting a unique challenge of natural resources management while ensuring a resilient and equitable future for the inhabitants. The maintenance of ecological processes underlying natural resource conservation is imperative to achieve a transition towards sustainability, with water being one of the natural resources which is under tremendous stress. The Composite Water Management Index, Niti Aayog, 2018 states that 21 cities, including Delhi, Bengaluru, Chennai and Hyderabad will run out of ground water by 2020 affecting 100 million people.

The guidelines for Urban Water Conservation Jal Shakti Abhiyan of Ministry of Jal Shakti 2019, has emphasized the need to address sustainable Development Goal 6 (SDG 6) w.r.t to India which is facing the challenge of serving 17% of world population with 4% of worlds fresh water resource.

The Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines, 2014 state the need to strengthen the plan making process of urban areas by ensuring that cities and towns are able to generate enough resources to sustain themselves. This can be achieved through a comprehensive and integrated approach inclusive of sustainability guidelines. Till 2014 out of a total number of 7933 urban areas only 2100 has Master Plans notified for Planned Development. In view of the above, the urban planning process can still address the conservation/restoration or rejuvenation of water bodies while formulating their plans.

Urban areas which have traditionally depended on water from rivers, lakes, springs have gradually been replaced by canal network, reservoirs followed by ground water pumping and with increasing water demand have resulted into a situation of water stress. The towns and cities which are situated on the banks of Rivers and lakes also exhibit a gap in demand and supply of water which is aplenty compared to settlements which are away the river. It has become imperative to look for alternate methods of water management to enable settlements to develop sustainably and become resilient.

The National Mission of Clean Ganga had initiated the present study to address the preceding concerns by formulating a Toolkit for management of wetlands and water bodies in urban areas. The objectives of the toolkit are:

- Protection of the ecological processes that sustain water resources in urban settings,
- Mainstream protection of water bodies in the urban planning process, and
- Provide a step by step approach to identify, prioritize and prepare an action plan for protection of water bodies in urban areas.

The toolkit will enable the Urban Local Bodies, urban managers, urban planners and other stakeholders to address the water management issues by achieving action on ground in an comprehensive and integrated manner.

# STAGE I

IDENTIFICATION OF URBAN  
WETLANDS/WATER BODIES  
FOR CONSERVATION



01

MAPPING CITY LEVEL  
INFORMATION



02

MAPPING OF URBAN WETLANDS  
/WATER BODIES &  
ITS ATTRIBUTES



03

IDENTIFICATION OF  
ECOSYSTEM SERVICE OF URBAN  
WETLANDS/WATER BODIES



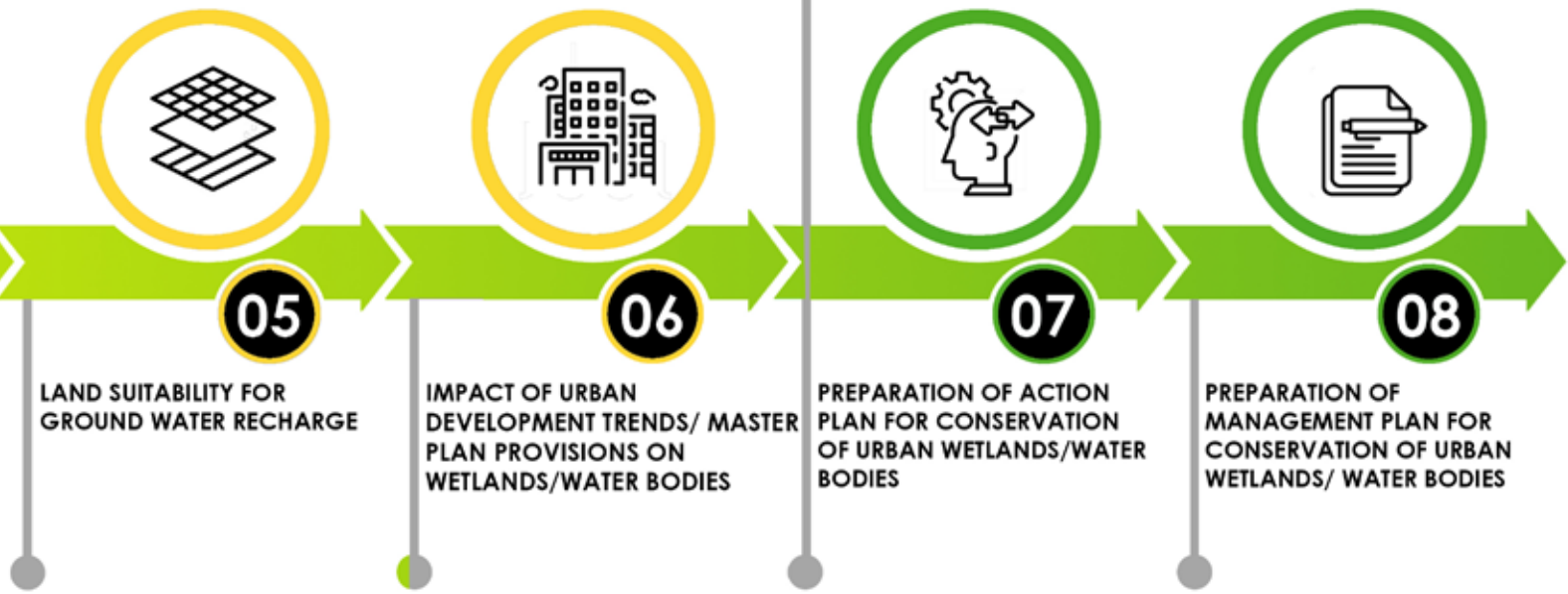
04

GROUND WATER  
ASSESSMENT



# STAGE II

ACTION PLAN FOR IDENTIFIED  
URBAN WETLANDS/ WATER BODIES



# METHODOLOGY

# STAGE I

The Stage I is divided into 6 chapters which will guide the urban local bodies and stakeholders in mapping and prioritizing of water bodies based on several identified parameters.

At this stage, a GIS & Remote Sensing expert is necessary for preparation of interactive database of city, urban wetland/water bodies and its associated attributes. Active involvement of stakeholders is essential for identification of various ecosystem services of urban wetlands/water bodies. The steps also require a consistent support of Central Ground Water Board/Authority and hydrologists for understanding the complexity of hydrological regime and for carrying out ground water assessment at proper scale. Understanding hydrogeological parameters will help in identification of various parameters influencing the urban wetlands/water bodies. This in turn help in identifying implications of urban development/master plan provisions and developing indicators and standards for management of urban wetlands/water bodies.

# 1.1

## MAPPING CITY LEVEL INFORMATION

Urban local bodies and stakeholders are confronted with a complex and dynamic environment. For preparation of a management guideline for urban wetlands/water bodies, they require up-to-date information. A detailed and up-to-date land use map for urban areas is the basic and essential information required for urban local bodies to plan and manage city development in view of conservation of urban wetlands/water bodies. A detail documentation of natural resources such as temperature, humidity, soil, hydro-geology, ground water level, land use and land cover provides a better insight into the water regime of wetland/water bodies. Thus delineating the catchment and zone of influence of wetland/water bodies is necessary to understand its prevailing pattern of water flow over a given time.

The prioritization of watershed is necessary to understand the criticality/potential of watersheds which shall have a big impact on the associated wetlands/water bodies. GIS based expertise and Hydrologists (CGWB) are required for prioritizing watersheds.



**INPUT**



**Administrative Boundaries**  
 Planning Boundary  
 Municipal Boundary  
 Ward Boundary



**Natural Resource**

- Temperature, Rainfall, Humidity, Land Use Land Cover map of city, Geological Map of City/District, Soil Map of City/ District
- Hydro-geological Map of City/ District, Basin/ Watershed/ Micro-Watershed Boundaries, Ground Water Level (depth) at City/ District level.



**Infrastructure**

- Drainage Network
- Sewerage Network



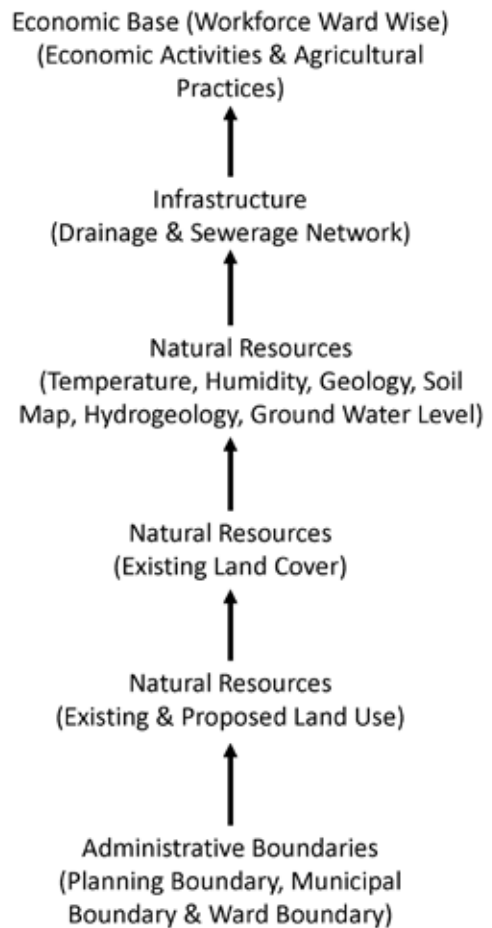
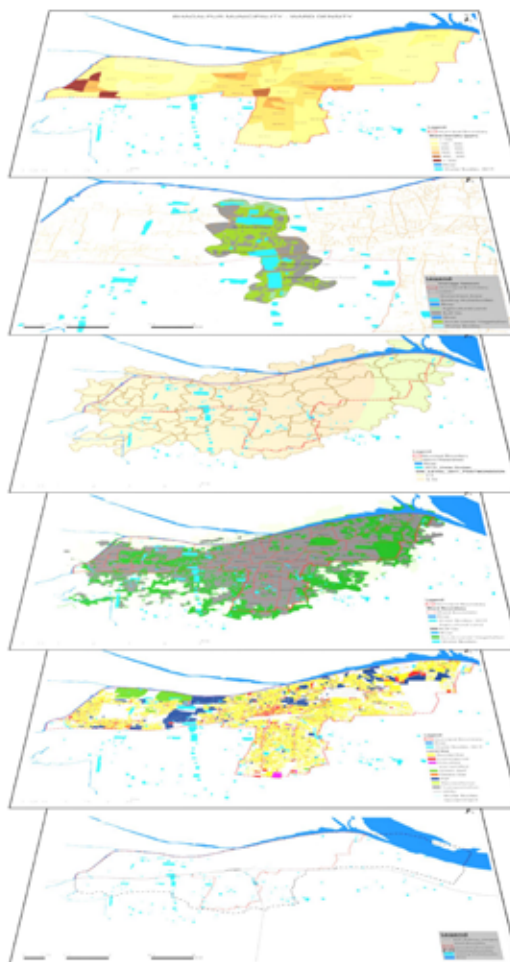
**Economic Base (Workforce ward wise based on District Census Handbook)**

- Economic Activities
- Agricultural Practices

**Note:**

- Information on natural resources should be mapped for notified planning area or identified assessment unit (will be bigger than notified planning area)
- Information should be collected for at least municipal area and if possible proposed network for planning area.

**Layers of City Level Information**

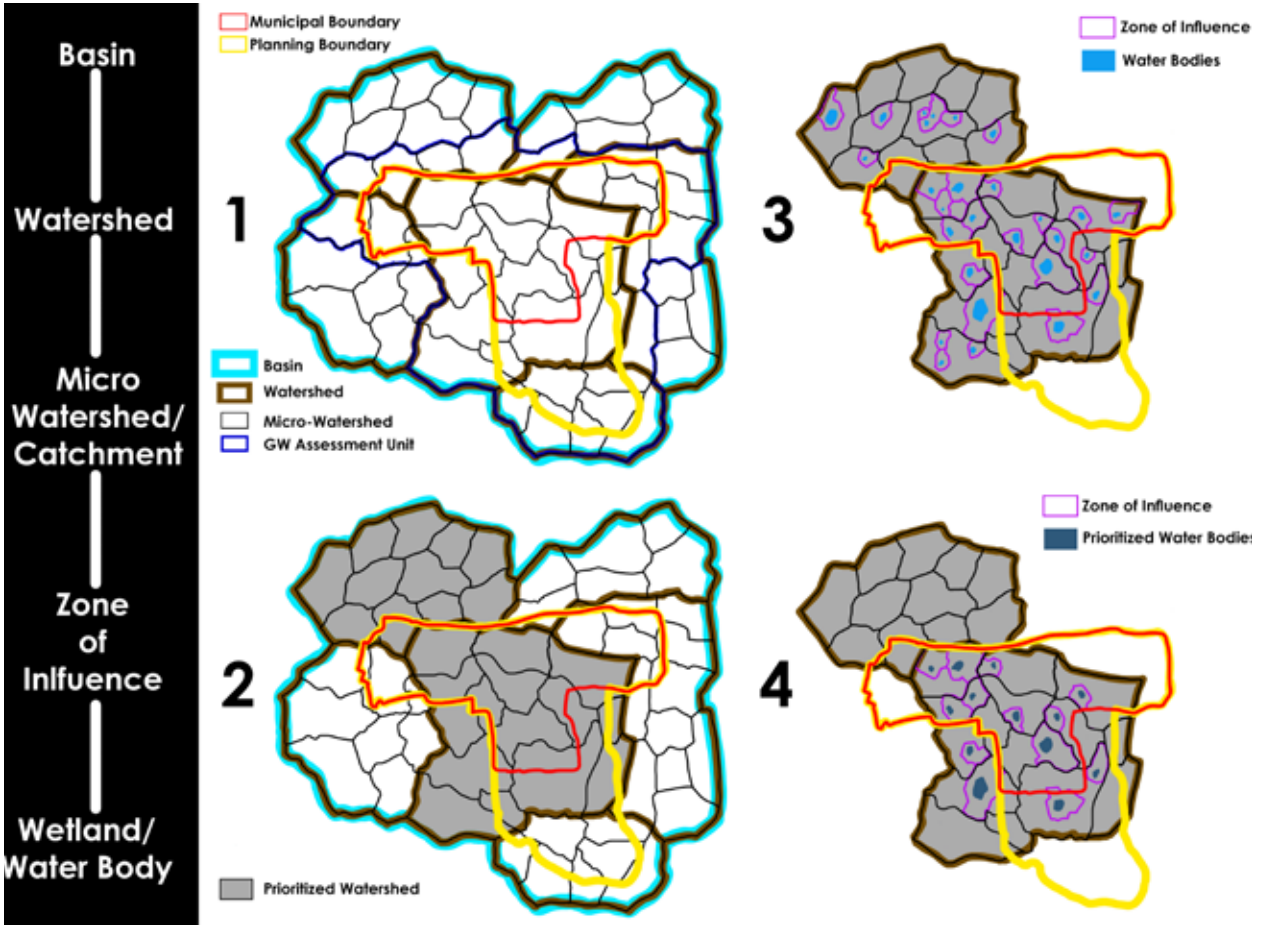


CATCHMENT AREA

ZONE OF INFLUENCE

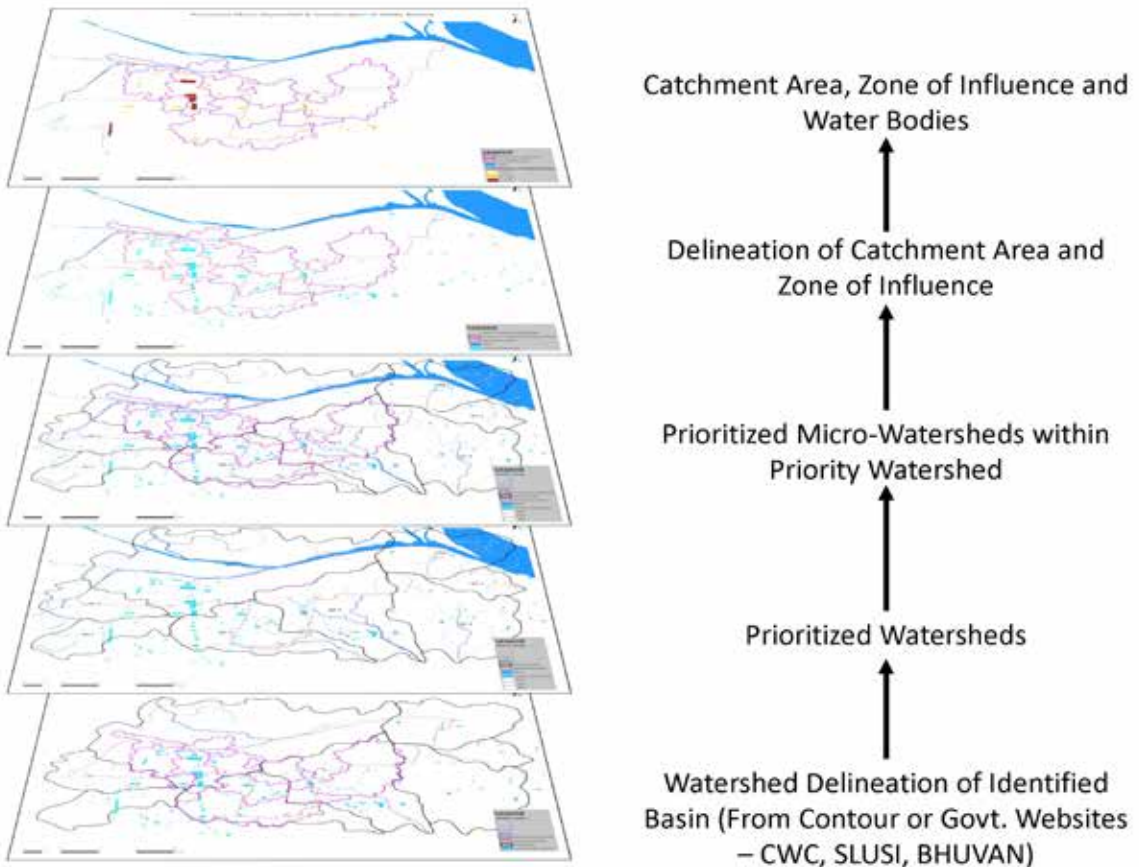
ON-SITE

Methodology for Identification/Delineating Catchment Area and Zone of Influence of Water Bodies



Reference: <http://slusi.dacnet.nic.in/dwainew.html>

Identification/Delineating Catchment Area and Zone of Influence of Water Bodies



CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE

## OUTPUT

1. GIS Baseline Thematic Maps
2. Priority Watershed Matrix (Based on Linear, Aerial and Relief Parameters)
3. Delineation of Micro-watershed (from Watershed in case of non-availability)
4. Delineation/Identification of Assessment Unit (Cluster of Micro-watershed) – Area bounding the Municipal Boundary/Planning Area Boundary
5. Delineation/Identification of Catchment Area
6. Delineation/Identification of Zone of Influence

### Checklist for Mapping City Level Information

CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE

Inputs	Level of Data Collection		Source of Data
	City	District	
<b>Administrative</b>			
Planning Boundary			Municipality & Development Authority
Municipal Boundary			Municipality & Development Authority
Ward Boundary			Municipality & Development Authority
<b>Natural Resource</b>			
Temperature			Indian Meteorological Department
Rainfall			Indian Meteorological Department
Humidity			Indian Meteorological Department
Land Use			Municipality & Development Authority
Land Cover			Municipality & Development Authority; Land Cover can also be prepared via Satellite Imagery In Erdas/ArcGIS or Freely Available In BHUVAN Portal.
Geological Map			Geological Survey of India
Soil Map			Soil & Land Use Survey of India
Hydro-geological Map			Central Ground Water Board & Central Ground Water Authority
Watershed/Micro-watershed			Soil and Land Use Survey of India
Ground Water Data (Aquifer and Depth)			Central Ground Water Board & Central Ground Water Authority
<b>Infrastructure</b>			
Drainage Network			Municipality & Development Authority
Sewerage Network			Municipality & Development Authority
<b>Water Demand (Existing population based on latest data available/ District Census Handbook)</b>			
Domestic Water Demand			Municipality & Development Authority
Industrial Water Demand			Municipality & Development Authority
Irrigation Water Demand			Municipality & Development Authority

# 1.2

## MAPPING URBAN WETLANDS/ WATER BODIES & ITS ATTRIBUTES

Preparation of interactive GIS map includes identifying and mapping of urban water bodies at city scale. This may also include the peri-urban areas. This part will not only cover the demarcation of urban wetlands, but also the zone of influence and the catchment area. This is done collectively from primary survey and with the help of local stakeholders and Urban Local Bodies (ULBs).

Look for the available information with local administration, with former and current landowners or land-users, local groups and NGOs. Most cities have official survey records of natural resources, geological, forests, water resources, etc. Try to use this data, which are often precise and of good quality. Make a list of all available maps and data from different sources and compile them in GIS .



## INPUT



### Satellite Imagery (Minimum past 10 year data)

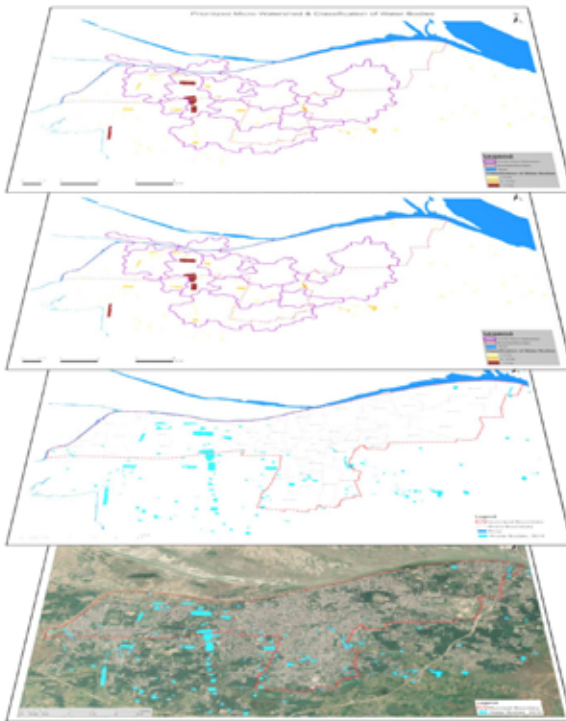
- Location of Urban Wetlands/Water Bodies (latitude & longitude)
- Typology & Size of Urban Wetlands/Water Bodies
- Status of Urban Wetlands/Water Bodies : Existing or Encroached



### Primary & Secondary Survey Reports (Existing Condition)

- Characteristics of Urban Wetlands/Water Bodies: Perennial or Seasonal
- Ownership details of Urban Wetlands/Water Bodies
- Physical & Chemical characteristics of Urban Wetlands/Water Bodies

### Layers for Mapping Urban Wetlands/Water Bodies & Its Attributes



### Classification of Existing Water Bodies (Based on Size, Characteristics & Ownership)

Documentation of existing condition of water bodies: physical and chemical characteristics

Mapping Water Bodies (Trends)  
(for past 10 years)

Historical Dataset of Satellite Imagery  
(for past 10 years)

CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE

## OUTPUT

1. Classification of Urban Wetlands/Water Bodies (Based on Typology, Size & Existing Condition)
2. Prioritization of Wetlands/Water Bodies for management.



### 1.2.1 CLASSIFICATION OF URBAN WETLANDS/WATER BODIES – NATIONAL WETLAND ATLAS, ISRO & MOEFCC

Modified National Wetland Classification system is used for wetland delineation and mapping comprising 19 wetland classes which are organized under a Level-III hierarchical system. Level-I has two wetland classes: inland and coastal, these are further bifurcated into two categories as: natural and man-made under which 19 wetland classes are suitably placed. (National Wetland Atlas, ISRO & MoEFCC, 2011)

**Wetland Classification System as per National Wetland Atlas, March 2011**

Inland Wetlands		Coastal Wetlands	
Natural	Man-Made	Natural	Man-Made
Lake Ox-Bow Lake/Cut-off Meander High altitude wetlands Riverine Wetland Waterlogged River/Stream	Reservoir/ Barrage Tank/Pond Waterlogged Salt Pan	Lagoon Creek Sand/Beach Intertidal Mud Flats Salt Marsh Mangrove Coral Reef	Salt Pan Aquaculture Pond

Source: NWIA, ISRO, 2011

Note: Please refer to annexure for imagery on wetland categories and glossary section for wetland definitions.

### 1.2.2 FORMAT FOR WETLAND CLASSIFICATION SYSTEM IN URBAN AREAS

Name of Wetland/ Water Body	Area in Ha.	Depth of Wetland/ Water Body (in meters)	Type		Status (Existing Condition)						Remarks (Others)	
			Natural	Man Made	Discharge of domestic and Industrial Waste Water (m <sup>3</sup> /sec)	Dumping of municipal solid waste (Kgs)	Other non-point sources of pollution	Flow of heavy silt loads in water bodies from the catchment area	Degraded and not meeting the desired standards (CPCB)			
Wetland/ Water Body 1												
Wetland/ Water Body 2												
Wetland/ Water Body 3												
Wetland/ Water Body 4												
Wetland/ Water Body 5												

### 1.2.3 PRIORITIZATION OF URBAN WETLANDS

Based on the background study of various policies and programmes, the following parameter were considered suitable for the prioritization of urban wetlands for the management purposes. In view of the prevailing dynamic situation, urban local bodies may revise the priority list at an interval of 5 years based on ground water status, land use changes and changes in administrative boundary.

#### A. Hydrological Criteria

Physical parameters of the lake are: -

(i) Water bodies of size > 2ha are considered suitable for the management based on size and also based on potential of convergence with other scheme and programmes.

As per National Plan for Conservation of Aquatic Ecosystems (NPCA), April 2019, Wetlands/ Water body located within urban, peri-urban and semi-urban areas of size  $\geq 5$  Ha is proposed for inclusion in its programme.

Water bodies having minimum 5 ha in rural area and urban water bodies with water spread area between 2ha to 10ha will be eligible for inclusion under Repair, Renovation and Restoration (RRR) of Water Bodies Under PMKSY Scheme, June 2017.

(ii) Water body depth (maximum depth) > 3 m (at its peak level)

#### B. Scientific Criteria

1. The water body is justifiably prioritized by the concerned Urban Local Bodies (ULBs) or if the water body is highly degraded and cannot be put to its traditional use (drinking water source, dhobi ghat, aquaculture, etc.), primarily due to pollution resulting from:

- Discharge of domestic and industrial waste water into the water body
- Dumping of municipal solid waste
- Other non-point sources of pollution
- Flow of heavy silt loads in water-bodies from the catchment area.

2. The water body is degraded and not meeting the desired standards. In the absence of specific water quality criteria developed in respect of water bodies, for the present Designated Best Use criteria for surface waters for bathing quality as given by Central Pollution Control Board (CPCB) shall be the target for lake water quality.

#### Designated Best Use Criteria for Surface Waters

Designated Best Use	Class of Criteria	Criteria
<b>Drinking Water Source without conventional treatment but after disinfection</b>	A	1. Total Coliform Organism MPN/100 ml shall be 50 or less. 2. pH between 6.5 to 8.5 3. Dissolved Oxygen @6ml/l or more. 4. Biochemical Oxygen Demand: 5 days @20°C should be 3mg/l or less.
<b>Outdoor Bathing (Organized)</b>	B	1. Faecal Coliform Organism MPN/100ml shall be 2500 (max permissible) or 1000 (desirable). 2. pH between 6.5 to 8.5 3. Dissolved Oxygen @ 5mg/l or more. 4. Biochemical Oxygen Demand: 5 days @20° C should be 3mg/l or less.

Designated Best Use	Class of Criteria	Criteria
<b>Drinking water source after conventional treatment and disinfection</b>	C	<ol style="list-style-type: none"> <li>1. Total Coliform Organisms MPN/100ml shall be 5000 or less.</li> <li>2. pH between 6 to 9</li> <li>3. Dissolved Oxygen 4mg/l or more</li> <li>4. Biochemical Oxygen Demand: 5 days @20° C 3mg/l or less.</li> </ol>
<b>Propagation of Wildlife and Fisheries</b>	D	<ol style="list-style-type: none"> <li>1. pH between 6.5 to 8.5</li> <li>2. Dissolved Oxygen @4mg/l or more</li> <li>3. Free Ammonia @1.2 mg/l or less.</li> </ol>
<b>Irrigation, Industrial Cooling, Controlled Waste Disposal</b>	E	<ol style="list-style-type: none"> <li>1. pH between 6.0 to 8.6</li> <li>2. Electrical Conductivity at 25°C micro mhos/cm Max.2250</li> <li>3. Sodium absorption Ratio Max. 26 mg/l</li> <li>4. Boron Max. 2mg/l.</li> </ol>

Source: CPCB

CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE

# 1.3

## IDENTIFICATION OF ECOSYSTEM SERVICES OF URBAN WETLANDS/ WATER BODIES

The ecosystem services of urban wetlands/water bodies are to be identified through local stakeholder surveys. The ecosystem services include Provisioning Services, Regulating Services, Cultural Services and Supporting Services. The ecosystem services of wetlands have already been very well documented in RAMSAR Wetland Management Report and Millennium Development Goals which forms the basis of ranking the services. Services are ranked based on their availability. The total ecosystem services value is presented in the matrix format in the form of scores for each services i.e., Provisioning, Regulating, Cultural and Supporting.



## INPUT

**Provisioning Services**

- Food
- Fresh Water
- Fiber & Fuel
- Biochemical Products
- Genetic Material

**Regulating Services**

- Climate Regulation
- Hydrological Regime
- Pollution Control & Detoxification
- Natural Hazard Mitigation
- Erosion Protection

**Cultural Services**

- Spiritual & Inspirational
- Educational
- Recreational
- Aesthetics

**Supporting Services**

- Biodiversity
- Soil Formation
- Nutrient Cycling
- Pollination

CATCHMENT AREA

The following table will help in identification of ecosystem services in urban wetlands and rank them based on their services provided.

**1. Provisioning Services (14 points)****Food (1 point each)**



Fish



Fruits &amp; Grains

**Fiber & Fuel (1 point each)**



Fuelwood



Timber

ZONE OF INFLUENCE

**Fresh Water (1 point each)**



Water Storage



Irrigation



Drinking Water



Fodder



Peat



Livestock Rearing

ON-SITE

**Biochemical Products (1 point)**

Extraction of materials from biota

**Genetic Material (1 point each)**

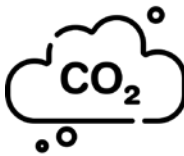
Medicine



Ornamental Species



Genes for resistance to plant pathogens

**2. Regulating Services (10 Points)****Climate Regulation (1 point each)**

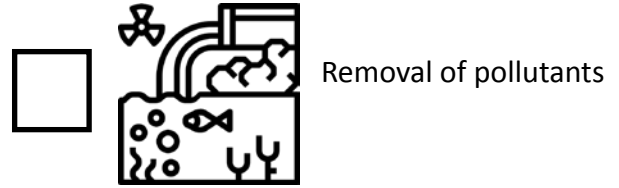
Regulation of Greenhouse gases



Regulation of temperature/ micro-climate

**Hydrological Regime (1 point each)**Groundwater recharge  
and DischargeStorage of water for  
agricultureStorage of water for  
industry

### Pollution Control & Detoxification (1 point each)



CATCHMENT AREA

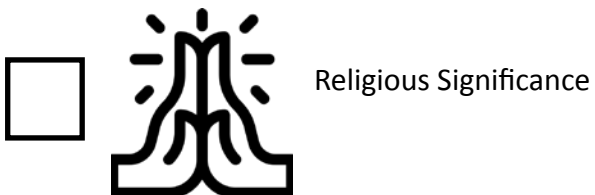
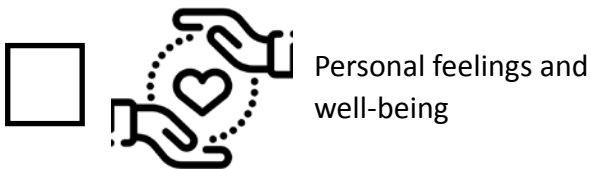
### Natural Hazard Mitigation (1 point each)



ZONE OF INFLUENCE

### 3. Cultural Services (6 Points)

#### Spiritual & Inspirational (1 point each)



ON-SITE

#### Recreational (1 point each)



#### Educational (1 point)



#### Aesthetics (1 point)






**4. Supporting Services (5 Points)**

**Biodiversity (1 point)**

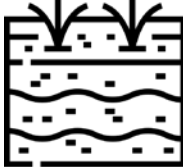
 Habitats for residents or transient species

**Nutrient Cycling (1 point)**

 Storage, recycling, processing and acquisition of nutrients

**Soil Formation (1 point each)**

 Sediment Retention

 Accumulation of organic matter

**Pollination (1 point)**

 Support for pollinators

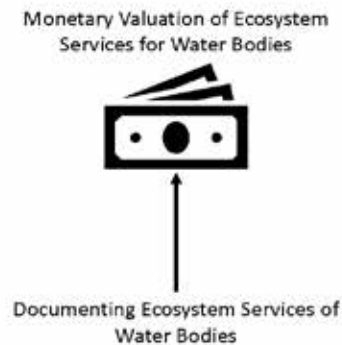
Ranking of Ecosystem Services of Urban Wetlands/Water Bodies is given as:

Category	Score
Poor	0-9
Good	10-18
Very Good	19-27
Excellent	28-36

**OUTPUT**

1. Ecosystem services matrix and ranking of urban wetlands/water bodies based on parameters present.
2. Monetary evaluation of urban wetlands/water bodies (market pricing method)

**1.3.1 MONETARY VALUATION OF ECOSYSTEM SERVICES OF URBAN WETLANDS/WATER BODIES**

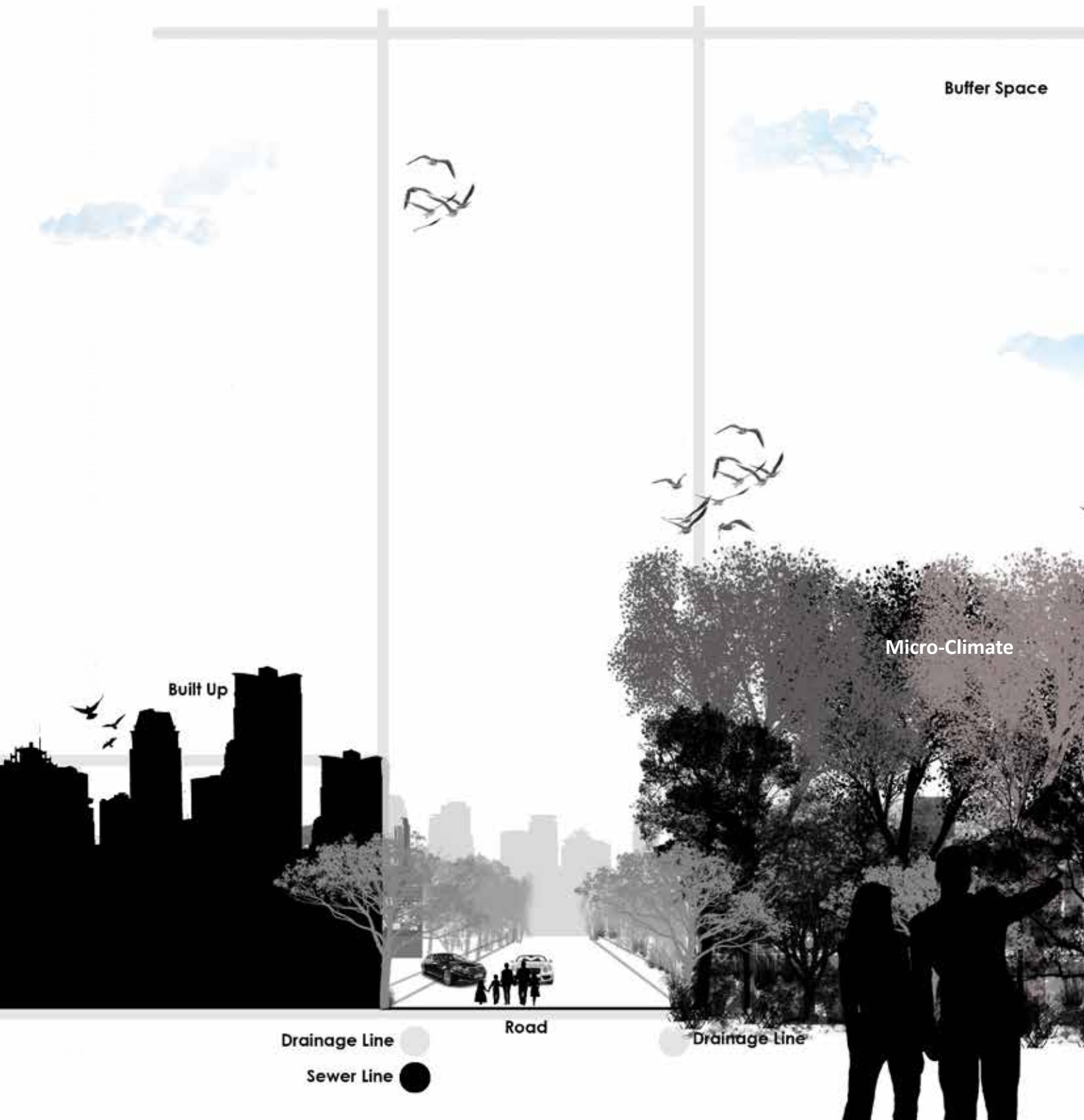


CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE

# INTERACTION BETWEEN URBAN AREA & WETLAND/WATER BODIES



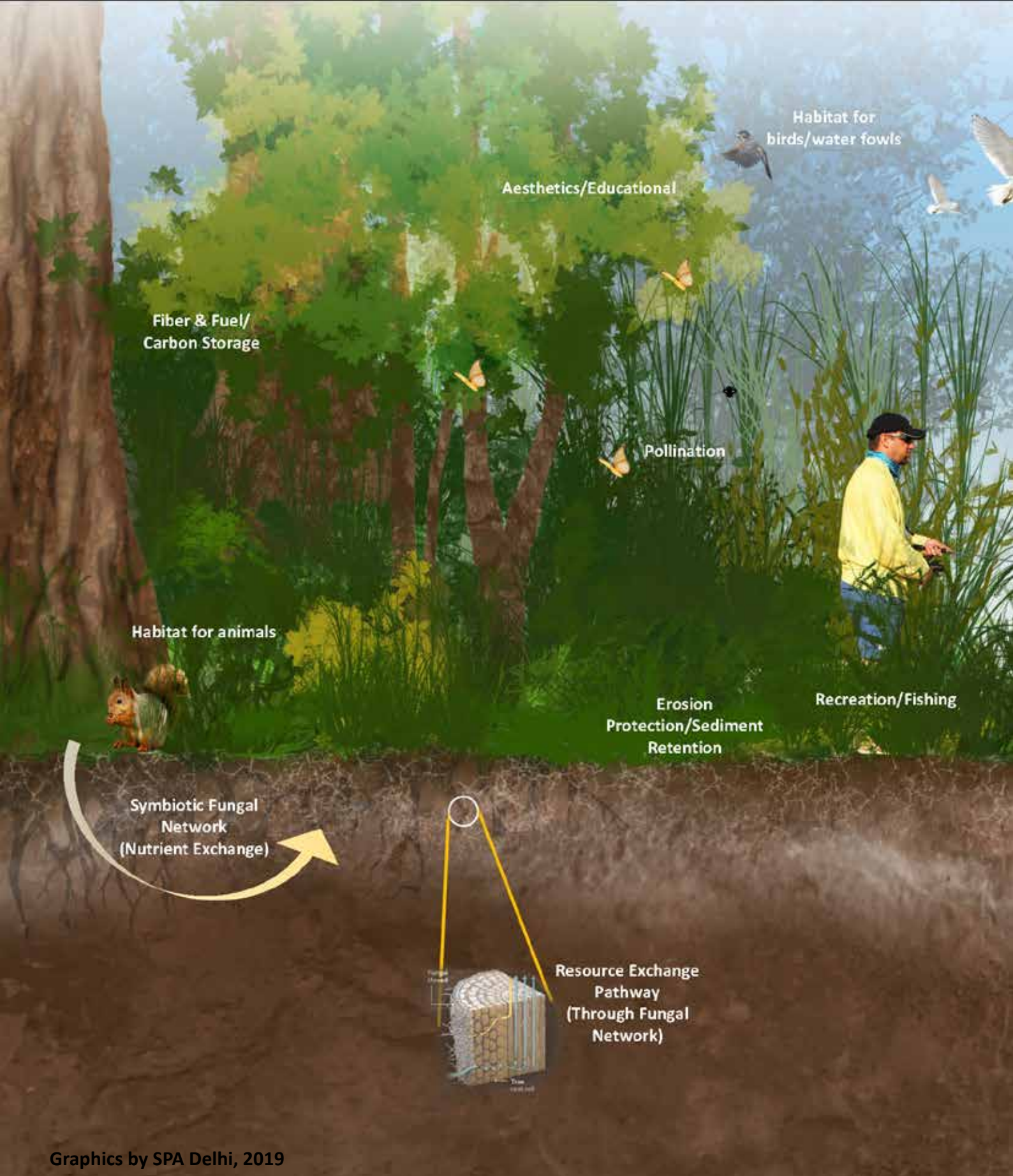


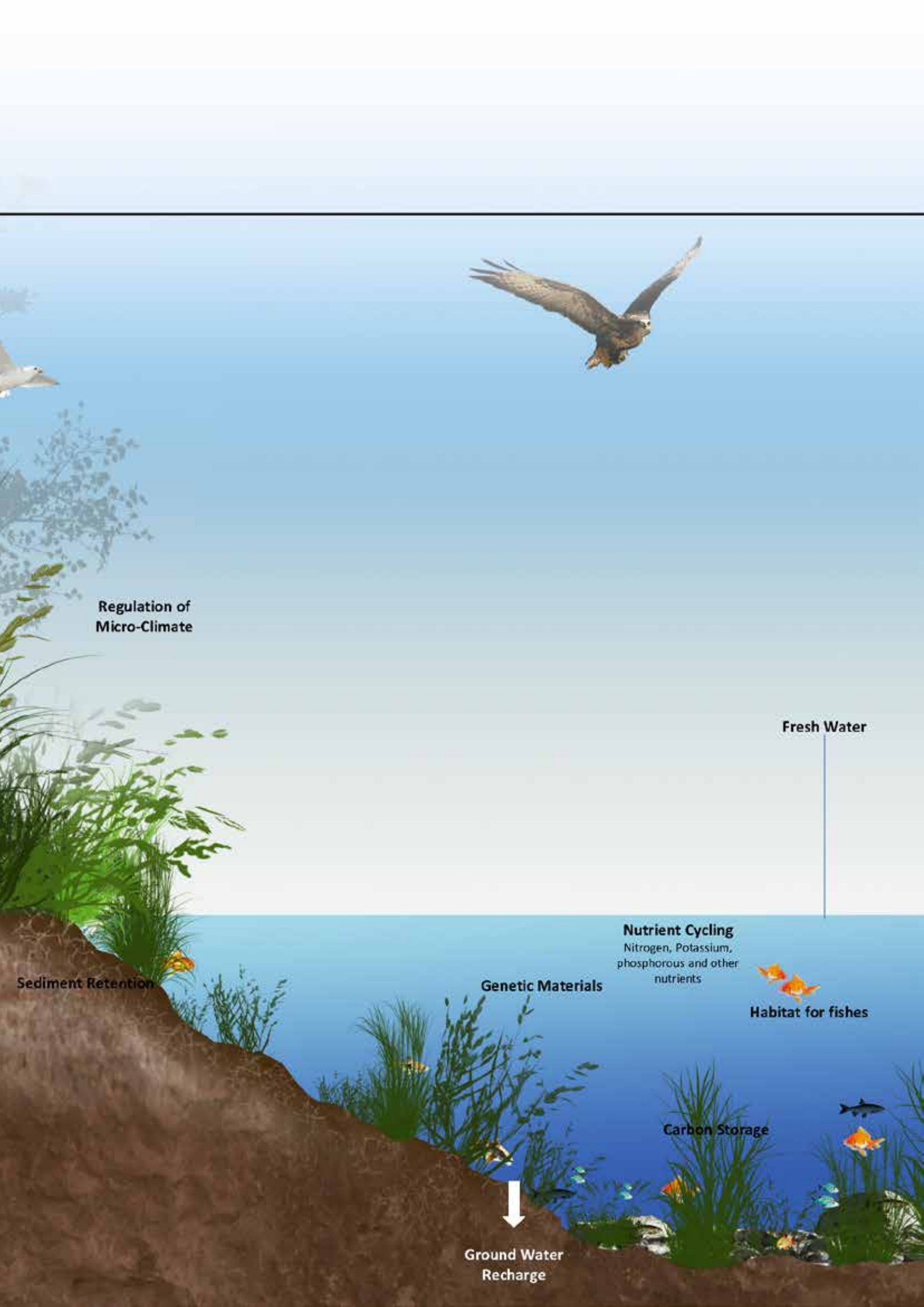
Urban Wetland/Water Body

Biodiversity

Recreation

# ECOSYSTEM SERVICES OF URBAN WETLAND/WATER BODIES





**Regulation of  
Micro-Climate**

**Fresh Water**

**Sediment Retention**

**Genetic Materials**

**Nutrient Cycling**  
Nitrogen, Potassium,  
phosphorous and other  
nutrients

**Habitat for fishes**

**Carbon Storage**

↓  
**Ground Water  
Recharge**

### 1.3.2 ECOSYSTEM SERVICES AND MONETARY VALUATION TECHNIQUE

Services	Parameter	Indicators	Quantification Criteria	Market Pricing Technique
ON-SITE	Food	Production of fish	Quantity of fish & fish products produced in tons or Kgs	Price of fish per kg
		Production of fruits and grains	Quantity of fruits and fruit products produced in tons or Kgs	Price of fruits and fruit products per kg
	Fresh Water	Storage and retention of water	Volume of water storage in MLD	Price of water harvesting structure required to maintain ground water level. (1m <sup>3</sup> increase in ground water level)
		Provision of water for irrigation	Volume of water supplied for irrigation in MLD	Price of water/construction of bore well to meet crop water requirement for irrigation purposes.
		Provision of water for drinking	Volume of water supplied for drinking water purpose in MLD	Opportunity cost for obtaining private tankers for drinking water: Cost of private water supply per litre.
	Fiber and Fuel	Production of timber	Quantity of timber produced in tons or Kg	Should not be promoted for use and exploitation of resource
		Production of fuelwood	Number of trees, plants, etc.	
		Production of peat	Area of peat land in Ha.	Opportunity cost for obtaining LPG gas and other alternatives.
		Production of fodder	Area of pasture land in Ha.	Cost of fodder per kg
		Livestock rearing	No. of cattle dependent on wetland/water bodies	Cost of products from livestock rearing: eggs, meat, milk, etc.
	Biochemical Products	Extraction of materials from biota	Minerals extracted from wetland in Ha.	-
	Genetic Material	Medicine	Area covered under medicinal plants in Ha.	Cost of ayurvedic and homeopathy medicines obtained from wetlands
		Genes for resistance to plant pathogens		
		Ornamental species	Area covered under ornamental species in Ha.	Cost of ornamental species: lotus, ornamental fish for aquariums, etc.
	Regulating	Climate Regulation	Regulation of greenhouse gases	Area covered under wetland including buffer space in Ha.
Regulation of temperature/micro-climate			Temperature variations around the wetland (°C)	Opportunity cost for usage of ACs/Fans/ Other electrical appliances to regulate temperature.

CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE

Services	Parameter	Indicators	Quantification Criteria	Market Pricing Technique
Regulating (Cont.)	Hydrological Regime	Ground water recharge and discharge	Volume of water recharge in MLD	Opportunity cost for construction of percolation tanks, dams, storage tanks, etc.
	Hydrological Regime (Cont.)	Storage of water for agriculture	Wetland/Water body use for agriculture	Opportunity cost for setting up bore well/ cost of municipality bore well water supply for irrigation.
		Storage of water for industry	Wetland/Water body use for industry	Should not be promoted for use in industrial units/estates
	Pollution control and detoxification	Nutrient Retention	Nutrient (Nitrogen and Phosphorous) in wetlands (in mg/l)	Cost of bioremediation, aeration, denitrification, etc., facilities for pollutant and nutrient control.
		Removal of excess nutrients		
		Removal of pollutants		
	Erosion Protection	Retention of soils and prevention of structural changes (such as erosion, bank slumping and so on)	Area of vegetated buffer space around wetland in Ha.	Cost of desilting wetlands/water bodies
	Natural Hazard	Flood Control	Area under wetlands/ water bodies including buffer in Ha.	Financial estimates of flood damage reduction due to wetlands/ponds on infrastructure & other facilities.
		Storm Protection	Area under vegetated buffer space in Ha.	Financial estimates of storm damage reduction due to wetlands/ponds on infrastructure & other facilities.
	Cultural	Spiritual & Inspirational	Personal feelings and well-being	Investment made by individuals for wetland/ water bodies conservation; payment for ecosystem services
Religious Significance			Existing cultural activities within wetland	Services and benefits accrued by informal vendors
Recreational		Opportunities for tourism	Availability of sustainable tourism infrastructure	Revenue collection from tourism services provided in relation ecotourism.
		Opportunities for recreational activities	Area under green cover in Ha.	Cost of development of recreational space to meet open space requirement per person in city.

CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE

Services	Parameter	Indicators	Quantification Criteria	Market Pricing Technique
<b>Cultural (Cont.)</b>	Aesthetics	Appreciation of natural features	Type of vegetation and habitats present	Revenue generated from promotions
	Educational	Opportunities for formal and informal education and training	Ecological Character of urban wetland/water bodies	Cost for the maintenance of ecological character of urban wetlands/ water bodies
<b>Supporting</b>	Biodiversity	Habitats for residents and transient species	Type of species present in urban wetlands/ water bodies	Opportunity cost for restoration activities to maintain and enhance habitats for species
	Soil Formation	Sediment retention	Chemical properties of soil – pH, Nitrates, Ammonia, Phosphates, etc.	Cost of bioremediation, aeration, denitrification, etc., facilities for pollutant and nutrient control.
		Accumulation of organic matter	Total organic carbon present in soil	–
	Nutrient Cycling	Storage recycling, processing and acquisition of nutrients	Regulation of nutrients: pre-monsoon to post-monsoon.	–
	Pollination	Support for pollinators	Key species available: dragon fly, frogs, etc.	Cost for maintenance of parks for pollinators – butterfly parks, biodiversity parks, etc.
Source: Collated from RAMSAR Wetland Handbook and Various other sources by SPA Delhi				

CATCHMENT AREA

ZONE OF INFLUENCE

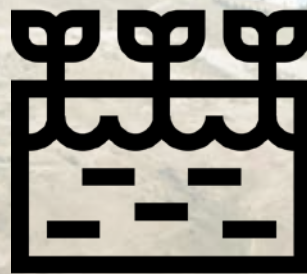
ON-SITE



# 1.4

## GROUND WATER ASSESSMENT

Watershed with well defined hydrological boundaries is an appropriate hydrological unit for ground water resource estimation. This will include delineation of sub-areas in the assessment unit, season wise-assessment of ground water resources, estimation of ground water draft, estimation of ground water recharges during monsoon and non-monsoon season. This will help us in identifying the stage of ground water development. The ground water assessment exercise should be carried out by Central Ground Water Board/Authority and Hydrologists.



# INPUT



**Ground Water Draft at identified ground water assessment unit for pre-monsoon and post monsoon.**

- Domestic Use
- Industrial Use
- Agricultural Use



**Ground Water Availability**

- Pre-Monsoon
- Post-Monsoon

## Layers for Ground Water Assessment

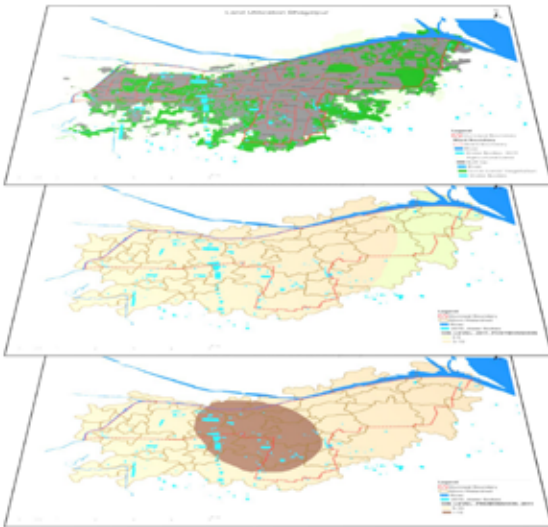
Consultation with CGWB, CGWA & Hydrologists



CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE



CGWB GEC-97 & 2015 Report



Land Cover

Post-Monsoon Ground Water Level

Pre-Monsoon Ground Water Level

### 1.4.1 PARAMETERS REQUIRED FOR GROUND WATER ASSESSMENT

Parameters	Units
<b>Monsoon Season</b>	
Rainfall (May to September)	mm
Area of Watershed (Assessment Unit), A	Sq.m
Area of River/ Flood Plain	Sq.m
Area of Water Bodies	Sq.m
Area of Agricultural Land	Sq.m
Area of Built Up	Sq.m
Area for computation of recharge	Sq.m
Rise in water level in monsoon season	meters
Gross Ground Water Draft (Irrigation)	Cubic meters
Annual Gross Ground Water Draft (Domestic and Industrial Use)	Cubic meters
Gross Ground Water Draft Monsoon Season	Cubic meters
Specific Yield (based on soil type)	Percent
Recharge from ground water irrigation in the area	Cubic meters
Recharge from tanks and ponds	Cubic meters
Recharge from Flood Plain/River (if exists)	Cubic meters
Recharge from Rainfall in Monsoon Season	Cubic meters
Recharge from Rainfall Using Infiltration Method	Cubic meters
Percent Deviation, PD	Percent
Recharge from rainfall in normal monsoon	Cubic meters
Total Recharge during Monsoon Season	Cubic meters
<b>Non-Monsoon Season</b>	
Rainfall	mm
Area of River	Sq.m
Area of Water Bodies	Sq.m
Area of Agricultural Land	Sq.m
Area of Built Up	Sq.m
Area for Computation of Recharge	Sq.m
Recharge from Rainfall infiltration	Cubic meters
Recharge from ground water irrigation in the area	Cubic meters
Recharge from tanks and ponds	Cubic meters

CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE

### 1.4.1 PARAMETERS REQUIRED FOR GROUND WATER ASSESSMENT (CONT.)

CATCHMENT AREA	Recharge from Flood Plain/River	Cubic meters	
	Ground Water Draft for Irrigation Purpose	Cubic meters	
	Ground Water Draft for Domestic and Industrial Purpose	Cubic meters	
	Gross Ground Water Draft Non-Monsoon	Cubic meters	
	Total Recharge in Non-Monsoon Season	Cubic meters	
	Annual Ground Water Recharge		
	Total Ground Water Availability	Cubic meters	
	Unaccounted Natural Discharges in Non-Monsoon Season	Cubic meters	
	Existing Ground Water withdrawal for various uses and potential for future development	Cubic meters	
	Annual water requirement for domestic and industrial use, Present Year	Cubic meters	
	Annual water requirement for domestic and industrial use, Projected Year	Cubic meters	
	ZONE OF INFLUENCE	Net annual Ground Water availability for irrigation, Present Year	Cubic meters
		Existing Gross Ground Water Draft for Domestic and Industrial Water Supply	Cubic meters
		Stage of Ground Water Development	Percent
Source: CGWB Ground Water Resource Estimation Committee Report, GEC-97 & GEC-2015, October 2015			

### OUTPUT

1. Identification of stage of ground water development.

# 1.5

## LAND SUITABILITY FOR GROUND WATER RECHARGE

Once the stage of ground water development is well established from ground water assessment, the land suitability for ground water recharge can be undertaken based on whether it is in semi-critical, critical or over-exploited stage.

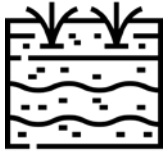
For this purpose, manual on artificial recharge of ground water by CGWB is followed which establishes the steps for establishing the need, estimation of sub-surface storage capacity of aquifers, prioritization of areas for artificial recharge, availability of source water and suitability of area for recharge.

The process of preparation of land suitability map requires information on ground water depth (pre-monsoon and post-monsoon) to identify the areas that have declining trend. Drainage density is a measure of how well the areas are drained by water flow and thus becomes a good parameter in land suitability analysis. The prioritization of areas for recharge includes all available open spaces, agricultural land and scrub land. The three parameters i.e., ground water depth (pre-monsoon), drainage density and open areas/agricultural land/scrub land forms a major input for land suitability analysis for ground water recharge.

The suitability of area for recharge is further assessed to obtain the final output. Parameters such as climatic condition, topographic, soil, land use and hydrogeological conditions are important factors controlling the suitability of an area for recharge. The land suitability assessment for ground water recharge exercise should be carried out by Central Ground Water Board/Authority and Hydrologists. The process and procedure for land suitability assessment for ground water recharge should be followed as per Manual on Artificial Recharge of Ground Water, September 2007.



## INPUT



### Ground Water Depth

- Pre-Monsoon
- Post-Monsoon



### Drainage Density (Areas Well Drained)



### Natural Areas (as per existing land use land cover)

- Open Areas
- Agricultural Land
- Scrub Land

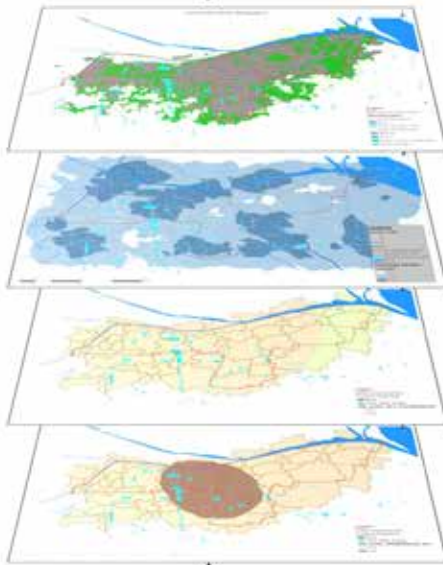
CATCHMENT AREA

## Layers of Land Suitability Assessment for Ground Water Recharge

Consultation with CGWB, CGWA & Hydrologists



ZONE OF INFLUENCE



ON-SITE

CGWB Manual on Artificial Recharge of Ground Water



Land Cover

Drainage Density

Post-Monsoon Ground Water Level

Pre-Monsoon Ground Water Level

## OUTPUT

1. Suitable areas for ground water recharge and rain water harvesting
2. Rechargeable volume of water

# 1.6

## IMPACT OF URBAN DEVELOPMENT TRENDS/ MASTER PLAN PROVISIONS ON IDENTIFIED WETLANDS/WATER BODIES

This step deals with identification of drivers of changes in hydrological regime of wetlands/water bodies. Assessment of impact is carried out at the level of 'zone of influence' of wetlands/water bodies, 'catchment of Wetlands/Water Bodies' and within '200 meter buffer area' of wetlands/water bodies. This will help in identification of all the possible drivers and impacts on wetlands/water bodies. The assessment will provide a basis for formulating synergy between wetlands/water bodies and urban development within the city.

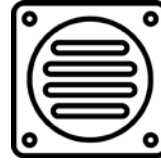


## INPUT



### Imagery/Maps

- Historical Dataset (Satellite Imagery of city for past 10 years)
- Existing Land Use Map
- Proposed Land Use Map
- Flood Hazard Zone/Areas flooded frequently



### Infrastructure Data

- Drainage Network
- Sewerage Network

CATCHMENT AREA

Layers for Assessment of Impact of Urban Development Trends/Master Plan Provisions on Identified Wetlands

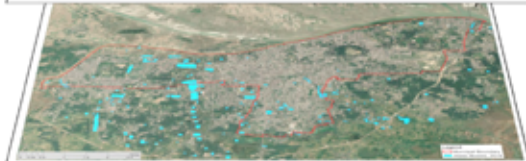
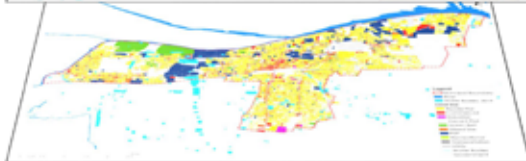
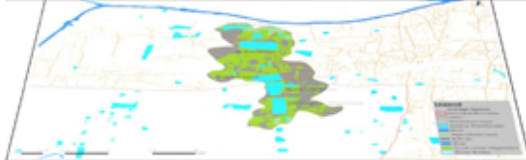
Identification of Critical Urban Wetlands/Water Bodies based on Urban Development



Estimation of Water Demand & Waste Water Generation and Solid Waste Generation



ZONE OF INFLUENCE



ON-SITE

Flood Prone Area  
(Based on Historical Flood Events & Flood Plain Demarcation)

Infrastructure  
(Drainage & Sewerage Network)

Natural Resources  
(Existing & Proposed Land Use)

Historical Dataset of Satellite Imagery  
(for past 10 years)



## OUTPUT

1. Criticality of Water Bodies/Wetlands with respect to urban development trends/master plan provisions & Ecosystem Services. (Ranking based in impact of urban development on identified wetlands/water bodies and ecosystem services of water bodies)
2. Establishing future scenarios

### 1.6.1 FORMAT FOR ASSESSMENT OF IMPACTS OF URBAN DEVELOPMENT TRENDS ON WETLANDS/WATER BODIES

Sl. No.	Parameters (within catchment area/zone of influence of urban wetlands/water bodies)	Units
1	Area of Catchment/Zone of Influence	Sq. Kms
2	Population	Numbers
3	Population Density	pph
4	Total area under Built-Up	Sq. m
5	Total area under agricultural land use/plantation	Sq. m
6	Total area under scrub land/grassland/vegetation	Sq. m
7	Total area under water bodies	Sq. m
8	Total area under river	Sq. m
9	Built-Up/Open Space ratio	-
10	Depth of water body	meters
11	Water level fluctuation (Pre-Monsoon & Post Monsoon)	meters
12	Storage capacity of water bodies	Cubic meters
13	Annual recharge potential of water bodies	Cubic meters
14	Category: Natural or Man-made	-
15	Source of water: Rainfall/ Ground water seepage/ Catchment runoff/ Direct or indirect flow from river or stream or creek)	-
16	Total Water Demand for domestic use (annually)	lpcd
17	Total water supply for domestic use by municipality (annually)	lpcd
18	Total solid waste generation (annually)	Kgs
Sl. No.	Parameters (within 10m & 100m buffer area)	Units
19	Total built up area within 10m buffer area of water body	Sq. m
20	Open space within 10m buffer area of water body	Sq. m
21	Built-Up/Open Space ratio within 10m buffer area of water body	-
22	Total built up area within 100m buffer area of water body	Sq. m
23	Open space within 100m buffer area of water body	Sq. m
24	Built-Up/Open Space ratio within 100m buffer area of water body	-
Criticality based on total normalization values: (3+9+16+18+21+24)		
Note: Normalization of the values are done to bring all the parameters at same scale		

CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE

### 1.6.1 FORMAT FOR ASSESSMENT OF IMPACTS OF URBAN DEVELOPMENT TRENDS ON WETLANDS/WATER BODIES (CONT.)

Criticality	Score
Low	< 1.5
Medium	1.5-3
High	> 3

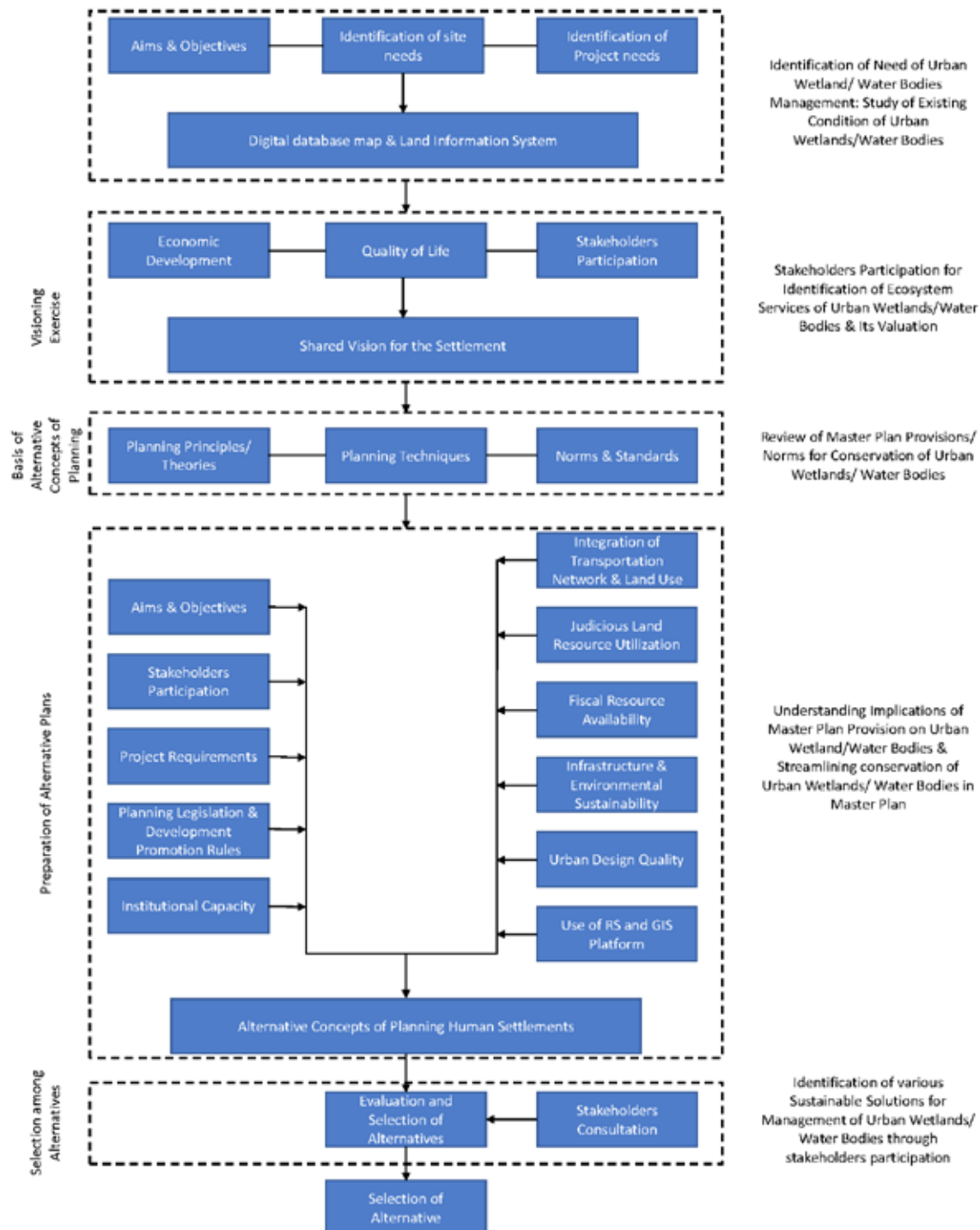
Note: Criticality indicators based on scores can be adjusted with scientific output and proper reasoning.

### 1.6.2 MAINSTREAMING MANAGEMENT OF URBAN WETLAND/WATER BODIES IN DEVELOPMENT PLAN FORMULATION PROCESS

CATCHMENT AREA

ZONE OF INFLUENCE

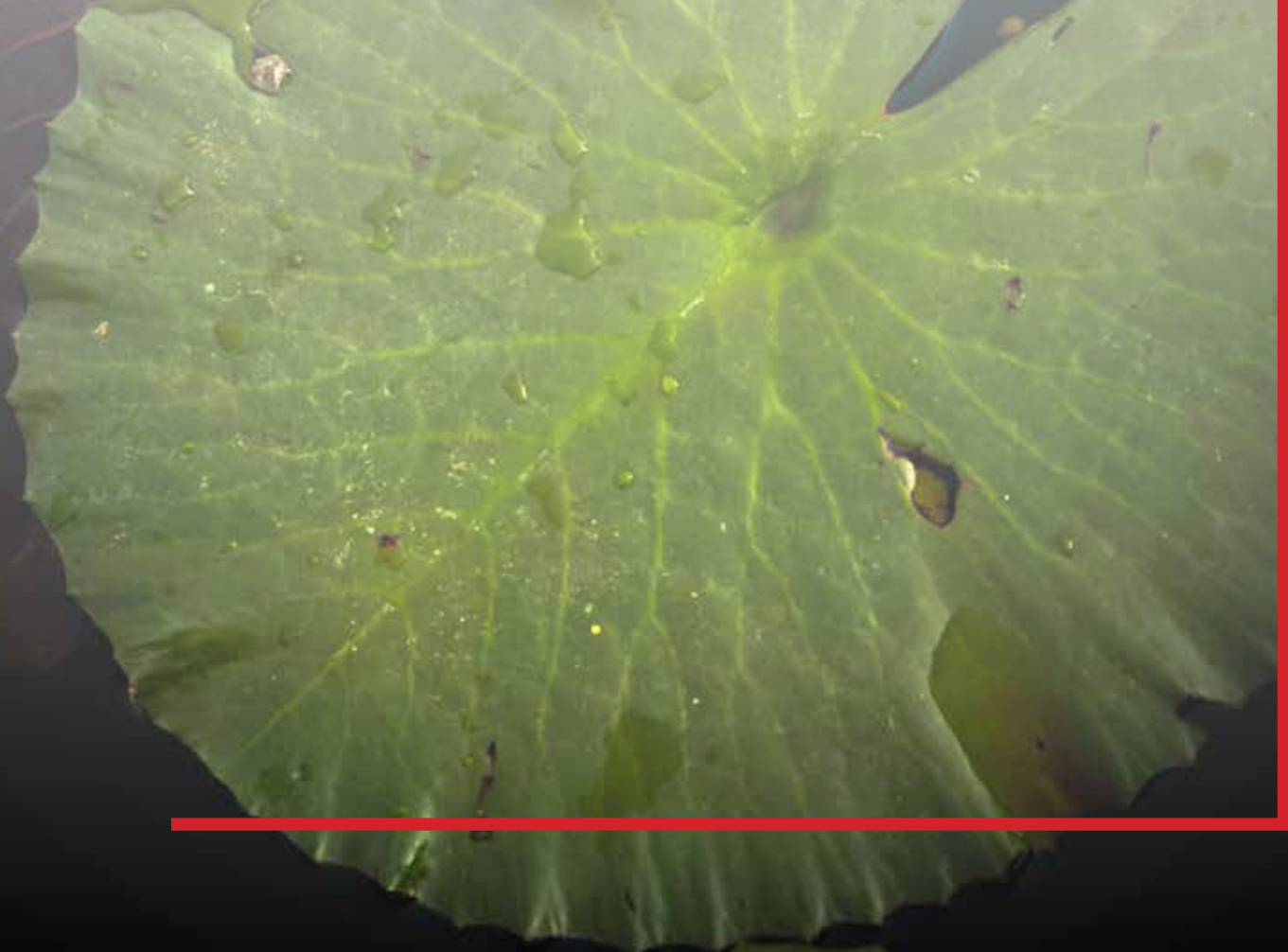
ON-SITE



# STAGE II

The Stage II is divided into 2 chapters which will guide the urban local bodies and stakeholders in preparation of action plan for conservation of urban wetlands/water bodies and preparation of management plan based on actions identified.

After establishing the criticality of urban wetland/water bodies based on hydrogeological conditions and urban development trends/master plan provisions along with ecosystem services of urban wetlands/water bodies, the next step is to prepare action plan for tackling the issues of each individual identified critical urban wetlands/water bodies. A list of activities have been identified in the toolkit and additional actions/inputs can also be added after carrying out proper scientific studies for management of urban wetlands/water bodies. After the identification of actions, management plan for the conservation of urban wetlands/water bodies is formulated enlisting the action plans, governance, budget, operation & maintenance and monitoring mechanism. A list of schemes have also been listed out in the Toolkit for convergence of schemes along with existing norms/guidelines to help the urban local bodies and stakeholders identify synergy between urban development and management of urban wetlands/water bodies. Also a list of best practices on management of urban wetlands/water bodies covering various cities in India have also been provided in the Toolkit (see Annexures) to guide the urban local bodies and stakeholders.



# 2.1

## PREPARATION OF ACTION PLAN FOR CONSERVATION OF URBAN WETLANDS/ WATER BODIES

The action plan should be developed in two steps. The first step should be a comprehensive listing of activities which are required to be implemented such as wetland/water bodies boundary mapping and delineation or removal of encroachment at site level; afforestation and aided regeneration or small scale engineering measures (check dams, etc.) at catchment level; selective dredging and desilting or interception, diversion and treatment of point sources of pollution, balancing water allocation for human and ecological purposes for water management; maintenance of breeding and spawning grounds for key species, management of invasive species; setting regulatory regimes, development of monitoring and evaluation system at institutional level, etc.

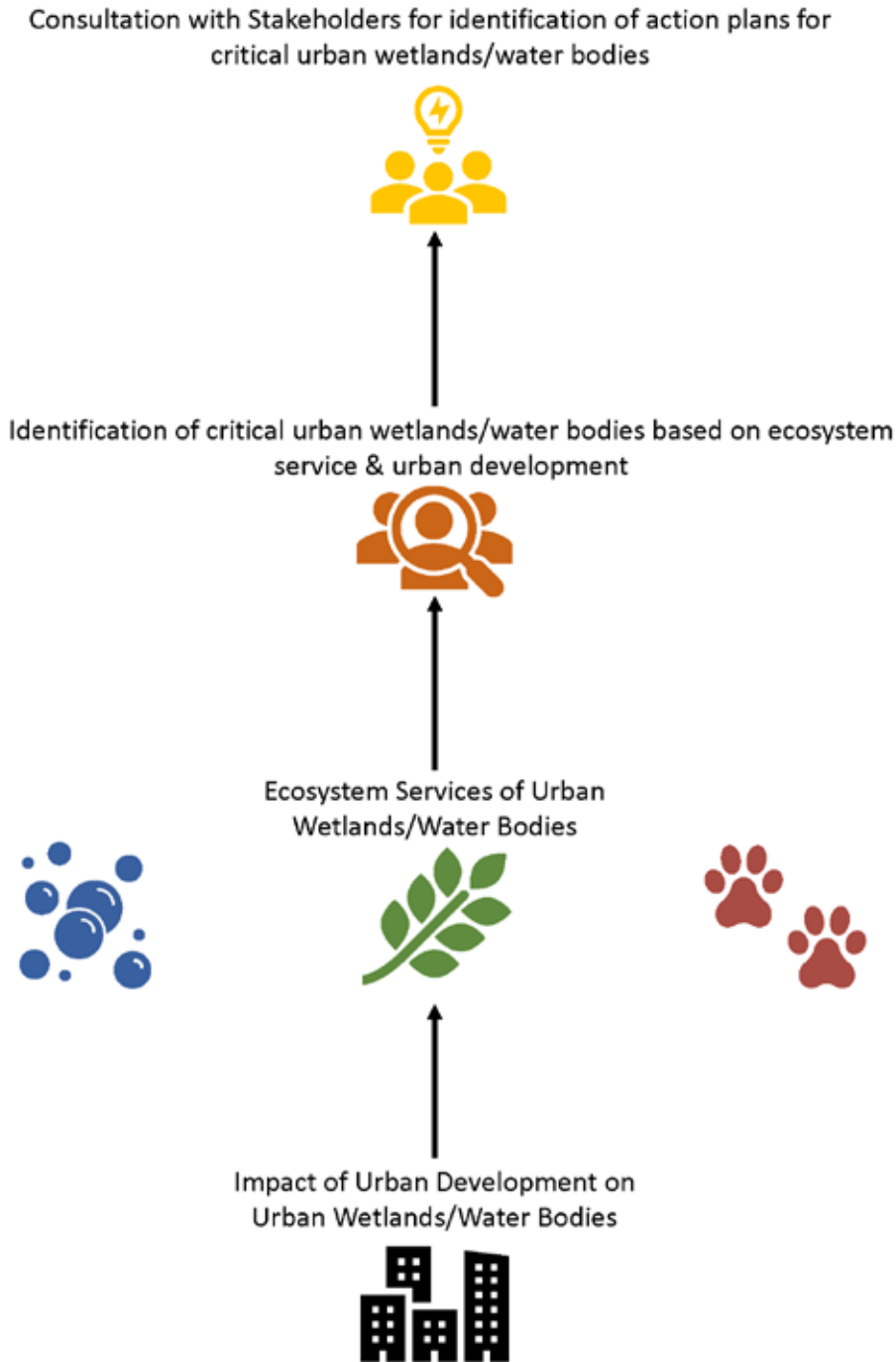


**INPUT**



**Critical Wetlands/water bodies based on urban development and Ecosystem Services**

**Layers for Preparation of Action Plan for Conservation of Identified Urban Wetlands/Water Bodies**



CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE

## GENERIC LISTING OF ACTIVITIES FOR MANAGEMENT OF WETLANDS AND ITS IMPLICATION IN MASTER PLANS

	Management Plan Component	Activities	Key Considerations	Implications on Master Plan
CATCHMENT AREA  ZONE OF INFLUENCE	Boundary Delineation and Demarcation	Boundary mapping and delineation	Site boundaries should be established with reference to inundation regimes, soil conditions and vegetation types. Landscape connectivity should also be considered when aquatic ecosystems exist in patches. All activities should be completed within the first year.	Demarcation of water bodies and listing it as a separate land use to properly manage and conserve the urban water bodies
		Removal of encroachments	Boundaries should be notified and legally protected wherever possible. All activities should be completed within the first year.	Demarcation of slums, solid waste management strategies and establishment of proper drainage and sewerage network; identification of slum improvement plans in Master Plan
		Shoreline management	Mostly required for wetlands in urban and peri-urban setting. For stabilizing bunds of wetlands, naturalization of slopes using vegetative measures should be preferred. Development of promenade for urban lakes can be included based on an evaluation of natural drainage and shoreline ecosystem niches.	A dedicated chapter on environment tackling all environmental components should be well defined in Master Plan.
ON-SITE	Catchment Conservation	Afforestation and aided Regeneration	Catchment conservation plans should be developed at watershed scales and based on Joint Forest Management approaches. Only native species should be used for forestry operations. Pilot watershed should be periodically monitored to assess changes in soil moisture regimes.	Social Infrastructure component should include the component of water bodies and how these water bodies can serve the city.

Management Plan Component	Activities	Key Considerations	Implications on Master Plan
<b>Catchment Conservation (Cont.)</b>	Afforestation and aided Regeneration	Livelihood interventions for catchment communities aimed at reducing dependence on wood as an energy source should be included as appropriate.	Water Balancing should be well defined in order to manage the water issues of the city incorporating all the available resources.
	Small scale engineering measures (gully plugging, check dams, gabion structures etc.)	Community participation in design, implementation and post project maintenance of structures should be ensured.	
	Selective dredging and desilting to improve hydrological connectivity	Dredging to be used only selectively, and be based on assessments of bathymetric profile and species interactions. For inflowing channels, dredging can be used to improve water inflow.	
	Interception, diversion and treatment of point sources of pollution	Mostly recommended for wetlands in the urban and peri-urban setting. Provision of comprehensive sanitation and safe drinking water coverage to communities living around the aquatic ecosystem should be ensured. Engineering (STPs) as well as biological options (constructed wetlands) should be evaluated for application. Planning for Operation and Maintenance expenses should be included for all engineering structures.	
	Construction and operation of hydraulic structures for maintenance of water regimes and flood control	For each significant structure, detailed environmental impact assessments should be carried out prior to construction.	

CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE

CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE

Management Plan Component	Activities	Key Considerations	Implications on Master Plan
<b>Catchment Conservation (Cont.)</b>	Balancing water allocation for human and ecological purposes	Environmental flows for wetlands, hydrological regimes of which are affected by hydraulic structures, should be assessed and implemented in consultation in water managers	
<b>Biodiversity Conservation</b>	Habitat evaluation and improvement	Until specifically desired, plantation of terrestrial plant species in wetlands should be avoided.	A Biodiversity Action/ Management Plan should be developed for every city and should be included as a core part of environment in Master Plan.
	Improvement and maintenance of migratory routes	Community groups should be involved in habitat monitoring and maintenance of migratory routes	
	Maintenance of breeding and spawning grounds for key species	Community groups should be involved in the maintenance of breeding and spawning grounds	
	Management of invasive species	A mix of mechanical and biological methods for controlling species invasion should be used. For plant invasive, economic utilization along with physical removal should be included.	
<b>Sustainable Resource Development and Livelihood Improvement</b>	Micro-enterprise development for reducing dependence on wetlands resources for livelihoods	Identification of micro-enterprise development options should be based on an assessment of community livelihoods, capacities, resources and market linkages.	Master Plans should highlight the economic base and potential in the city with respect to management of water bodies and other sectors.
	Sustainable fisheries development	Only capture based fisheries techniques should be promoted in natural wetlands. Options for improving culture fisheries in areas around wetlands may be included to reduce dependence on capture fisheries	



Management Plan Component	Activities	Key Considerations	Implications on Master Plan
<b>Sustainable Resource Development and Livelihood Improvement (Cont.)</b>	Sustainable agriculture development	Organic farming practices in immediate catchments should be included to minimize nutrient enrichment in wetland.	
<b>Institutional Development</b>	Setting regulatory regimes	Site regulation should be harmonized with national and State level regulations. Local customary self-regulation which supports maintenance of conservation values should be promoted	Master Plans should identify institutional arrangements for proper management and conservation of water bodies in environment section.
	Development of monitoring and evaluation system	Comprehensive monitoring and evaluation mechanism for hydrological, ecological, socio-economic and institutional features should be made a part of the management system Involvement of stakeholders in monitoring should be encouraged.	
	Communication and Outreach	Increasing awareness on values and functions of wetland should be made an integral part of the management plan.	
	Research	For each site, key research areas to support management needs should be identified and included in the management plan	
Source: Adapted from RAMSAR Wetland Management Guideline & NPCA Guideline of Wetland Management, April 2019			

CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE

## OUTPUT

Indicative actions to be undertaken for conservation of identified urban wetlands/water bodies:

- Interventions within catchment area
- Interventions within zone of influence – as per land uses
- Interventions on site

# 2.2

## PREPARATION OF MANAGEMENT PLAN FOR CONSERVATION OF URBAN WETLANDS/WATER BODIES

The Management Plan should define all the indicative actions, core and non-core activities to be undertaken along with a complete costing (activity wise) for the entire tenure of the plan using the existing norms of the State and central government, as may be the case. Year wise requirement of funds for various work/ activities, bar and PERT charts for the works/activities should be prepared.

For each of the activity, an analysis of ongoing development or conservation sector schemes should be done to assess the extent of funding that can be generated through convergence with these schemes.

Opportunities for private sector participation should also be identified.



**INPUT**

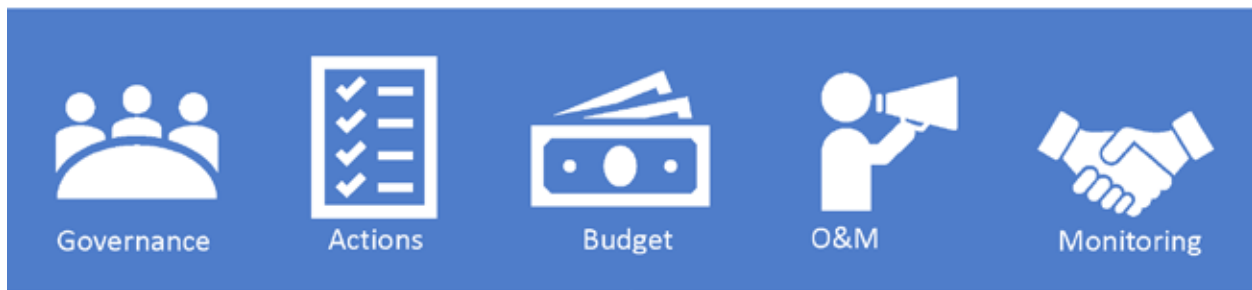


**Indicative actions to be undertaken for the conservation of identified urban wetlands/water bodies**

**Layers for Preparation of Management Plan for Conservation of Identified Urban Wetlands/Water Bodies**  
**Creating awareness among Urban Local Bodies & Stakeholders**



**Preparation of Management Plan for Identified Urban Wetlands/Water Bodies**



**Indicative actions for Identified Urban Wetlands/Water Bodies for Conservation**



CATCHMENT AREA

ZONE OF INFLUENCE

ON-SITE

**OUTPUT**

1. Management Plan outlining necessary Governance, Actions, Budget, Operation and Maintenance & Monitoring Mechanism
2. Convergence of Schemes.

# ANNEXURES

Annexure 1 – Categories of Wetland

Annexure 2 – Institutional Arrangements

Annexure 3 – Convergence of Schemes

Annexure 4 – Format for Preparation of Management Guidelines

Annexure 5 – Norms, Rules and Regulations for Conservation of Urban Wetlands/Water Bodies

Annexure 6 – Best Practices for Conservation of Urban Wetlands/Water Bodies



## ANNEXURE 1 – CATEGORIES OF WETLAND

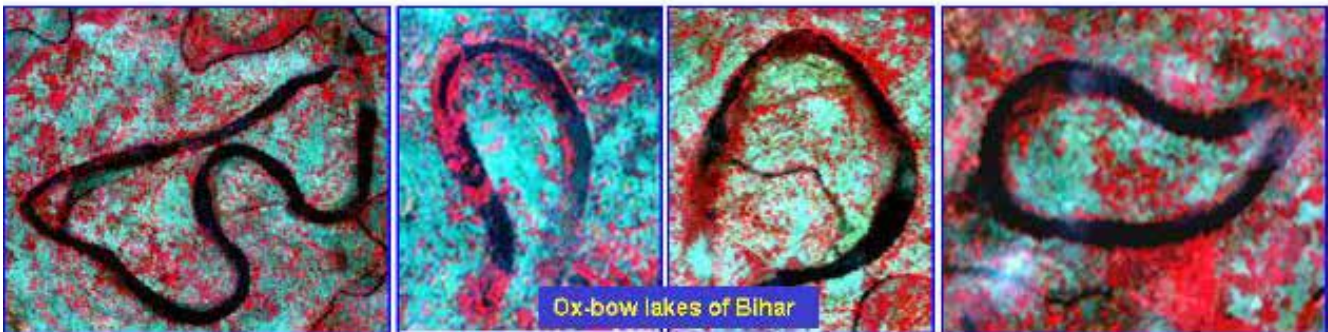
For ease of understanding, different wetland categories have been shown below with their typical appearances on satellite imagery.

### Inland Wetland: Lakes (Natural)



Source: National Wetland Atlas, March 2011

**Inland Wetland: Ox-Bow Lake/ Cut-off Meander (Natural)**



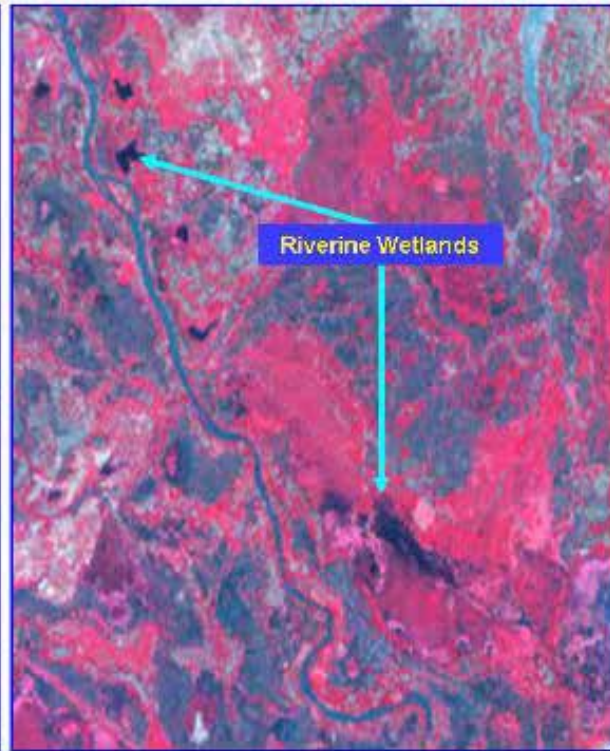
Source: National Wetland Atlas, March 2011

**Inland Wetland: High Altitude Wetlands (Natural)**



Source: National Wetland Atlas, March 2011

**Inland Wetland: Riverine Wetland (Natural)**



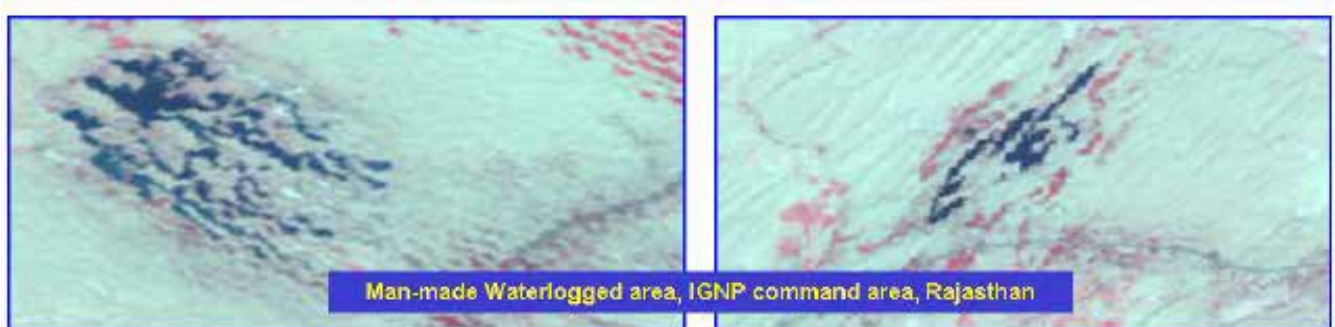
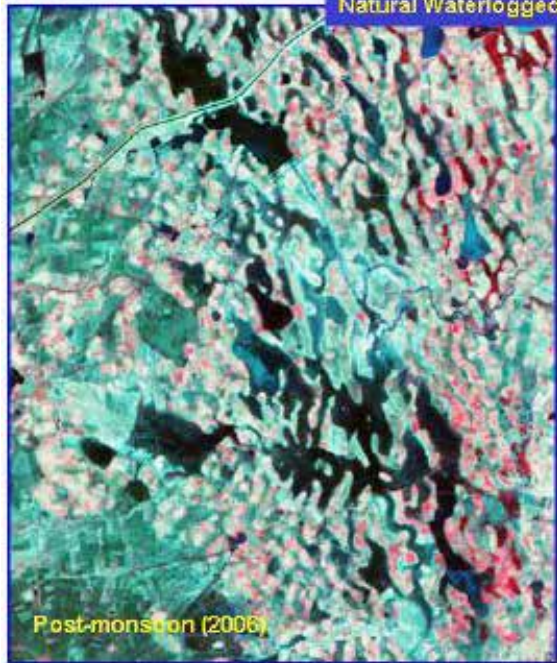
Source: National Wetland Atlas, March 2011



# Inland Wetland: Waterlogged Areas (Natural & Man-made)

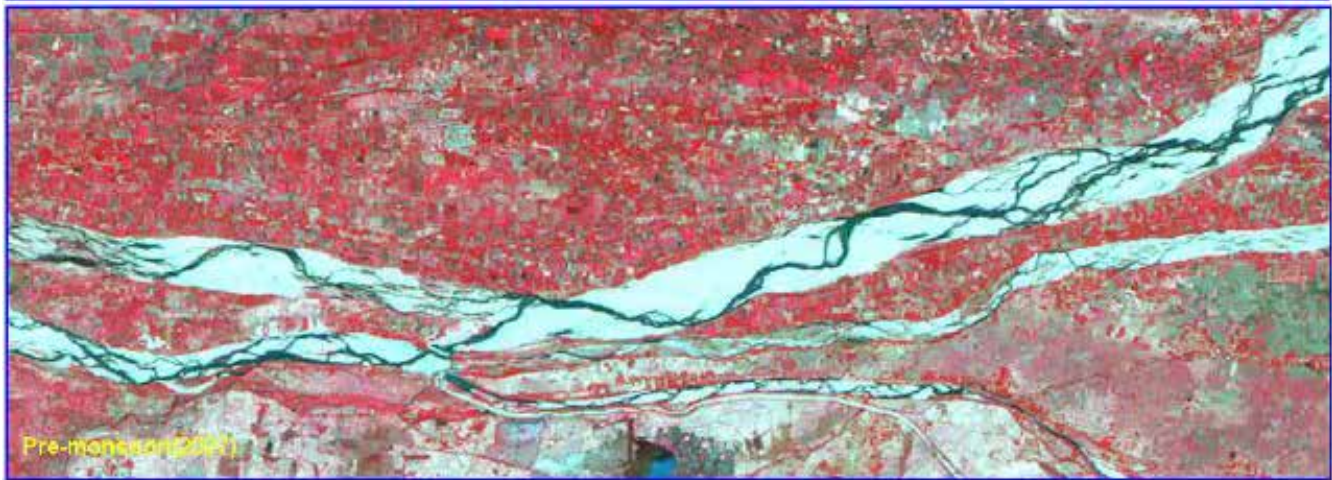
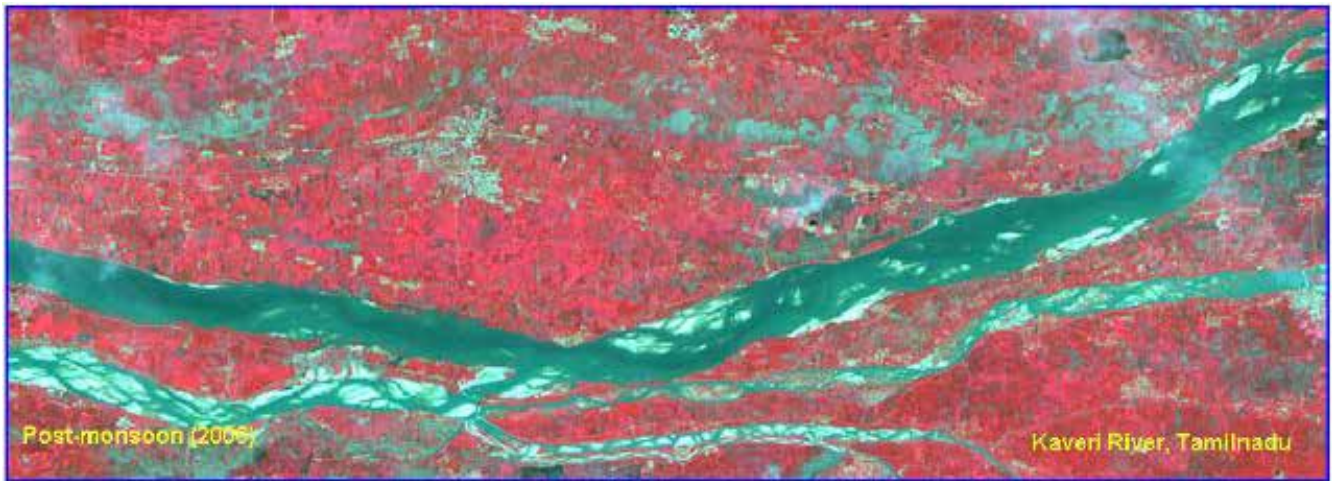


Natural Waterlogged area (Nal Sarover catchment area), Gujarat



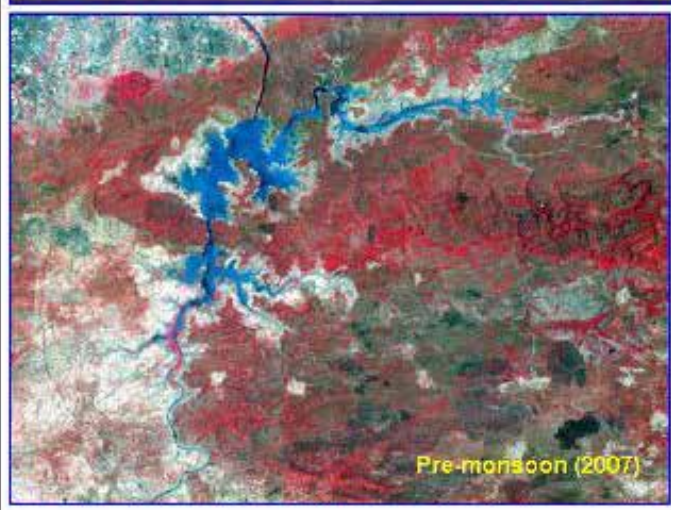
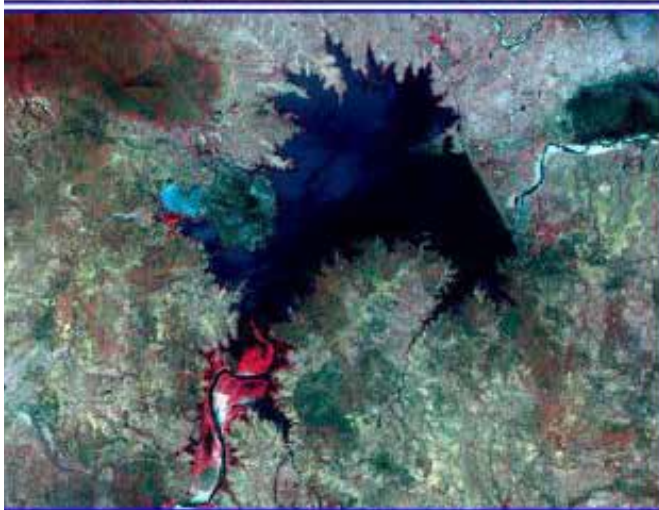
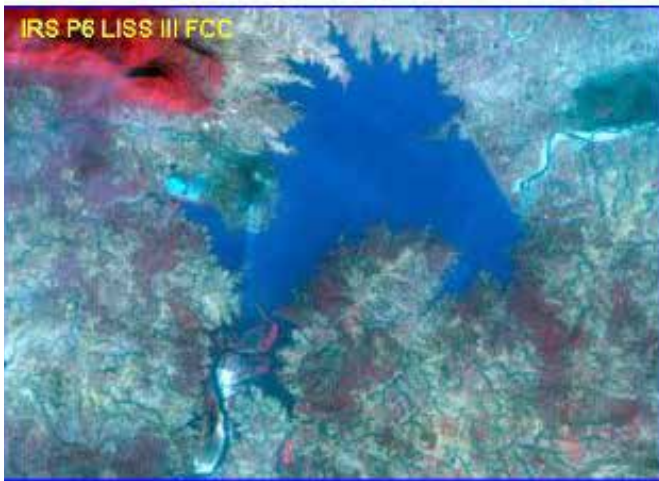
Source: National Wetland Atlas, March 2011

Inland Wetland: River/Stream (Natural)



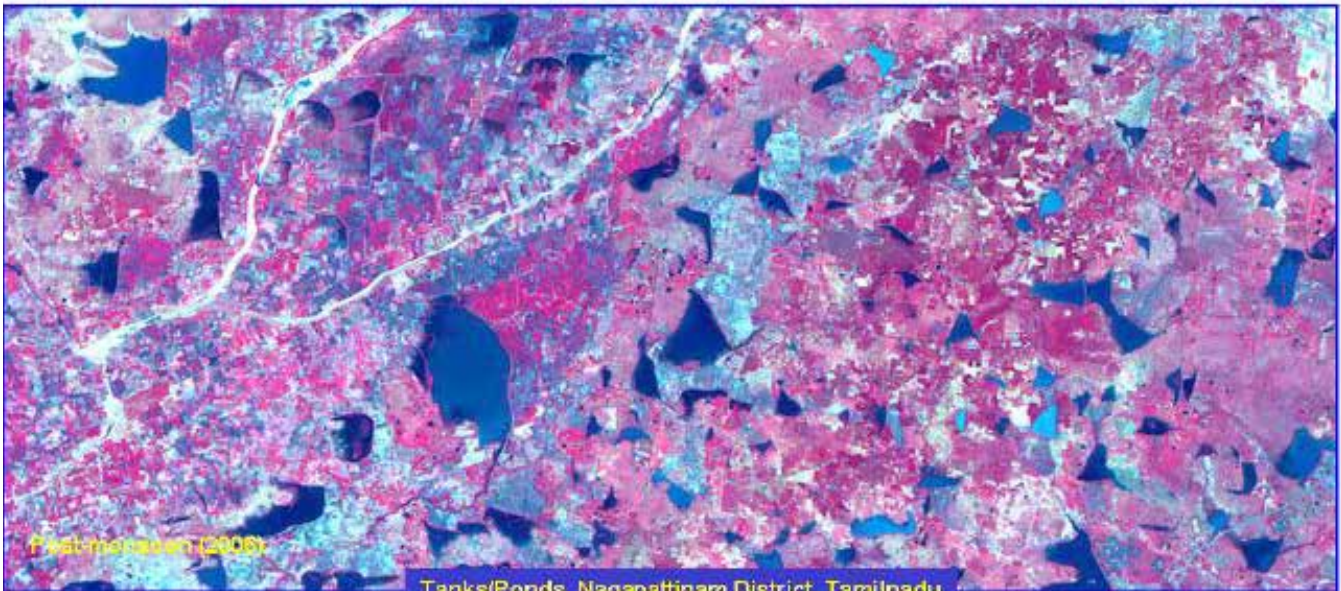
Source: National Wetland Atlas, March 2011

**Inland Wetland: Reservoir/Barrages (Man-made)**



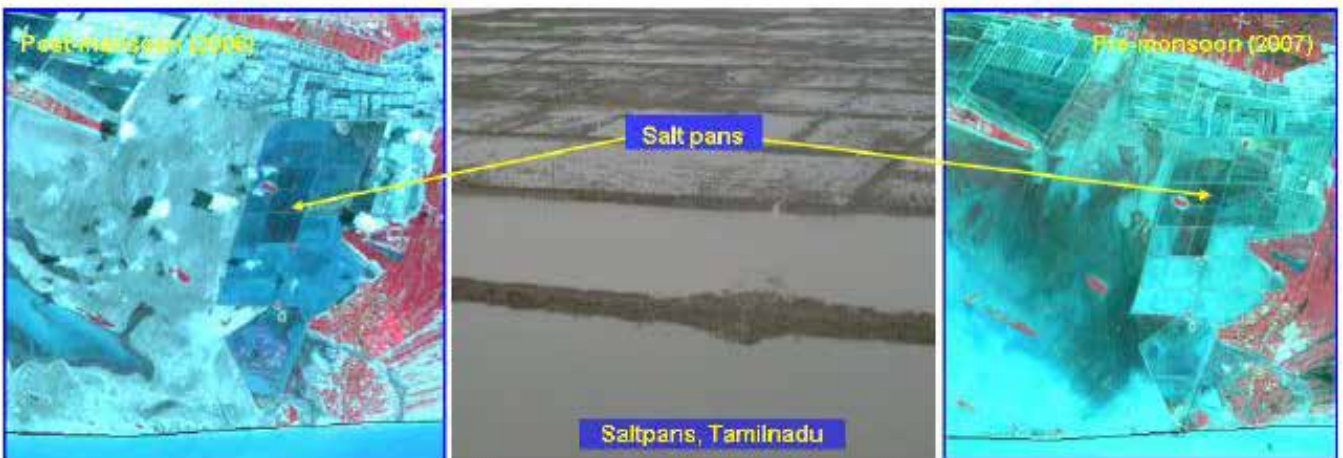
Source: National Wetland Atlas, March 2011

**Inland Wetland: Tank/Pond (Man-made)**



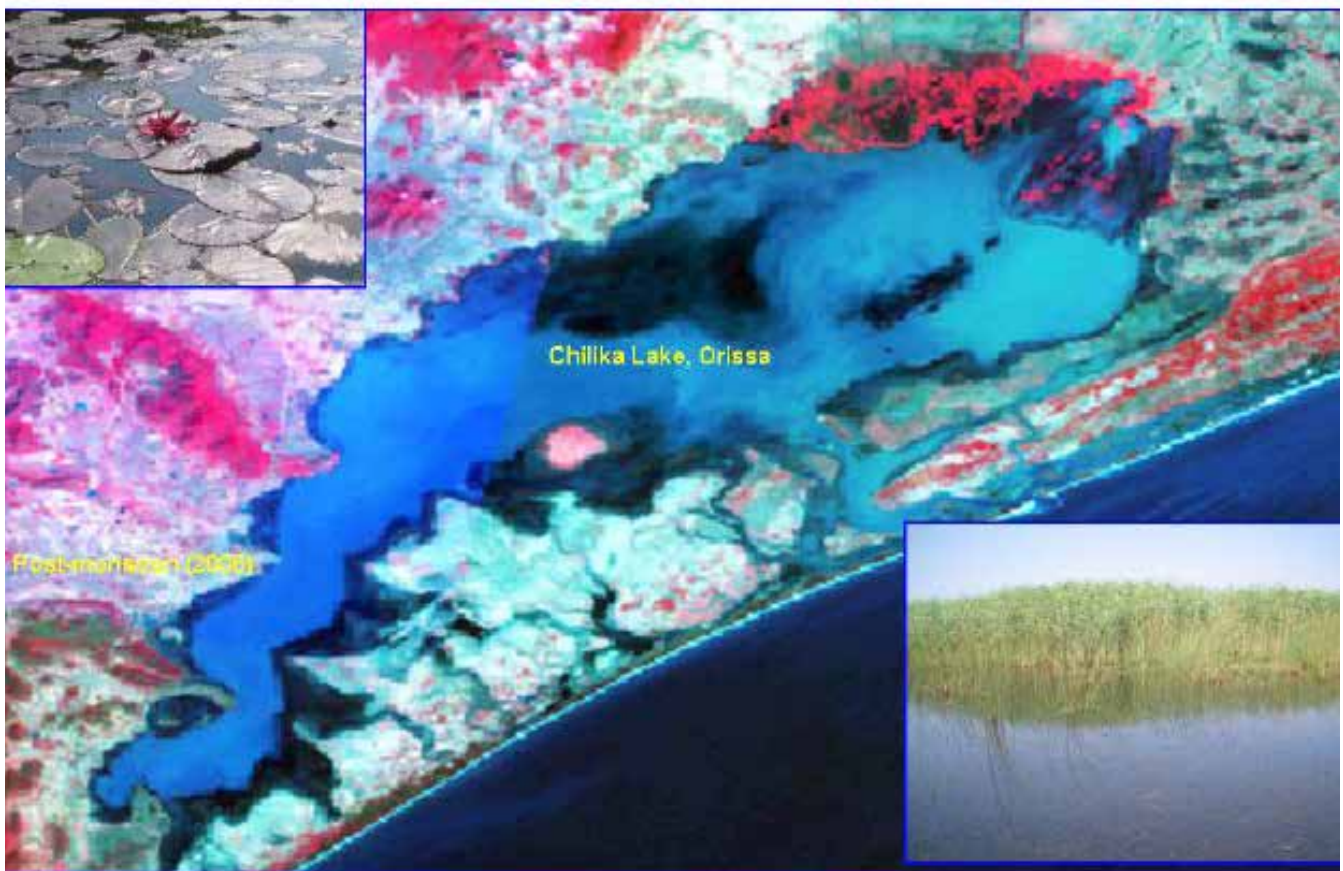
Source: National Wetland Atlas, March 2011

**Inland & Coastal Wetland: Salt Pan (Man-made)**



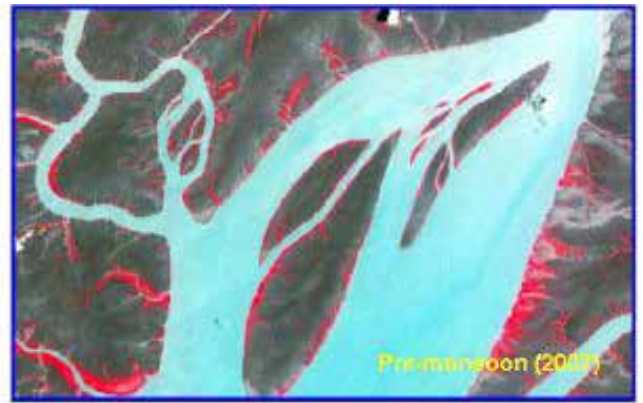
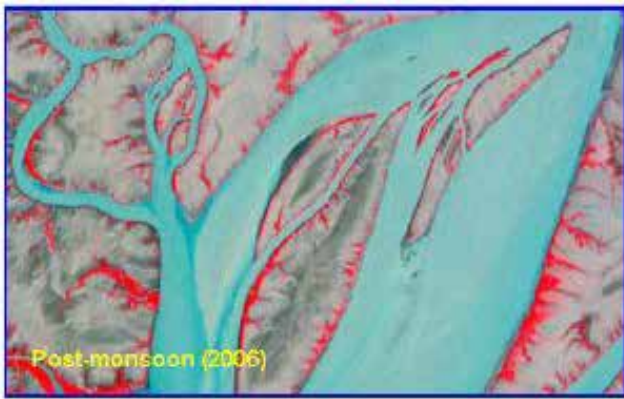
Source: National Wetland Atlas, March 2011

## Coastal Wetland: Lagoon (Natural)



Source: National Wetland Atlas, March 2011

Coastal Wetland: Creek (Natural)



Source: National Wetland Atlas, March 2011

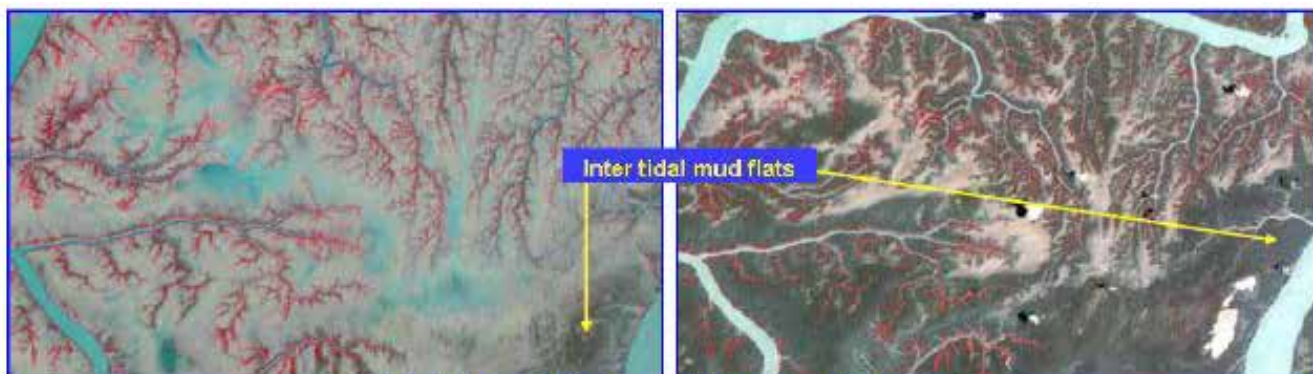
**Coastal Wetland: Sand/Beach (Natural)**



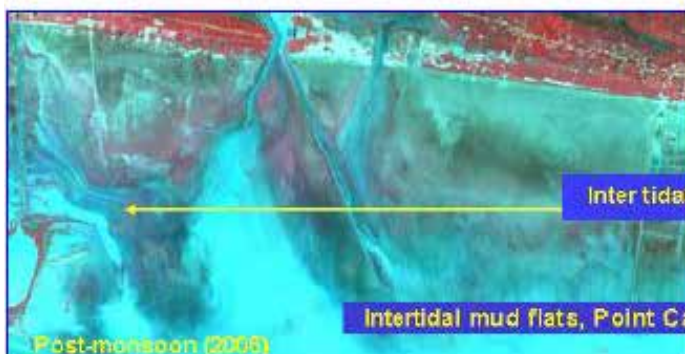
Source: National Wetland Atlas, March 2011



**Coastal Wetland: Inter-tidal Mud Flats (Natural)**



**Intertidal mud flats, Gulf of Khambhat, Gujarat**



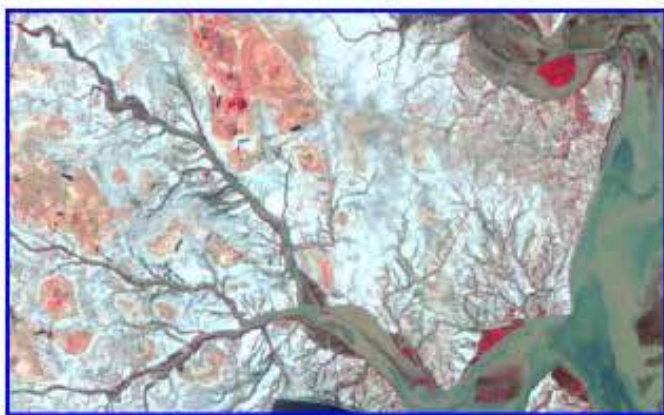
**Intertidal mud flats, Point Calimere Sanctuary, Tamilnadu**



**Intertidal Mud flats, Goa**

Source: National Wetland Atlas, March 2011

**Coastal Wetland: Salt Marsh (Natural)**



Salt Marsh, Gujarat



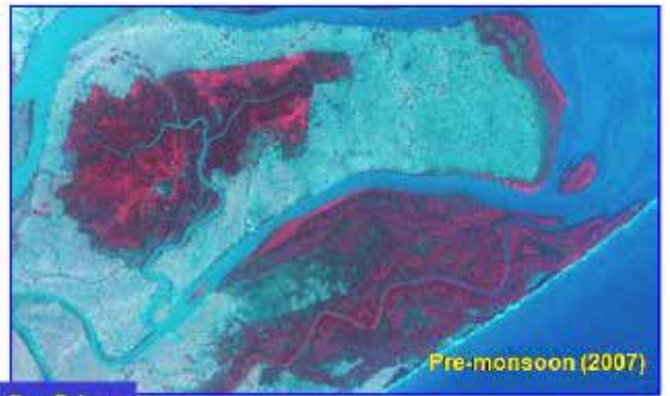
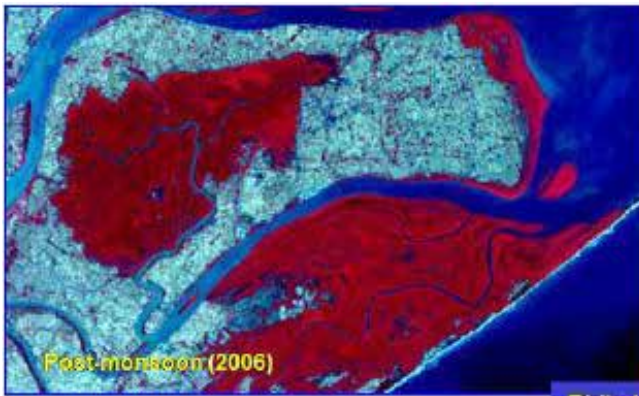
72° 15' 06" E, 22° 06' 47" N



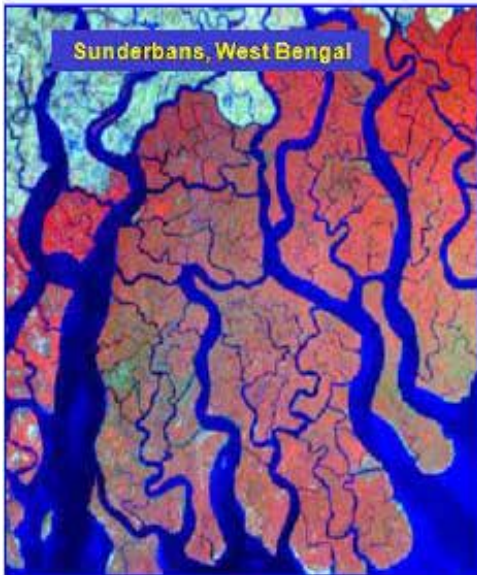
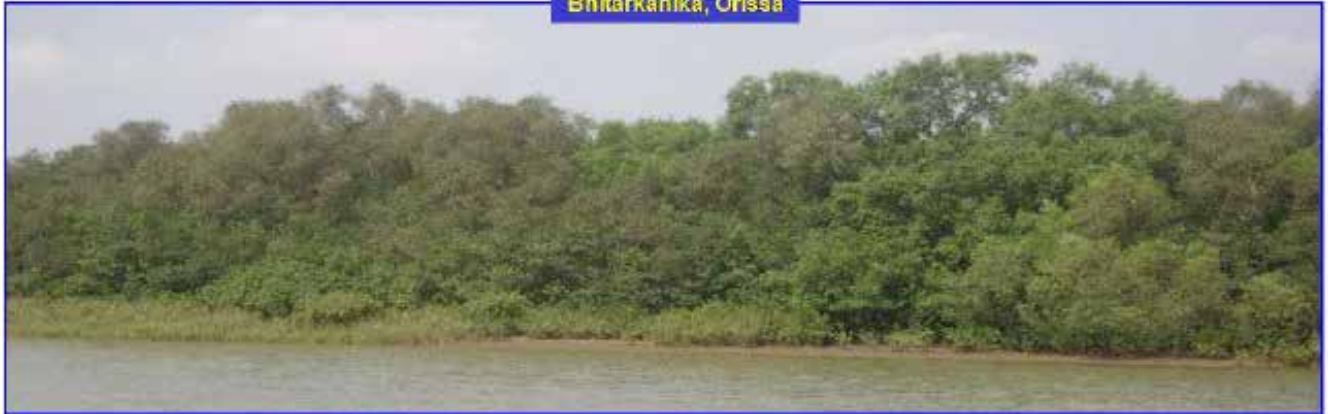
Salt Marsh, Salt pans, Creek and Mangroves, Northern Gulf of Kachchh, Gujarat

Source: National Wetland Atlas, March 2011

**Coastal Wetland: Mangrove (Natural)**



**Bhitarkanika, Orissa**

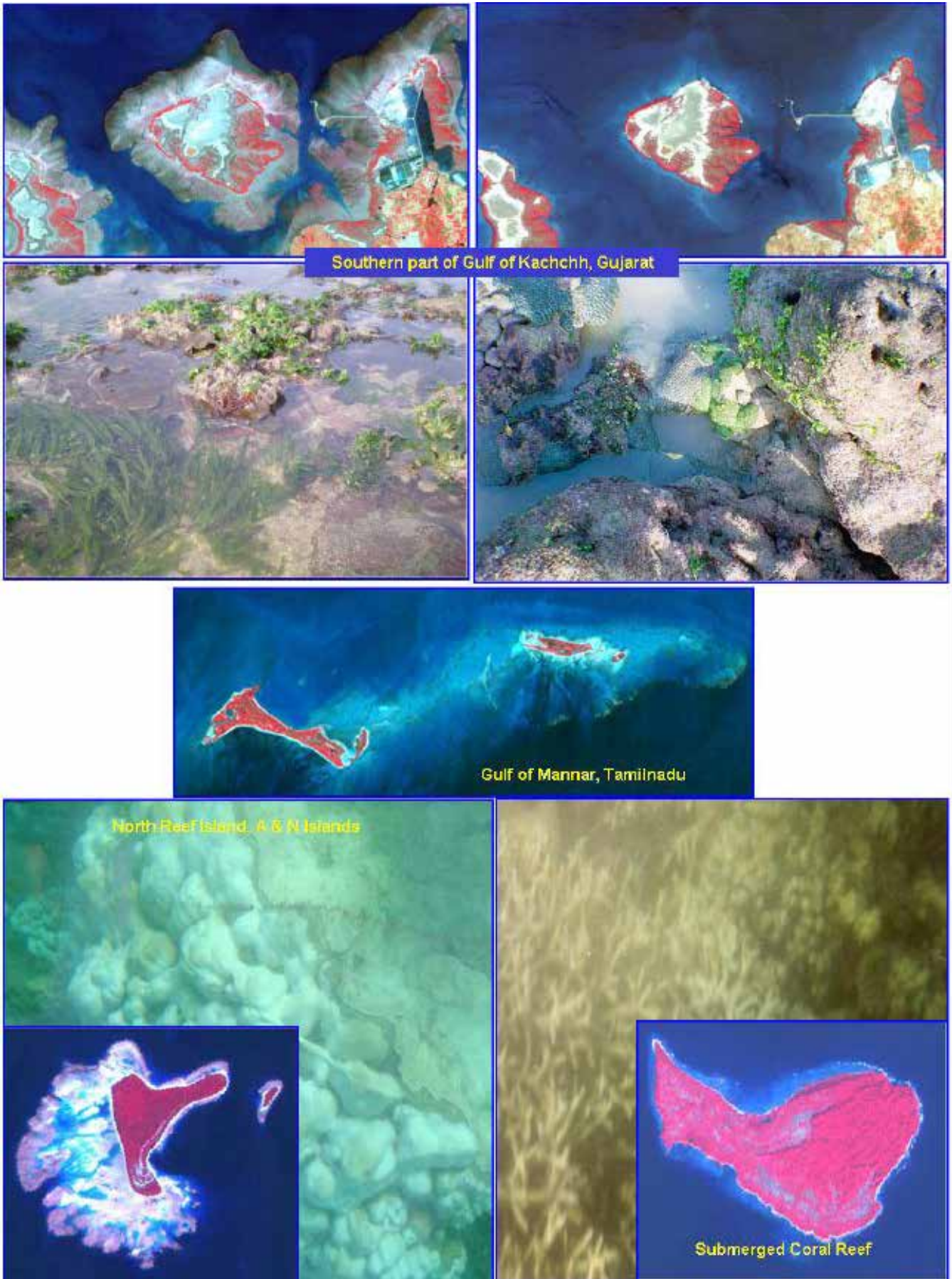


**Gulf of Khambhat, Gujarat**



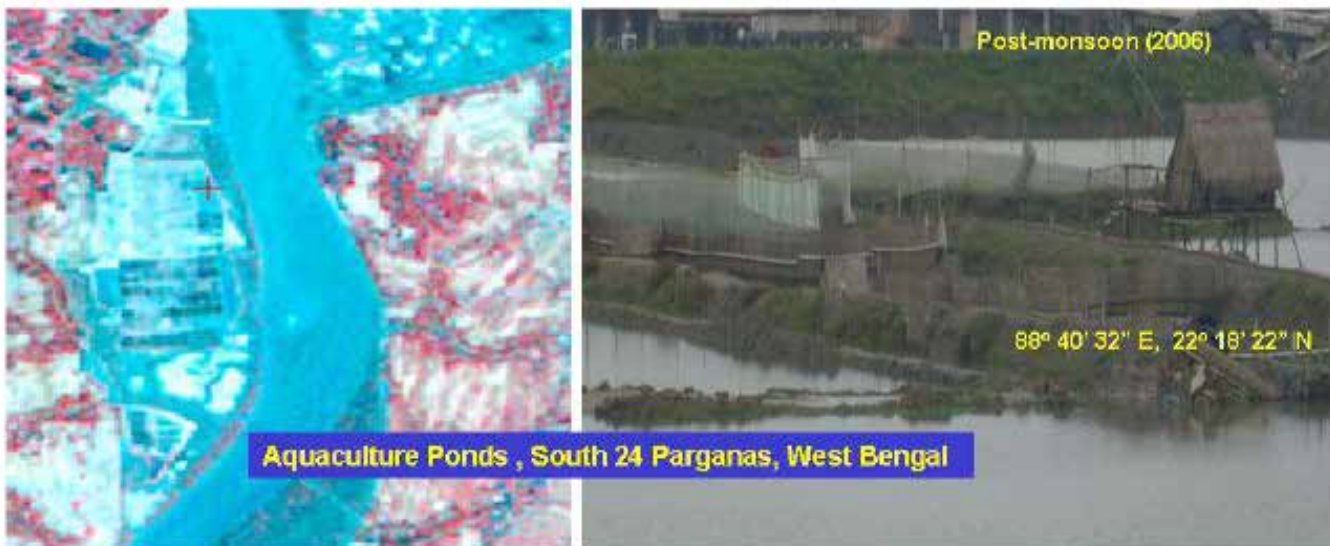
Source: National Wetland Atlas, March 2011

Coastal Wetland: Coral Reef (Natural)



Source: National Wetland Atlas, March 2011

**Coastal Wetland: Aquaculture Pond (Man-made)**



Source: National Wetland Atlas, March 2011

## ANNEXURE 2 – INSTITUTIONAL ARRANGEMENTS

For successful management of urban wetlands/water bodies, a well defined institutional mechanism is mandatory. This section highlights the institutional arrangements and enabling mechanism for application of toolkit.

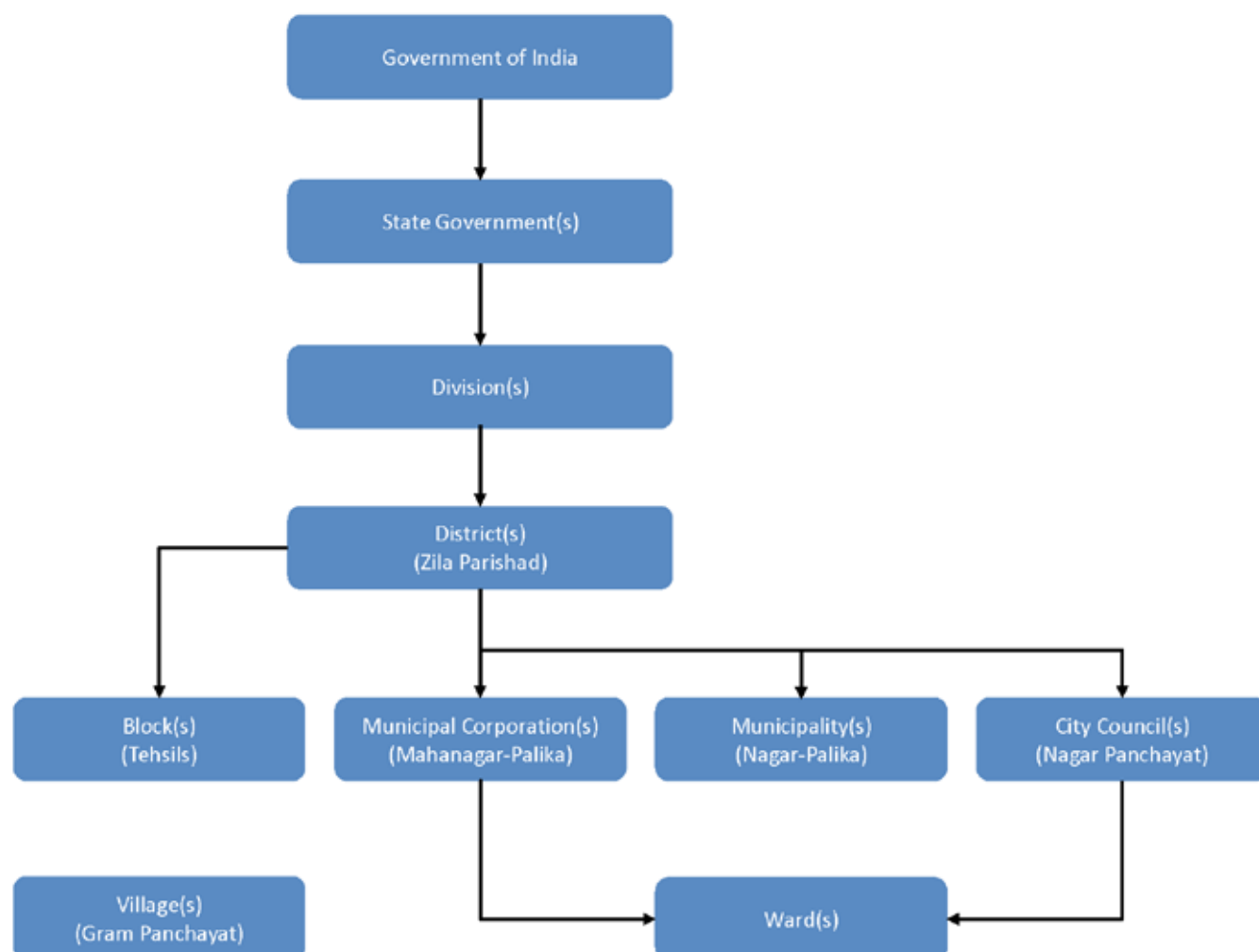
The local bodies, which are constituted for local planning, development and administration in the urban areas are referred as Urban Local Bodies (Municipalities).

The system of urban government was constitutionalised through the 74th constitutional amendment act of 1992. This act gave the constitutional status to the municipalities in India. Twelfth Schedule was added by the 74th Amendment Act of 1992 which contains the powers, authority and responsibilities of Municipalities. This schedule has 18 items.

After the 74th Amendment was enacted there are only three categories of urban local bodies:

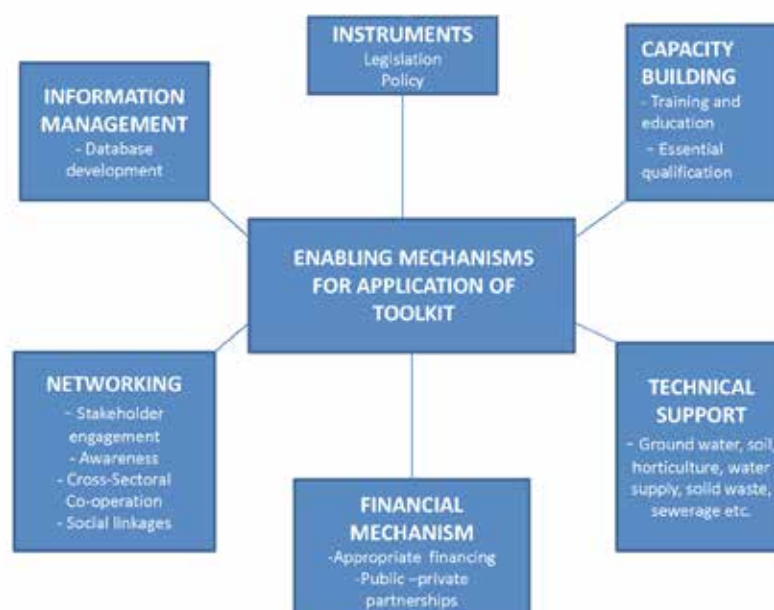
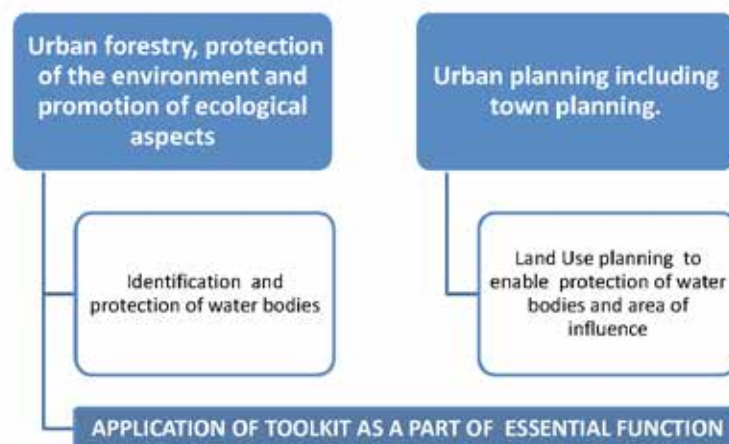
- Mahanagar Nigam (Municipal Corporation), administers urban areas with a Population of more than one million
- Nagar Palika (Municipality) administers a city of population 100,000 or more. However, there are exceptions to that, as previously Nagar Palikas were constituted in urban centers with populations over 20,000, continue as Municipalities.
- Nagar Panchayat (Notified Area Council or City Council)  
An urban centre with more than 11,000 and less than 25,000 population.

### Administrative Structure of India



## FUNCTIONS/RESPONSIBILITIES OF MUNICIPALITIES

1. Urban Planning including town planning.
2. Regulation of land-use and construction of buildings.
3. Planning for economic and social development.
4. Roads and bridges.
5. Water supply for domestic, industrial and commercial purposes.
6. Public health, sanitation conservancy and solid waste management.
7. Fire services.
8. Urban forestry, protection of the environment and promotion of ecological aspects.
9. Safeguarding the interests of weaker sections of society, including the handicapped and mentally retarded.
10. Slum improvement and up-gradation.
11. Urban poverty alleviation.
12. Provision of urban amenities and facilities such as parks, gardens, playgrounds.
13. Promotion of cultural, educational and aesthetic aspects.
14. Burials and burial grounds; cremations, cremation grounds and electric crematoriums
15. Cattle pounds; prevention of cruelty to animals.
16. Vital statistics including registration of births and deaths.
17. Public amenities including street lighting, parking lots, bus stops and public conveniences.
18. Regulation of slaughter houses and tanneries.



### ANNEXURE 3 – CONVERGENCE OF SCHEMES

This Step deals with mainstreaming wetlands in State level policy and decision making by building convergence with ongoing developmental sector investments. It will help to address the anthropogenic threats on wetlands. This will help in cross-sectoral involvement towards the management of urban wetlands/water Bodies.

Suggestive list of Central and State Government Schemes which can support implementation of Urban Wetland Management Projects are:

<b>Name of Scheme</b>	<b>Areas of Convergence</b>	<b>Implementing Ministry</b>
<b>Atal mission for rejuvenation and urban transformation (AMRUT)</b>	Enhancing amenity value of cities by creating and upgrading green spaces, parks and recreation centres, sewage facilities	Ministry of Urban Development
<b>Smart Cities Mission</b>	Area-based development for improvement, renewal and greenfield development.	
<b>Heritage City Development and Augmentation Yojana (HRIDAY)</b>	Holistic development of services like such as water supply, sanitation, roads, etc.	
<b>National Afforestation Programme</b>	Catchment conservation	Ministry of Environment, Green India Mission Catchment conservation Forest and Climate Change
<b>Green India Mission</b>	Catchment conservation	
<b>National Action Programme to Combat Desertification</b>	Assessment and mapping of land degradation, Drought Preparedness and Mitigation in the Context of Climate Change	
<b>National Afforestation and Eco-Development Board (NAEB)</b>	Ecological restoration and Eco-development activities	
<b>National Coastal Management Programme</b>	Conserve and protect coastal stretches and to promote Sustainable development	
<b>National Mission on Himalayan Studies</b>	Conservation of Himalayan Ecosystem and sustainable development	
<b>Repair, Renovation &amp; Restoration of Water Bodies</b>	Restoration of aquatic ecosystems used as sources of drinking water	Ministry of Water Resources, River Development & Ganga Rejuvenation



<b>Name of Scheme</b>	<b>Areas of Convergence</b>	<b>Implementing Ministry</b>
<b>Natural Resources Management, Rainfed Farming System, Horticulture, Integrated Nutrient Management</b>	Sustainable agriculture	Ministry of Agriculture and Farmers Welfare & Department of Animal Husbandry, Dairying and Fisheries (DADF)
<b>National Scheme on “Welfare of Fishermen” and “Development of Inland Fisheries”</b>	Sustainable fisheries development	Ministry of Agriculture and Farmers Welfare & Department of Animal Husbandry, Dairying and Fisheries (DADF)
<b>Swachh Bharat Mission (SBM)</b>	Development of sanitation infrastructure to improve water quality of Urban and Rural Ecosystems.	Ministry of Urban Development & Ministry of Drinking Water and Sanitation
<b>NPCA</b>	Conservation of wetlands above 5 Ha.	MoEF&CC
<b>National Mission on Pilgrimage Rejuvenation and Spiritual Augmentation Drive (PRASAD)</b>	Beautify and improve amenities and infrastructure at major pilgrimage sites in the country	Ministry of Tourism
<b>State Government schemes on fisheries, agriculture, forestry, wildlife protection, irrigation development etc.</b>	Various components of DPR	Various State Governments and Ministries Concerned.

## ANNEXURE 4 – FORMAT FOR PREPARATION OF MANAGEMENT GUIDELINES

Wetlands/ water bodies provide a wide-range of ecosystem services which support human well-being in a number of ways. In order to ensure the functioning and maintenance of ecological character of wetland, it is essential that a well defined strategy and actions are identified for conservation and wise use.

The management plan is formulated to identify the objectives of wetland management, identify the factors that influence the wetlands, resolve conflicts between various stakeholders having an interest in the wetland/water Bodies, define monitoring mechanism, identify convergence of schemes to pool financial resources for managing the wetlands, enable communication between wetland users, managers, organizations and various other stakeholders, ensure compliance with laws and regulation and demonstrate the management effectiveness and efficiency.

The management plan may be compiled in the following eight chapters:

Chapter	Sub-Heads	Explanations
<b>1. Introduction</b>	1.1 Rationale for management planning	Describe the importance of wetland, ways in which wetlands conservation and wise use will contribute to state conservation and development goals and alignment with state and central government policies, directives and planning frameworks.
	1.2 Terms of Reference	Enlist the overall terms of reference for the management plan.
	1.3 Approach and Method	Provide an overview of approach (ways in which the recommended steps have been used) Describe the data sources and research carried out for management planning if any.
<b>2. Description of Wetlands feature</b>	2.1 Description of wetland features <ul style="list-style-type: none"> <li>• Location and extent</li> <li>• Wetland catchments</li> <li>• Hydrological regimes</li> <li>• Biodiversity</li> <li>• Ecosystem Services</li> <li>• Socioeconomics &amp; livelihoods</li> </ul>	Describe wetland features. As far as possible, present the data in maps.
<b>3. Evaluation of Wetlands feature</b>	3.1 Evaluation <ul style="list-style-type: none"> <li>• Priority wetland</li> <li>• Features that need to be maintained and thresholds thereof</li> <li>• Threats</li> </ul>	Provide an overview of the current institutional arrangements in the context of wetlands management
<b>4. Setting Management Objectives</b>	4.1 Review of existing arrangements <ul style="list-style-type: none"> <li>• Key organizations and programmes</li> <li>• Rules and Regulations</li> <li>• Role of civil society and community based organization.</li> </ul>	Provide an overview of the current institutional arrangements in the context of wetland management.
	4.2 Gaps	Discuss why the current institutional arrangements are insufficient in ensuring wetlands conservation and wise use.

Chapter	Sub-Heads	Explanations
<b>4. Setting Management Objectives (Cont.)</b>	4.3 Proposed arrangements for wetland management	Propose institutional arrangement for wetland management, which specific focus on a) nodal agency, b) role of various departments and agencies and coordination mechanism, and c) the role of civil society and communities. Develop an organogram for management plan implementation.
<b>5. Setting Management Objectives</b>	5.1 Goal and purpose	Provide a statement of the overall goal that the management plan seeks to achieve
	5.2 Benefits (ecological as well as societal)	Summarize the ecological and economic benefits that are expected from management plan implementation
	5.3 Management objectives	Enlist the specific objectives
	5.4 Strategies	Describe strategy(ies) for achieving each of the management objectives
<b>6. Monitoring and Evaluation Plan</b>	6.1 Monitoring strategy	Present an overview of monitoring the wetland, and management plan implementation
	6.2 Monitoring parameters, frequency and responsibility	Describe the monitoring parameters, the frequency of monitoring and the agency that will be responsible for monitoring
	6.3 Institutional design	Describe how coordination between different monitoring agencies will be achieved
	6.4 Infrastructure and human resources design	Discuss the infrastructure and human resource requirement for implementing the management plan. As far as possible, including local universities, research organizations and NGOs in wetlands monitoring.
	6.5 Reporting	Discuss the frequency in which reporting shall be done and the responsible agency.
	6.6 Review and adaptation	Discuss how the monitoring outcomes will be used to adapt management
<b>7. Developing an Action Plan</b>	7.1 Component wise activities linked with management objectives	Generic listing of activities indicating: - What will be done? - Where will the activity be done? - What is the priority for the activity?
<b>8. Budget and Activity Phasing</b>	8.1 Activity linked budget	Present a summary budget Provide details of funding available from convergence sources in line with Table given.
	8.2 Time planning	Present a monthly Gantt Chart for management plan implementation

Source: Adapted from RAMSAR Handbook and NPCA Guidelines, April 2019

## ANNEXURE 5 – NORMS, RULES AND REGULATIONS FOR CONSERVATION OF URBAN WETLANDS/ WATER BODIES

The following norms, rules and regulations pertaining to conservation of wetlands in urban areas have been compiled from various guidelines, schemes, bye-laws and notifications provided by various Ministries in India and International Countries.

Organization/ Department / Govt. Bodies	Norms/Regulations
<p><b>National Disaster Management Authority (Urban Flood Management Guidelines, September 2010 &amp; National Disaster Management Guidelines, September 2017)</b></p>	<p><b>Restrictions of Building Activity in Vicinity of Certain Areas</b></p> <p>i) No building/ development activity shall be allowed in the bed of water bodies like river or nallah/ stormwater drain and in the Full Tank Level (FTL) of any lake, pond, tank or pond/ tank bed lands,</p> <p>ii) The above water bodies and courses shall be maintained as recreational/green buffer zone, and no building activity other than recreational use, shall be carried out within:</p> <ul style="list-style-type: none"> <li>• The Coastal Regulation Zone (CRZ) restricted area in case of areas along the sea coast,</li> <li>• 100 m from the river edge outside Municipal Corporation/ Municipal limits and 50 m within Municipal Corporation/ Municipal limits. No permanent constructions/structures will be permitted within the above-mentioned buffer zone,</li> <li>• 50 m from the boundary of lakes of area 10 Ha and above,</li> <li>• 30 m from the boundary of lakes of area less than 10 Ha / ponds/tank bed lands,</li> <li>• 12 m from the boundaries of major canal, stream, etc., and</li> <li>• 2 m from the defined boundary of nallahs/ storm-water drains, etc. The above shall be in addition to the mandatory setbacks. Unless and otherwise stated, the area and the FTL of a lake/ pond shall be reckoned, as measured or given in the Survey of India topographical maps/Irrigation Department records/ Revenue records. The above buffer zone may be reckoned as part of the building setback.</li> </ul> <p>iii) Unless and otherwise specified in the Master Plan/Zonal Development Plan:</p> <ul style="list-style-type: none"> <li>• The space to be left in and around the major canal/ stream (including the actual canal/stream bed width and alignment) shall be minimum 12 m. This may be developed as Green Buffer/recreational and / or utilized for road of minimum 9 m width, wherever feasible,</li> <li>• In case of lakes of area 10 Ha and above, in addition to development of recreational/green belt along the fore shores of a lake, a ring road or promenade of minimum 12 m may be developed, wherever feasible; while in respect of fore shores of river, a river drive road of minimum 18 m may be developed in the said 50 m buffer zone, and</li> <li>• The above greenery/landscaping and development shall conform to the guidelines and provisions of the NBC of India, 2005.</li> </ul>
<p><b>National Building Codes 2016</b></p>	<p><b>General Building Requirements: Chapter 4</b></p> <p>a) Provision of Exterior Open Spaces around the buildings</p>

Organization/ Department / Govt. Bodies	Norms/Regulations
<p><b>Model Building Bye Laws, 2016 (Ministry of Urban Dev. &amp; Town and Country Planning Organization)</b></p>	<p><b>Services Plan and Water Supply Provision</b></p> <p>i. For recharging of ground water, rain water harvesting provisions are to be provided within the plot, which are to be indicated on the building plans.</p> <p>ii. Where a septic tank is used for sewage disposal, the location, design and construction of septic tank shall conform to requirements of Part 9 'Plumbing Services, Section 1 Water Supply, Drainage and Sanitation (Including Solid Waste Management)' of NBC, 2005.</p> <p>iii. Under no circumstances shall effluent from a septic tank be allowed into an open channel drain or body of water without adequate treatment</p> <p>iv. It is desirable to conserve rain water using suitable rain water harvesting techniques including by roof water collection.</p>
	<p><b>Harvesting provisions in various Building categories:</b></p> <p>i. Residential Plotted Houses</p> <p>ii. Group Housing</p> <p>iii. Public &amp; Semi-Public Buildings</p> <p>iv. Commercial/Mixed Use</p> <p>v. Industrial</p>
	<p><b>Rain Water Harvesting Provisions for Open spaces in cities</b></p> <p><b>Ground Water Recharge:</b></p> <p>i. Recharging of ground water should be made mandatory not only for residential buildings but for all types of buildings, including Group Housing Societies having a plot area more than 500 sq.m. and above.</p> <p>ii. The Ground Water Recharge should also be mandatory for open spaces like parks, parking, plazas and playgrounds. The harvesting and recharge structures could be constructed by the Authority with the involvement of community-based organizations like Resident Welfare Associations.</p> <p><b>Green Buildings &amp; Sustainability Provisions:</b></p> <p>i. All buildings on various plot sizes above 100 sq.m. shall comply with the green norms and conform to the requirements mandatory for sanction.</p> <p>ii. All building having a minimum discharge of 10,000 l. and above per day shall incorporate waste water recycling system. The recycled water should be used for horticultural purposes.</p>
	<p><b>Provisions for City and Site level greening:</b></p> <p>In alignment with National Sustainable Habitat Mission, the Authority shall encourage augmentation of green cover in the city/plot, by following: The Urban Greening Guidelines, 2014 and other provisions as given below -</p> <p>i. Provision of minimum 1 tree / every 80sqmt of plot area for plot sizes &gt; 100sqmt and planted within the setback of the plot.</p> <p>ii. Compensatory Plantation for felled/transplanted trees in the ratio 1:3 within the premises under consideration.</p> <p>iii. Choice of species for plantation in site and abutting the road to be adopted as per Section 8 of the Urban Green Guidelines, 2014.</p> <p>iv. The unpaved area shall be more than or equal to 20% of the recreational open spaces.</p>

Organization/ Department / Govt. Bodies	Norms/Regulations
<p><b>Model Building Bye Laws, 2016 (Ministry of Urban Dev. &amp; Town and Country Planning Organization) (Cont.)</b></p>	<p><b>Clearances at Master Plan level:</b> Individual construction proposals should not generally require separate clearances from various authorities each time. Such clearances should be integrated into the DCR of the Master/ Development Plan of the concerned city. Clearances from various agencies proposed to be integrated in Master Plans: i. National Monuments Authority through Competent Authority – Ancient Monument Approval ii. Ministry of Environment – Environment Clearance (EC) iii. Central Ground Water Authority – Borewell Registration Certificate iv. Ministry of Civil Aviation – AAI Height NOC v. Coastal Zone Management Authority – NOC (if near sea/coastal areas) vi. NHAI/PWD – Road Access vii. Ministry of Railways – Area Clearance</p>
	<p><b>Environmental Conditions for Building and Construction</b> <b>Category “A”: 5000 Sq.m – 20,000 Sq.m &amp; Category “B”: 20000 Sq.m – 50,000 Sq.m</b> i. Natural Drainage: The inlet and outlet point of natural drain system should be maintained with adequate size of channel for ensuring unrestricted flow of water. ii. Water conservations: Rain Water Harvesting and Ground Water Recharge: A rain water harvesting plan needs to be designed where the recharge bores (minimum one per 5000 sq.m of built-up area) shall be provided. The rain water harvested should be stored in a tank for reuse in household through a provision of separate water tank and pipeline to avoid mixing with potable municipal water supply. The unpaved area shall be more than or equal to 20% of the recreational open spaces. iii. Green Cover: A minimum of 1 tree for every 80 sq.m of land shall be planted and maintained. The existing trees will be counted for this purpose. Preference should be given to planting native species. Where the trees need to be cut, compensatory plantation in the ratio of 1:3 (i.e. planting of 3 trees for every 1 tree that is cut) shall be done with the obligation to provide continued maintenance for such plantations.</p>
	<p><b>Category “C”: 50000 Sq.m – 1,50,000 Sq.m</b> i. Natural Drainage: The inlet and outlet point of natural drain system should be maintained with adequate size of channel for ensuring unrestricted flow of water. ii. Water conservations: Rain Water Harvesting and Ground Water Recharge: a. A rain water harvesting plan needs to be designed where the recharge bores (minimum one per 5000 sq.m of built-up area) shall be provided. The rain water harvested should be stored in a tank for reuse in household through a provision of separate water tank and pipeline to avoid mixing with potable municipal water supply. The excess rain water harvested is to be linked to the tube well bore in the premise through a pipeline after filtration in the installed filters. b. The unpaved area shall be more than or equal to 20% of the recreational open spaces. c. The ground water shall not be withdrawn without approval from the competent authority.</p>

Organization/ Department / Govt. Bodies	Norms/Regulations
<p><b>Model Building Bye Laws, 2016 (Ministry of Urban Dev. &amp; Town and Country Planning Organization) (Cont.)</b></p>	<p><b>Category “C”: 50000 Sq.m – 1,50,000 Sq.m (Cont.)</b></p> <p>d. Use of potable water in construction should be minimized.</p> <p>e. Low flow fixtures and sensors must be used to promote water conservation.</p> <p>f. Separation of grey and black water should be done by the use of dual plumbing system.</p> <p>iii. Solid Waste Management:</p> <p>a. Organic waste composters/ vermiculture pit with a minimum capacity of 0.3 Kg/tenement/day must be installed wherein the STP sludge may be used to be converted to manure which could be used at the site or handed over to authorized recyclers for which a written tie-up must be done with the authorized recyclers.</p> <p>b. All non-biodegradable waste shall be handed over to authorized recyclers for which a written tie-up must be done with the authorized recyclers.</p> <p>iv. Green Cover:</p> <p>a. A minimum of 1 tree for every 80 sqm of land shall be planted and maintained. The existing trees will be counted for this purpose. Preference should be given to planting native species.</p> <p>b. Where the trees need to be cut, compensatory plantation in the ratio of 1:3 (i.e. planting of 3 trees for every 1 tree that is cut) shall be done with the obligation to provide continued maintenance for such plantations.</p> <p>v. Sewage Treatment Plant: Sewage treatment plant with capacity of treating 100% waste water shall be installed. Treated water must be recycled for gardening and flushing.</p> <p><b>Regulations for Resettlement and Slum In-situ Up-gradation</b></p> <p>a. Septic tank and leaching pit (soak pit) A septic tank shall be provided with capacity 141.6 m litres (five cubic feet) per capita, where the municipal services are likely to be available within four or five years or so, pour flush water seal latrines (NEERI type) shall be permitted, where the municipal sewage system is not available and the water table in the area is not high.</p>
<p><b>Indicative Guidelines for Restoration of Water Bodies, June 2019</b></p>	<p><b>Green or Buffer Zone</b></p> <p>A. Buffer Zone around a lake or pond (at least 50 to 100 m periphery) should be maintained as green belt zone or no activity zone and no activity is allowed within the buffer zone by the concerned Departments in the State/UT. In case, any activity presently existing within the buffer zone (50 to 100 m), such as residential or commercial or industrial activity should take necessary measures to prevent discharge of any wastes into the water body.</p> <p>B. Within the buffer zone, no impervious cover is allowed and mainly plantation with a dense population of deeply rooted plants, trees, shrubs and grasses should be created so as to absorb nutrients (which promotes aquatic plant growth and a shift in the water quality) that comes directly from the anthropogenic activities.</p>

Organization/ Department / Govt. Bodies	Norms/Regulations
<p style="text-align: center;"><b>Indicative Guidelines for Restoration of Water Bodies, June 2019 (Cont.)</b></p>	<p>Protection drainage basin including preservation of drainage channels A. Major channels running from the larger watersheds should be identified based on the historical data and such drainage channels should be preserved and protected with suitable buffer land without any impervious cover. This aspect should be ensured by the State Local/ Urban Development/Town Planning authorities while planning or expansion of a locality.</p>
	<p>B. Historically the drainage channels which used to carry natural runoff from the drainage basin and presently carrying either untreated municipal sewage or industrial effluent or both and contributing to pollution of water bodies eventually due to encroachment in view of urbanization. All such drainage channels need to be restored by interventions such as (i) stoppage of inflow of untreated municipal sewage or industrial effluent. If required, interaction and diversion of untreated sewage or industrial effluent from such drainage channels by routing through properly designed dedicated sewerage network to ensure conveyance and for ensuring treatment and disposal through STPs/CETPs. Feasibility of in-situ treatment of treated sewage and industrial effluent within drainage channels and prior to the inflow into the water bodies also be explored by the concerned authorities.</p>
<p style="text-align: center;"><b>River Regulation Zone (RRZ) Notification</b></p>	<p>The RRZ notification intends to regulate developmental and industrial activities upto 5 kms from the banks of the river stretches having floodplains and an equivalent area for mountain/hill stretches under three River Conservation Zones (RCZ) demarcated with reference to the Highest Flood Level (HFL) with a 100-year return period.</p>
	<p><b>Categorization of river stretches:</b> A. CATEGORY I stretch (pristine / protected): shall include stretches (including tributaries) in ecologically sensitive and fragile watersheds, areas of pristine/ outstanding beauty, heritage sites, areas rich in genetic diversity or otherwise important for rare and endangered species. This will also include the stretches of rivers within national parks, wildlife sanctuaries, biosphere reserves or similarly protected areas. B. CATEGORY II stretch (urbanized): shall include stretches of rivers (including their tributaries), with or without embankments, in designated urban areas where infrastructure facilities in form of roads, buildings (residential, commercial, recreational), temples, ghats etc exist. C. CATEGORY III stretch (rural): shall include stretches of rivers (including their tributaries) in suburban and rural areas, with or without embankments, where infrastructure development if any is moderate and the land is primarily under natural vegetation, forestry, agriculture and grazing.</p>



Organization/ Department / Govt. Bodies	Norms/Regulations
<b>River Regulation Zone (RRZ) Notification (Cont.)</b>	<p><b>Lateral zonation of river banks:</b></p> <p>A. "Active Flood Plain" as defined by High Flood Line (HFL) which in entrenched /embanked stretches of a river stretch shall be the available space (including the river channel/s) in the valley of entrenched stretch or between two embankments or between existing roads on either side along a river acting as an embankment.</p> <p>B. In other stretches of the river HFL / active flood plain shall be the 100-year flood line.</p> <p>i. No Development Zone The competent authority shall determine an NDZ on either bank for each river which shall not be less than the "Active Flood Plain" of the river.</p> <p>ii. High &amp; Medium Impact Zones The competent authority shall identify and designate suitable distance/s, from the NDZ, on either bank keeping local topographical conditions in mind, to be called as High impact and Medium impact zones (HIZ and MIZ). In plains where river topography is relatively flat, these distances shall not be less than 1 and 3 Km respectively from the NDZ.</p>
	<p><b>Regulations:</b></p> <p><b>A. Siting of industries and other polluting influences</b> All RED industries/activities with pollution control measures shall be permitted by the Competent Authority for siting only beyond the medium impact zone. ORANGE industries/activities with pollution control measures could be permitted by the Competent Authority for siting within the medium impact zone. GREEN industries/activities with pollution control measures could be permitted by the Competent Authority for siting within high impact zone.</p>
	<p><b>B. Removal of sand and gravel from the river beds</b> Permissions for removal of sand and gravel from the river bed in Category III stretches only shall be given on the basis of the guidelines as prescribed by the MOEF&amp;CC and upheld by the Hon'ble Supreme Court in February 2012.</p>
	<p>The Competent authority may consider permission for removal of sand and gravel from the river bed in Category II stretches after a prior environmental impact assessment study</p>
	<p><b>C. Constructions of permanent nature</b> No permanent construction of residential, industrial, commercial, recreational and public semi-public (PSP) nature shall be permitted within No Development Zones, NDZ of river stretches I, II and III and also the High Impact Zones, HIZ of river stretch I.</p> <p><b>Exceptions:</b> Existing constructions in any zones shall not be affected by these rules unless a change in use or expansion or reconstruction is being carried out. Similarly, construction of 'true' bridges (from one bank to another) over the river shall not attract the provision of these rules.</p>

Organization/ Department / Govt. Bodies	Norms/Regulations
<p><b>Planner’s Guide to Wetland Buffers for Local Governments (March 2008, Environmental Law Institute)</b></p>	<p><b>Maintenance of effective buffer sizes for:</b>  a. Water quality and  b. Wildlife habitat</p> <p><b>Approaches to Setting Buffer Distances</b>  a. Fixed Non-disturbance Buffer  Some local ordinances provide for a fixed buffer distance within which disturbance activities are prohibited (or strictly limited)  b. Non-disturbance Buffer plus Additional Setback  Some ordinances prescribe a fixed non-disturbance wetland buffer, and then prescribe an additional setback distance for structures from the edge of the wetland buffer. The idea is that the prescribed non-disturbance buffer protects the wetland, and that buildings should not be constructed on the buffer’s edge if a functional buffer is to be maintained.  c. Regulated Buffer Area with Minimum Non-disturbance Area.  Another approach defines the buffer in terms of the area within which regulatory scrutiny will be applied to limit uses by permit or other review. (<a href="https://www.ecosystemmarketplace.com/wp-content/uploads/archive/documents/Doc_457.pdf">https://www.ecosystemmarketplace.com/wp-content/uploads/archive/documents/Doc_457.pdf</a>)</p>
<p><b>Written rules prohibiting construction near water bodies in other States in India</b></p>	<p><b>Andhra Pradesh and Telangana (GONo.168 dated 09.04.2012)</b>  a. 100m from the boundary of the river outside the municipal corporation / municipality / nagar panchayat limits and 50m within their limits. The boundary of the river shall be as fixed and certified by the irrigation department and revenue department.  b. 30m from the FTL boundary of lakes / tanks / kuntas of area 10Ha and above  c. 9m from the FTL boundary of lakes / tanks / kuntas of area less than 10Ha / shikam lands  d. 9m from the defined boundary of canal, vagu, nala, storm water drain of width more than 10m  e. 2m from the defined boundary of canal, vagu, nala, storm water drain of width up to 10m</p> <p><b>Assam</b>  a. No construction upto 15 m from River and notified water bodies &amp; upto 10 m from pond or other notified water bodies</p> <p><b>Madhya Pradesh</b>  a. No construction upto 30 m from rivers or lakes/ponds/reservoirs or nala/ canal or flood affected areas</p> <p><b>Chhattisgarh</b>  a. No construction upto 100m from Mahanadi Canal</p>

Organization/ Department / Govt. Bodies	Norms/Regulations
<p align="center"><b>Written rules prohibiting construction near water bodies in other States in India (Cont.)</b></p>	<p><b>Bihar</b></p> <p>a. No Construction or re-construction of any building shall be allowed within a strip of land of 200 m or such other higher distance as may be prescribed from time to time by the State Government from the outer boundary of the river of Ganges (as prescribed by the irrigation department) shall be permitted (except for repair and renovation of heritage buildings) and in the case of other rivers, no construction or re-construction of any building shall be allowed within a strip of land of 100 meters.</p>
	<p><b>Karnataka</b></p> <p>I. A buffer of 45 m is assumed all along the flow of the river on both banks, which shall be treated as a no-development zone.</p> <p>a) No building/ development activity shall be allowed in the bed of water bodies like nala, and in the Full Tank Level (FTL) of any lake, pond etc.,</p> <p>b) As per the Judgement of the National Green Tribunal, Principal Bench, New Delhi in O.A.No.222 of 2014, no construction activity is allowed in Karnataka in buffer/green zone.</p> <p>i) In case of lakes, 75 meters from the periphery of water body to be maintained as a green belt and buffer zone for all existing water bodies i.e., lakes/wetlands.</p> <p>ii) 50 m from the edge of the primary Rajkulewas</p> <p>iii) 35 m from the edge of the secondary Rajkulewas</p> <p>iv) 25 m from the edge of the tertiary Rajkulewas</p>
	<p><b>Maharashtra</b></p> <p>a. If the site is within a distance of 9 m from the edge of water mark of a minor watercourse (like nallah) and 15 m from the edge of water mark of a major water course (like river) shown in the development plan or village/city survey map or otherwise.</p>
<p align="center"><b>Repair, Renovation and Restoration (RRR) of Water Bodies under PMKSY (HKKP), MoWR, January 2017</b></p>	<p><b>Water Bodies Covered Under Scheme:</b></p> <p>a. Rural water bodies having minimum water spread area of 5 hectare.</p> <p>b. Urban water bodies having water spread area from 2.0 hectare to 10 hectares.</p> <p>The scheme will emphasize development of catchment area, de-siltation and command area development in respect of water bodies. The RRR scheme in rural areas is proposed to be implemented in convergence with the Integrated Watershed Management Programme (IWMP) so that the catchment areas of the water body selected are located either in treated micro/mini watershed or those selected for treatment during the next year or two. The proposals of only those water bodies in which catchment area treatment works have started under IWMP would be included in the scheme of RRR of water bodies.</p>
	<p><b>Preparation of DPR:</b></p> <p>a. Details of present status of the water bodies (in use or partially used or not in use) with reasons for deterioration in condition and also its 8 categorizations in terms of geographic location i.e.,</p> <ul style="list-style-type: none"> <li>• Special category states, hilly states, etc</li> <li>• Desert, flood prone, drought prone, tribal and naxal affected areas in non-special category states</li> <li>• Other states not covered under category (i) and (ii)</li> </ul>

Organization/ Department / Govt. Bodies	Norms/Regulations
<p style="text-align: center;"><b>Repair, Renovation and Restoration (RRR) of Water Bodies under PMKSY (HKKP), MoWR, January 2017 (Cont.)</b></p>	<p>A. Rainfall during the last ten years, ground water level, land use pattern, soil characteristics, climate conditions, availability of water in the catchment area for channelization into water body, water quality situation in the water body and adjoining areas.</p>
	<p>B. Details of original CCA, present CCA and CCA planned in the DPR, original storage capacity/present storage capacity and storage capacity planned in the DPR, water quality situation in the water body and of ground water in adjoining areas with likely impact of the project on water quality of the water body and of the ground water.</p>
	<p>C. Scope of work viz De-silting in terms of quantum of silt to be removed, repair of conveyance system, strengthening of bund(s), repair of weirs and sluices, catchment treatment, command area development, soil erosion prevention works, quality control measures. Maps of catchment and command areas are to be enclosed in the DPR.</p>
	<p>D. The scheme envisages capacity building of implementing agencies such as Ministry of Water Resources, River Development &amp; Ganga Rejuvenation (MoWR, RD &amp; GR) and its attached and subordinate offices, State Governments, District Implementing agencies, Water Users' Associations (WUAs) and Panchayats. Accordingly, a capacity building programme aimed at sensitization of stakeholders, identification and selection of water bodies, preparation of Detailed Project Reports (DPRs), monitoring and evaluation is to be prepared and included in the DPRs.</p>
	<p>E. The proposals of only those water bodies in which catchment area treatment works have started under IWMP would be included in the scheme of RRR of water bodies. In case, the scheme of IWMP is being considered for implementation in the State based on IWMP programme, the water bodies of such area will also be included in the scheme. A certificate from State Government will be required for speedy implementation of IWMP in those areas.</p>
	<p>F. Targeted benefits under the project will include creation of additional irrigation potential, increase in agriculture / horticulture / pisciculture production and productivity, increase in recharge of ground water, improvement in water use efficiency, increase in availability of drinking water, impact on water quality, removal of weed growth, promotion of tourism and culture.</p>
	<p>G. Detailed calculation for working out the Benefit Cost ratio (BC ratio) for each water body. Cost per hectare is expected to be lower than that for Minor Irrigation Projects.</p>
	<p>H. Implementation schedule &amp; corresponding requirement of funds; details of arrangement for monitoring &amp; evaluation and arrangement for use and maintenance of the restored water bodies.</p>
	<p><b>Implementation of Scheme:</b>  a. Water Users' Association (WUA) at the Gram Panchayat Level  b. Arrangements at District Level  c. Arrangements at State Level  d. Arrangements at Central Level</p>

Organization/ Department / Govt. Bodies	Norms/Regulations
<p><b>NPCA Guidelines, April 2019</b></p>	<p><b>Inclusion of Wetlands under NPCA</b>  <b>A. Wetlands located with urban, peri-urban and semi-urban areas</b>  a. Wetland holds some water throughout the year and with peak inundation area equivalent or greater than 5 ha; and  b. Wetland is highly degraded and cannot be put to its traditional use due to pollution resulting from discharge of domestic and /or industrial wastewater, municipal solid waste or other non-point sources of pollution. Designated best use criteria for surface waters as recommended by CPCB is provided in Annexure IV.</p>
	<p><b>B. Wetlands located in high altitude areas (with elevations greater than 2,500 m a.m.s.l)</b>  a. Wetland has an area of 5 ha and above</p>
	<p><b>C. Wetlands located below 2,500 m a.m.s.l elevation</b>  a. Wetland or wetland cluster has a peak inundation area of 100 ha and above, and meets at least one of the following criteria:  b. Is representative, rare or unique example of natural or nearly natural wetland in a biogeographic zone;  c. Supports vulnerable, endangered or critically endangered species; or threatened ecological communities (as evaluated through IUCN Red List or any other national list);  d. Supports plant and/or animal species at a critical stage in their life cycle, or provides refuge during adverse conditions;  e. Supports populations of plant/ or animal species important for maintaining the biological diversity of a particular biogeographic region;  f. Regularly supports 20,000 or more water birds;  g. Regularly supports 1% of individuals in a population of one species or sub-species of water birds or is an important breeding site for rare/migratory bird species;  h. Is an important source of food for fishes, spawning ground, nursery and /or migration path on which fish stocks/ either within the wetlands or elsewhere depend;  i. Provides important hydrological functions as a source of water, regulates hydrological extremes, recharges groundwater, buffers floods and purifies water;</p>
	<p><b>C. Wetlands located below 2,500 m a.m.s.l elevation (Cont.)</b>  j. Is an important source of livelihoods for communities living in and around it;  k. Is of significant cultural/ religious / recreation value.  Wetlands smaller than the above-mentioned area thresholds may be considered by the Central Government on recommendation of the State/UT Wetland Authority.</p>

Organization/ Department / Govt. Bodies	Norms/Regulations
<p><b>Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) Har Khet ko Pani, 2018</b></p>	<p><b>Watershed Development</b> A. Integrated Watershed Management Programme (IWMP) was launched in 2009-10 after integrating and consolidating the then existing programmes namely Drought Prone Area Programme (DPAP), Desert Development Programme (DDP) and Integrated Wasteland Development Programme (IWDP).</p>
	<p>B. The objectives of IWMP are harnessing, conserving and developing degraded natural resources such as soil, vegetative cover and ground water; prevention of soil runoff; rain water harvesting and recharging of ground water table; increasing the productivity of crops; introduction of multi-cropping and diverse agro-based activities; promoting sustainable livelihoods and increasing household incomes, etc.</p>
	<p>The major activities undertaken under IWMP/WDC-PMKSY inter-alia include soil and moisture conservation works, rain water harvesting, nursery raising, afforestation, horticulture, pasture development, livelihood activities for asset-less persons and production system &amp; micro-enterprises for small and marginal farmers. Projects are taken up in a cluster of micro-watersheds having a total area of about 5000 ha in rain-fed/degraded areas having no assured irrigation. Area of micro-watershed is about 500 ha.</p>
<p><b>Guidelines for Urban Water Conservation, Jal Shakti Abhiyan, 2019</b></p>	<p><b>Focus Area:</b> <b>A. Rain Water Harvesting (RWH)</b> a. Illustrations of RWH structures taken from Model Building Bye-Laws 2016 b. ULBs may undertake the following measures: i. Enforcement of Building Bye-Laws: - RWH needs to be implemented as per the provisions of MBBL, 2016 shared with all States/UTs for adoption. Most of the States/UTs have incorporated RWH in their respective Building Bye-Laws. Cities need to ensure that the RWH provisions are incorporated in their or State Building Bye-Laws (BBLs), as may be applicable. ii. Establishment of Rain Water Harvesting Cell: - Urban Local Bodies (ULBs) should constitute a Rain Water Harvesting Cell which will be responsible for effective monitoring of Rain Water Harvesting in the city. The cell should monitor the extent of ground water extraction and ground water aquifer recharge. This Information should be displayed at prominent locations for public awareness.</p>
	<p><b>B. Reuse of Treated Waste Water</b> a. National Urban Sanitation Policy 2008 mandates reuse of at least 20% of treated waste water. b. In order to promote reuse of treated waste water, State Government and ULBs should undertake the following measures: - Provision of dual piping under Building Bye-Laws should be checked in all government (Central/State/UT/ULB) buildings, commercial complexes, public buildings like educational institutions, hospitals, and Group Housing Societies, whether the same is available, so that the treated waste water can be used for horticulture, toilet flushing and fire hydrants.</p>

Organization/ Department / Govt. Bodies	Norms/Regulations
<p><b>Guidelines for Urban Water Conservation, Jal Shakti Abhiyan, 2019 (Cont.)</b></p>	<p><b>B. Reuse of Treated Waste Water (Cont.)</b></p> <p>In all new government buildings/Group Housing Societies, public buildings, whenever building plan is approved, it should be ensured that there should be dual piping as has been provided in City/State/UT BBLs. At the time of inspection for issuance of Occupancy-cum-Completion Certificate, compliance of provision of Building Bye-Laws for dual piping to reuse the treated waste water should be checked thoroughly.</p> <p>- In case, city has got sewage treatment plants (STPs), ULB should ensure that treated waste water is used for the following purposes:</p> <ol style="list-style-type: none"> <li>i. Recycling for use in agriculture / horticulture;</li> <li>ii. Fire hydrants;</li> <li>iii. Large scale construction activities;</li> <li>iv. Made available to industry if it consumes water in bulk;</li> <li>v. Supplied to power plants located within 50 Km of the city. As per directions of Ministry of Power, Tariff Policy Circular dated 28 January 2016, it is mandatory that power plants within 50 kms from STPs have to develop a system for conveyance and use treated waste water.</li> </ol>
	<p><b>A. Rejuvenation of Water Bodies</b></p> <p>a. Every city must initiate action to revive at least one water body during Jal Shakti Abhiyan. ULBs should identify all the water bodies in the city and select one for rejuvenation through public consultations.</p> <p>b. ULBs should undertake following measures to rejuvenate the water bodies:</p> <ul style="list-style-type: none"> <li>- Water body should be cleaned through bio-remediation measures, de-silting, aeration, removal of floating and other invasive aquatic plant-species or any other technology suiting local conditions.</li> <li>- Shore-line of the water bodies should be properly fenced to protect them from encroachment. Inlet and outlet of the water body should be strengthened.</li> <li>- Inflow of domestic/ industrial sewage into the water body should be arrested and only treated effluent adhering to standards prescribed by CPCB may be allowed into the water body.</li> <li>- Catchment area treatment via afforestation, storm water drainage management, silt traps, etc. may be undertaken.</li> <li>- Water front development around the water body may be taken up, keeping in view the ecosystem based approach for the aquatic body, conforming to prevalent environmental legislation and maintaining social and cultural sanctity of the place.</li> <li>- Creation of public spaces may be taken up to ensure public eye and vigilance to protect from encroachment or throwing garbage.</li> <li>- Street vendor zones may be developed close to the water body, in convergence with National Urban Livelihood Mission (DAY-NULM).</li> <li>- Public toilets may be provided in convergence with SBM-Urban.</li> <li>- Participation of private sector, community-based organizations, philanthropic foundations may be encouraged in rejuvenation and maintenance of water bodies.</li> <li>- ULBs should monitor quality of water in the selected body on weekly basis and undertake appropriate action to improve wherever necessary.</li> <li>- Each water body may be geo tagged with photographs.</li> </ul>

Organization/ Department / Govt. Bodies	Norms/Regulations
<p><b>Guidelines for Urban Water Conservation, Jal Shakti Abhiyan, 2019 (Cont.)</b></p>	<p><b>B. Plantation</b></p> <p>a. ULBs should undertake plantation near water bodies, public spaces, parks and on roadside to improve green cover and water cycle.</p> <p>b. Measures to be taken by ULBs:</p> <ul style="list-style-type: none"> <li>- Such places where plantation could be done during the rainy season like roadside, around water bodies or vacant public spaces should be identified at the earliest.</li> <li>- Water hardy indigenous variety of trees should be identified for plantation and preferably tall plants (4-6 feet) may be used.</li> <li>- In collaboration with District Forest Department/Horticultural Department, special drive needs to be taken up during JSA to plant such trees in identified areas.</li> <li>- Adequate measures need to be taken up to protect and nurture such plants to ensure their survival.</li> <li>- Special drive may be taken up to motivate Resident Welfare Associations (RWAs), Civil Society Organizations (CSOs), NCC, NSS, NYK, etc to plant trees at large scale in the resident colonies, schools, public buildings etc, in the city during JSA.</li> </ul>
	<p><b>C. Awareness Campaign</b></p> <p>i. ULBs should engage RWAs, schools, businesses, Civil Society Organizations (CSOs), Nehru Yuva Kendras (NYKs), NSS volunteers, NCC cadets, SHGs formed under DAY-NULM, elected representatives, Swachhagrahis to organize door to door outreach, community events, workshops, flyers, banners, wall paintings, street plays, social media, etc. for dissemination and building awareness for all four enlisted Water Conservation measures in urban areas. Leading personalities in films, sports, social work or public life may be invited to the campaigns.</p> <p><b>Monitoring</b></p> <p>ii. In order to ensure effective monitoring, it is important to establish a clear baseline and benchmark for State/UT/ULB level performance on implementation of Rain Water Harvesting, Rejuvenation of Water Bodies, Reuse of Treated Waste Water and Plantation. The progress needs to be monitored on a real-time basis to ascertain the progress of ULBs and gaps therein in each of the thrust areas under JSA.</p> <p><b>Documentation</b></p> <p>iii. ULBs are encouraged to document their experiences and innovative practices which have led to successful implementation of water conservation measures and upload the same on the websites of Ministries of Jal Shakti and Housing and Urban Affairs. Such documentation may be used in future workshops, consultations, cross-learning and replicating best practices within and outside the States/UTs with/without local adaptive modifications.</p>



## ANNEXURE 6 – BEST PRACTICES FOR CONSERVATION OF URBAN WETLANDS/ WATER BODIES

The following section provides a wide range of management practices undertaken all over India in various cities for conservation of urban wetlands/water bodies.

### 1. POWAI LAKE, MUMBAI

Powai Lake is an artificial lake, situated in the northern suburb of Mumbai. The lake was created in 1891 by constructing dam between two hillocks across Mithi River.

**Powai Lake**



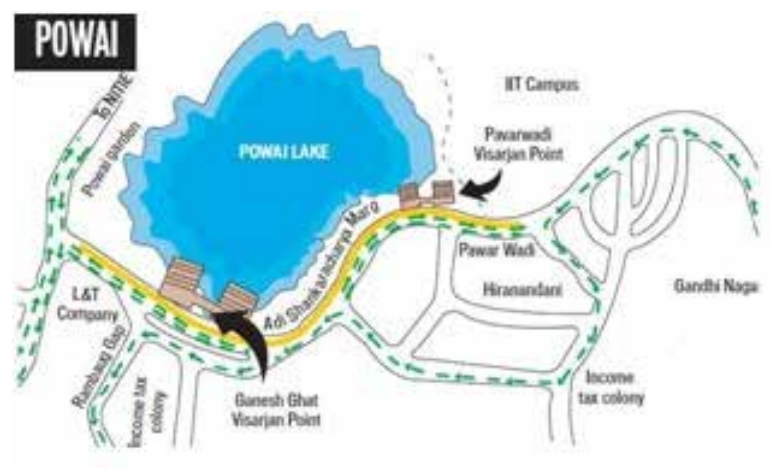
Source: Google, 2019

**Population of the city:** 1.89 crores

**Area:** Catchment area of the lake is about 600 hectares and water spread area at full supply level is 220 ha.

**Implementing Agency:** Bruhat Bengaluru Mahanagara Palike

#### Powai Lake and surrounding land uses



Source: Umesh Bhauraoji Kakde

#### Issues:

- The lake water is used for non-potable purposes i.e. gardening and industrial use.
- At present, 40% of the lake has disappeared.
- The lake has deteriorated due to accelerated growth of residential, commercial and industrial area around the lake.
- The untreated disposal of sewage and garbage from nearby residential and slum colonies have affected the quality of the water.
- The catchment of the lake has also been affected badly due to unplanned quarrying activities.
- The problem of silting, growth of water hyacinth, weed, and eutrophication of the lake,

**Key Stakeholders:** IIT Bombay's Class of 1980 launched a "Revitalization of Powai Lake" with the objective of restoring the lake to its original pristine and sustainable form by adopting Eco-friendly designs and materials for the restoration works. In 1995, the National Lake Conservation Plan (NLCP) of the Ministry of Environment and Forests (MoE&F), reviewed the condition of Powai Lake and included the lake in its list of ten major lakes in the country for revival and improvements. The restoration/revival programme, fully funded by the NLCP, was launched in April 2002, and implemented by Bombay Municipal Corporation (BMC) now called Brihanmumbai Municipal Corporation (BMC).

**Strategy:**

2002: The restoration/revival programme, fully funded by the NLCP, was launched in April 2002.

2006: The Supreme Court had passed an order directing all the state governments to remove encroachments along the side of all the water bodies immediately. Any government failing to do so is liable for action under contempt of court.

March, 2009: The Powai Senior Citizens' Association (PSCA) has come up with a self-sustainability plan for the lake. The group wants to convert the once-picturesque Powai lake into an eco-tourist hot spot using maximum natural resources and minimum funds from the civic body.

April 2009: The BMC has started desilting work from April 6. It has appointed around 44 contractors for clearing major and minor nullahs of silt, and claims to complete the work by May 25.

**Reference:**

[http://www.rainwaterharvesting.org/powai\\_lake/powai\\_lake.html](http://www.rainwaterharvesting.org/powai_lake/powai_lake.html)

## 2. KR PURAM LAKE, BANGALORE

Rapid urbanization and unplanned development have taken a toll on Bengaluru's lakes. The city once had about 2,000 lakes, but only 60 of them remain.

### KR Puram Lake, Bangalore



Source: <https://www.downtoearth.org.in/news/chance-of-revival-for-bengalurus-dying-lakes---40312>

**Population of the city:** 84.3 lakhs

**Area of Lake:** 19 ha

**Depth:**

**Time Frame:** January 2015

**Cost:** Rs. 95,000

**Implementing Agencies:** KSPCB and Bangalore water supply and sewerage board

**Issues:**

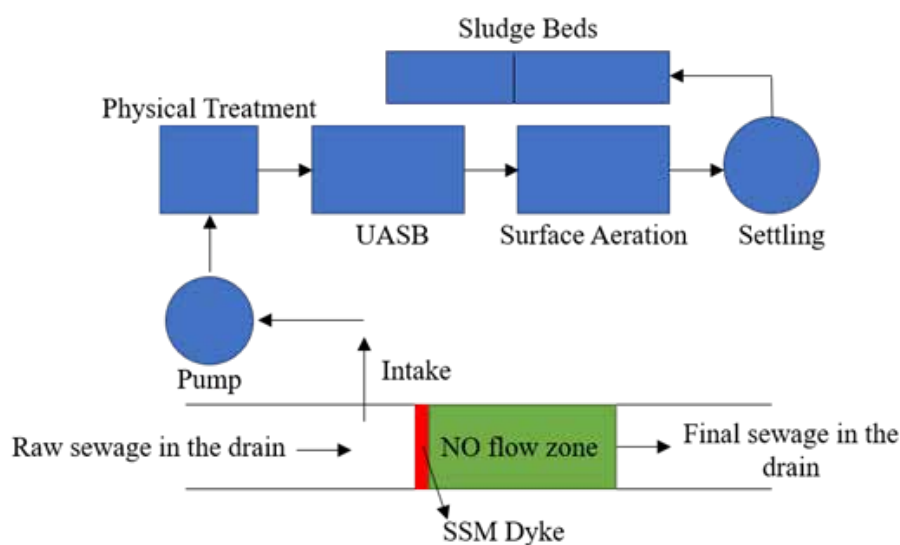
- Disposal of sewage into the lakes
- The storm water drains were initially directed into the lakes to recharge them and there were separate channels for domestic sewage. In due course of time, because of poor sewerage and haphazard expansion, sewage of the city was directed into the storm water drains, and from there into the city lakes.
- Encroachment

**Strategy:**

They developed a decentralized system to collect the sewage from drains, treat it and then discharge the treated wastewater into lakes.

The system installed at KR Puram Sewage Treatment Plant (STP) in eastern part of the city involved constructing a medium height barrage across the Kaluve drain and collecting the sewage through a pipe by gravity in a pit. From the pit, the sewage is pumped into the STP, which treats the sewage and releases the treated water into the same drain ahead of the barrage. Thus, only treated wastewater reaches the Vengayyana lake. The inlet quality of sewage is around 250 mg/l BOD and outlet concentration is just 5-6 mg/l BOD. The KR Puram STP has extended aeration system followed by UASB, which also takes care of nutrient removal. The up-flow anaerobic blanket reactor (UASB) is a single tank in which wastewater enters the chamber from below and is made to flow upwards; a suspended sludge blanket comprising microbial granules (microbe agglomerations) treats the wastewater as it flows through it.

**Sewage Treatment, KR Puram STP**



Source: <https://www.downtoearth.org.in/news/chance-of-revival-for-bengalurus-dying-lakes---40312>

Apart from preventing pollution of the Vengayyana lake, the project has also increased the capacity utilization of the STP. The total installed capacity of STPs in Bengaluru is 721 MLD, but only 56 per cent of Bengaluru's installed STP is utilized because of poor sewerage network.

The new system consumes minimal resources, can be installed in seven to eight days and the results are instant.

**Public and Private Participation:**

KSPCB is now planning to ask industries and builders to take responsibility of restoration of lakes polluted by them. The board is also planning to look for ways to use water cess charged by the water utility for lake restoration.

**Reference:**

<https://www.downtoearth.org.in/news/chance-of-revival-for-bengalurus-dying-lakes---40312>

### 3. KAIKONDRAHALLI LAKE, BANGALORE

**Population of the city:** 84.3 lakhs

**Area:** 19.4 ha

**Depth:** 2.5 metre

**Time Frame:** 2009 - 2012

**Cost:** Rs.7.5 crores

**Implementing Agency:** Bruhat Bengaluru Mahanagara Palike

**Issues:**

- Severe inflow of sewage
- Silting and settled deposits
- Dumping of debris and waste
- Land formation owing to eutrophication
- Encroachments

**Kaikondrahalli lake, Bangalore**



Source: <https://niti.gov.in/writereaddata/files/bestpractices/>

**Key Stakeholders:** BBMP, MAPSAS, United Way and Revenue Department

**Strategy:**

The BBMP used a phased approach for lake restoration, primarily because it did not have access to adequate funds to begin with.

**Phase I: December 2009 to March 2011**

1. Demarcation of the lake's boundaries to enable a precise mapping of the lake and to stop any encroachment in coordination with the revenue department.
2. Lake encroachers were then served eviction notices through the tehsildar.
3. The sewage inflow was diverted through a pipeline.
4. The next step was aimed at de-silting of the lake. The unruly vegetation growth in the lake was cleared before de-weeding and de-silting of the lakebed. These efforts increased the lake's depth by an additional metre and increased its storage capacity by 54%.
5. The restoration drive also involved the development of inlets and outlets to improve the flow of water, embankments and revetments, and a pathway around the lake.

**Phase II: September 2011 to March 2012**

1. A fence was constructed around the lake along the demarcated boundary.
  2. The lake periphery was afforested to improve water quality and prevent soil erosion.
  3. Separate ponds were constructed for religious activities to avoid pollution in the lake.
- Kaikondrahalli was then developed into an aesthetic and recreational urban space, with facilities like walking/ jogging pathway around the lake perimeter, a 2.5-km cycling track, an amphitheater for cultural performances, and pergolas and toilets.

**Monitoring:**

After project completion, the task of monitoring and maintenance was handed over to the local community. To this end, a tripartite agreement was signed between the following agencies:

- 1) Mahadevapura Parisara Samrakshane Mattu Abhivrudhi Samiti (MAPSAS), a society formed by residents and concerned citizens with the objective of safeguarding Kaikondrahalli
- 2) United Way, a U.S.-based NGO that funds community action
- 3) BBMP

While MAPSAS was given the responsibility of maintaining the facilities at the lake, BBMP agreed to fund any major repair work. The maintenance responsibilities included security, gardening, cleanliness, maintenance of fences and lighting. All fishing activities in the lake were stopped. This gave the local community control over their common property and enabled more effective monitoring and maintenance of the lake.

**Challenges:**

Kaikondrahalli continues to be threatened by new sources of sewage coming from the recently urbanized parts of Bengaluru. There are multiple administrative agencies involved in regulating the generation and management of sewage and solid waste, and effective coordination for concerted action remains a challenge. Also, the local community currently lacks funds to provide for adequate security personnel, owing to the high cost of human resources, thereby limiting the efficacy of security and site monitoring. The maintenance and monitoring of the lake is now largely dependent on funding from an international NGO, which could stop at some point. Thus, it is imperative that a stable source of funding be developed, either through commercial activities in the lake or through budgetary allocation.

The Kaikondrahalli model could be enhanced by putting a state-level nodal authority in charge of the lake and providing budget allocation for community-based monitoring.

**Reference:**

<https://niti.gov.in/writereaddata/files/bestpractices/>

**4. HEBBAL LAKE, BANGALORE**

**Population of the city:** 84.3 lakhs

**Area:** 75 Ha

**Implementing Agencies:** Lake Development Authority, Karnataka

**Time Frame:** 1998

**Cost:** Rs. 2.7 Crore (Indo-Norwegian Environment Programme)

Hebbal Lake is habitat for various local and migratory birds. It is used for different purposes like domestic water use, livestock water use, pisciculture by fisheries department, agriculture in catchment area and boating.

**Hebbal Lake, Bangalore**



Source: [http://globalbizresearch.org/chennai\\_conference/pdf/pdf/ID\\_C455\\_Formatted.pdf](http://globalbizresearch.org/chennai_conference/pdf/pdf/ID_C455_Formatted.pdf)

**Issues:**

- Catchment is covered by buildings and industries
- Water is polluted due to storm water channels drained into the lake, human activities like bathing washing clothes, idol immersions etc and toxic elements from the agricultural fields.
- Fishes and birds died due to pollution and dehydration
- Groundwater contamination

**Interventions:**

- Lake cleaning, de-weeding, desilting (by mechanical means using excavator) is done with the support of experts, forest department.
- Structural measures and surplus flow arrangement are proposed to isolate the lake from sewage to keep it clean.
- Other recommendation included construction of silt trap, providing sanitary facilities, STP, solid waste collection and disposal arrangement, awareness campaign, environment education and lake front development for recreation (VIMOS Technocrats and Associates, n.d.).
- Islands with fruit- bearing trees were created for birds in the lake.

**Implementation and Funding:**

Department of Forest, Ecology and Environment and Government of Karnataka made effort to rejuvenate Hebbal Lake. Hebbal Lake Park Association (HELPA) was formed in 2002 for conservation and management of Hebbal Lake.

After Privatization Lake dredging was done even though earlier dredging was done under INEP. Privatization neglected the restoration and conservation measures and concentrated more on Tourism oriented development via developing jogging track, boating facilities, food courts and park.

**Reference:**

[http://globalbizresearch.org/chennai\\_conference/pdf/pdf/ID\\_C455\\_Formatted.pdf](http://globalbizresearch.org/chennai_conference/pdf/pdf/ID_C455_Formatted.pdf)

**5. NARAYANPURAM LAKE, CHENNAI**

**Population of the city:** 70.9 lakhs

Narayanapuram Lake has been split in two by the 200 feet road and a badminton court, and a temple constructed illegally. Water hyacinths need to be removed to increase the holding capacity of the lake. On the channel connecting Kilkattalai and Narayanapuram Lake except for the initial 100m stretch the waterway has been heavily encroached on one side by private residences that have reduced the channel's width to 40 feet or even 15 feet at many places from an original width of 60 feet. The entire stretch is now clogged with garbage and construction debris, resulting in floods during December 2015.

**Narayanapuram Lake, Chennai**

Once invasive water hyacinth was removed and the inflow of sewage was plugged the water level in lake started recharging the groundwater table in localities too.

Untreated sewage causes contamination. After the lake was restored typha reed started growing in a portion of the lake indicating the improvement in the ecology of the lake. This reed does not allow water hyacinth to grow.

## 6. KANKARIA LAKE, AHMEDABAD

**Population of the city:** 55.7 lakhs

**Area of the lake:** 31 Ha

**Depth:** 6- 7 metre

**Time Frame:** 2008

**Cost:** Rs. 36 Crore

**Implementing Agencies:** Ahmedabad Municipal Corporation

### Kankaria Lake, Ahmedabad



Source: [http://globalbizresearch.org/chennai\\_conference/pdf/pdf/ID\\_C455\\_Formatted.pdf](http://globalbizresearch.org/chennai_conference/pdf/pdf/ID_C455_Formatted.pdf)

It acts as a Tourist place which attracts the people of all age group not only from India but also from abroad. It acts as a social performance and congregation platform for events like Ras Garbha, Kankaria Carnival and Dog show by Police.

#### **Issues:**

This Lake is in danger of drying due to siltation and has reduced from 16-17 feet depth to 10-12 feet depth.

#### **Interventions:**

- AMC took up the work of de-siltation and cleaning of lake.
- They also developed Lake front providing facilities like Toy Train, Indoor sports Stadium, Laser show, Jogging Track, Aquarium, Zoo, Park (Nagina wadi), Amusement Park (Balwatika) Butterfly Park, Food Court, Lighting.

#### **Reference:**

[http://globalbizresearch.org/chennai\\_conference/pdf/pdf/ID\\_C455\\_Formatted.pdf](http://globalbizresearch.org/chennai_conference/pdf/pdf/ID_C455_Formatted.pdf)

## 7. HUSSAIN SAGAR LAKE, HYDERABAD

Hussain Sagar Lake is one of the largest man made lake situated at the confluence of Hyderabad, Secunderabad and Begumpet. It is a sprawling artificial lake that holds water perennially. Its uniqueness lies in the fact that it connects the twin cities of Hyderabad and Secunderabad.

**Population of the city:** 68.1 lakhs

**Area:** Catchment area of the lake is about 600 hectares and water spread area at full supply level is 220 hectares.

**Time Frame:** The lake was built in the year 1575 by Sultan Ibrahim Kutb Shah

**Cost:** Rs. 2.5 lakhs

**Implementing Agency:** Bruhat Bengaluru Mahanagara Palike

### Hussain Sagar Lake



Source: [http://www.rainwaterharvesting.org/hussain\\_sagar/hussain\\_sagar.htm](http://www.rainwaterharvesting.org/hussain_sagar/hussain_sagar.htm)

### Issues:

The main threat to the lake is encroachment by both private and public agencies. In the past 30 years, the lake has shrunk about 40 % of its original size (550 ha to 349 ha).

The lake also faces the problem of pollution due to the continuous discharge of untreated domestic sewage and toxic industrial chemicals for several years.

Although several Central Effluent Treatment Plant and Sewage Treatment plant have grown up to restrict the pollution yet a considerable amount of sewage flows into the lake.

A number of tourism-related beautification works carried by HUDA (under the aegis of Buddha Purnima Project Development Authority) around Hussain Sagar could be considered a serious violation of its own notification.

The water quality has been deteriorating by the year, killing the lake's own ecosystem and making the groundwater in the vicinity highly toxic for human or animal use.

### Hussain Sagar



Source: [http://www.rainwaterharvesting.org/hussain\\_sagar/hussain\\_sagar.htm](http://www.rainwaterharvesting.org/hussain_sagar/hussain_sagar.htm)



Rs 1,034 crore has been spent on 'cleansing' the lake in the last 15 years. The latest in the series of expenditure is Rs 280 crore in 2016, spent by Hyderabad Metropolitan Development Authority on "restoration and management" of Hussainsagar. The money was from the funds extended by Japan International Cooperation Agency (JICA).

**Strategy:**

The Rs 300-crore Hussain Sagar Restoration Project aided by the Japan Bank for International Cooperation has made little progress though five years have passed since its launch. Although the Hyderabad Metropolitan Development Authority (HMDA) has allocated Rs 300 crore for cleaning the Hussainsagar lake, the authorities do not have machinery to clean the algae. They are depending on workers to clean it.

**Reference:**

[http://www.rainwaterharvesting.org/hussain\\_sagar/hussain\\_sagar.htm](http://www.rainwaterharvesting.org/hussain_sagar/hussain_sagar.htm)

## 8. RABINDRA SAROBAR LAKE OR DHAKURIA LAKE, KOLKATA

The Rabindra Sarobar Lake (previously called Dhakuria Lake), a lake of National Importance and the second largest water body (an artificial lake) in Kolkata, is situated in the southern part of the cityscape, within the roars and hustle-bustle of this busy and pollutant – ridden city. The Lake is known as the "Lungs of the city".

**Rabindra Sarobar Lake**



Source: <https://www.cseindia.org/cases-on-protection-of-lakes-2556>

**Population of the city:** 45 lakhs

**Area of Lake:** 48 hectares and comprises several smaller water bodies

**Time Frame:** It was dug in 1920s. The Calcutta Improvement Trust (CIT) decided to take over the entire area, beautify it.

**Cost:** In 2003, Rs 4 crores sanctioned under the National Lake conservation Scheme. State sanctioned 2 crores in 2006 for its beautification.

**Implementing Agencies:** The Kolkata Improvement Trust and the Eastern Railways under the National Lake conservation Scheme (2003) started to work for beautification of the area along with slum rehabilitation and resettlement.

**Issues:**

**A. Degrading Water Quality**

- The lake is suffering from environmental degradation. The water quality of the lake has deteriorated and is heavily polluted as large numbers of people are using its waters for washing and bathing purposes daily.
- The high pathogenic load in the water has been attributed to direct mixing of animal and human wastes into the lake water promoting eutrophication as well as high loads solid organic matter in the water.

- Increase in alkalinity and turbidity.
- Non-biodegradable items like plastic bottles, cups and packets and the practice of idol immersions by indiscriminate dumping of different idols as part of the Hindu celebration and rituals directly into the lake water has been another important causal factor contributing to serious water pollution through the leaching of synthetic lead based paints from immersed idols into the water body.
- In addition the putrefaction of the water due to dumping of flowers, fruits and different synthetic materials associated in the manufacture of the idols causing long term environmental damages to the aquatic ecosystem.

#### B. Encroachment and Surrounding land-use:

- Due to encroachment, the lake has shrunk beyond recognition.
- One of the distinguishing characteristics of the lake is the abundance of swimming pools and rowing clubs on the periphery since colonial times. None of these clubs however have any wastewater treatment plant and the entire release from these busy hubs of urban entertainment drain into the lake.
- Illegal construction and encroachment of the lake by one of the private clubs have been going on continuously.

#### C. Disturbances to biodiversity

- The unrestricted growth of aquatic vegetation transforming into thick floating vegetative mat along with receding water level at several edges and corners of the lake has been a common problem.
- The edge of the shore has accumulated huge vegetation mats trapping a large quantity of floating garbage and slowly deteriorating the water quality of the lake.
- Growth of water hyacinth (*Eichhorniacrassipes*) has resulted in bleaching of oxygen causing harm to fishes.
- Mass decimation of the aquatic species has occurred.
- Due to the frequent rowing events organized by the clubs, there has been a drop in the number of avian visitors to the lake.
- The strong light and noise from various events in the lake premises has been a cause of concern for the birds.

#### D. Concretization

- The beautification drive by the Kolkata Improvement Trust (KIT) includes creation of concretized pathways and sitting areas and installation of decorative lights along the shores of the lake. The concretized pathways that runs close to the water edge, has serious implications on the water quality and overall aquatic biodiversity. Due to the cementing of the bases of the trees in the lake premises, the roots of many trees have inadequate soil and water – leading to gradual weakening of roots and consequent withering of the trees.

#### E. Authority

- The authorities in charge of the lake do not take enough initiatives to clean and remove the vegetation regularly.
- The local administration is not able to control the rampant and unregulated entry of hawkers into the lake arena.

#### **Strategy:**

The transition of the Rabindra Sarobar Lakes, from marshy jungles to its present-day condition, was done under the supervision of the Calcutta Horticultural Society. During the lake excavations, some blocks of earth which were left undisturbed in the centre of the lake, were raised and planted with trees and flowering shrubs. These earth blocks are now islands, and are extremely attractive features of the lake. As per studies on the flora of Rabindra Sarobar, it was found that in the present time nearly 366 species of terrestrial vascular plants and around 7,000 trees are found in the Lake premises. Some parts of the lake have emergent and floating vegetation like Lotus and other vascular plants. Some medicinal plants like *Aegle marmelos*, *Aloe vera*, *Azadirachta indica* etc were also documented within the lake premises. Considering its importance, the lake was declared as a “National Lake” in 1997, under the National Lake

Conservation Programme of the Ministry of Environment, Forest & Climate Change

The lake serves as an important accessory lung, which provides a natural carbon-dioxide sink of the metropolitan city, apart from its pristine beauty and aesthetic value. A major environmental reserve with huge amenity and recreational value, the lake ecosystem plays a role in urban ecology and societal benefit and also serves as a suitable habitat for a variety of amphibians, fishes, reptiles, waterfowl and migratory birds.

#### **Methodology:**

The Rabindra Sarobar Lake and its surrounding area, play a very important role in maintaining the ecological balance of the city of Kolkata. The environmental imbalance that has occurred in the Lake area deserves special consideration and steps have to be taken by the Government authorities to control the situation and to restore the original ambience as well as aquatic and terrestrial biodiversity of the Sarobar area.

1. There must be regular awareness programmes in the Rabindra Sarovar area to educate people and make them aware about nature, plants, animals and biodiversity.
2. The area must be developed with more trees and wild indigenous fruit trees that have a large canopy must be introduced to give shelter and food for the small animals and birds. By conserving plant diversity around Rabindra Sarobar, the variety of insect life will also be conserved.
3. The islands in the middle of the lake should be free from all sorts of developmental activities, as they are vital nesting habitats of many water-birds as well as many migratory birds that visit the lakes. The bottom of the lake should be cleaned of garbage and pollutants as the lake water is vital for the survival of aquatic animals like turtles, amphibians and fishes.
4. Sewage should be strictly discharged into underground drainage line of the municipality. Any sewage or garbage generated in clubs and/or in other areas should never be discharged /deposited in the lakes.
5. Anthropogenic activities in the lake area should be restricted.
6. The KIT and other Government authorities must make people (who practice Chhat puja in the lake premises) aware of the problems resulting from Chhath Puja in the lakes.
7. The restoration measures planned for the lake include in-situ treatment through bioremediation using “Continuous Laminar Flow Inversion + Oxygenation” and introduction of indigenous fish for controlling mosquitoes. Other measures include the improvement of drainage and sanitation in the surrounding areas, shoreline protection by bamboo piling and improvement of aesthetics.

The importance of the RabindraSarobar Lakes cannot be overstated. Lack of education, awareness and sensitivity towards the local ecology and environment has contributed towards the lack of apathy in conserving it efficiently.

#### **References:**

1. <https://www.saevus.in/saving-rabindra-sarobar-an-oasis-in-the-city-of-kolkata/>
2. <https://www.cseindia.org/cases-on-protection-of-lakes-2556>
3. <http://webtest.wbpcb.gov.in/contents/view/4/30/18-reports>
4. Smart City Proposal (SCP)

## **9. KATRAJ LAKE, PUNE**

Katraj Lake is one of the important lakes in Pune Maharashtra which has a historical significance and it is situated in south Pune. It is a manmade lake built at the time of peshwa in the south Pune. The lake consists of two different proportion system that id dam and canals.

**Population of the city:** 31.2 lakhs

**Area of Lake:** The lake having total area of land is 82 hectares out of these 66 hectares belongs to the Pune municipal corporation. The remaining 65 acres are under the lake water.

**Time Frame:** In 1749 the water supplies system which was commissioned from “Ambil Odha” that flows down towards Katraj ghat.

**Depth:** 5 to 6 meters

### Katraj Lake, Pune



Source: Google maps

#### Issues:

- The pH of the Katraj Lake exceeds the desirable range of BIS and MPCB standards which means the present water in Katraj Lake is in alkaline condition.
- There is a difference found in both of the season that is in monsoon and post monsoon, in monsoon season the value of pH is slightly below as per the desirable standards of BIS and MPCB, but in post monsoon season it exceeds the limit as per BIS and MPCB.
- The Katraj Lake acts as sedimentation basin, because the dilution from rain to the lake body has been observed.
- Biochemical Oxygen Demand (BOD) concentration are found very high in Lake Water samples.
- Weed infestation.
- Waste water, sewage, slit etc are entering to the lake from their external source.
- The main cause for the degradation of the lake is due to the drainage pipeline the sewage is coming from the surrounding local residential area that degraded the water quality of lake which promotes to grow water hyacinth in Katraj Lake.

#### Strategy:

- Presently the lake water is just used for gardening purpose or sprinkling the water to the plants of the campus of Bharati Vidyapeeth Institute.
- The Pune Municipal Corporation has a plantation activity for the area in around 40 hectares of land.
- Removal of weeds by natural process is important, the diversion of drainage line is important because of from the drainage line the sewage is coming from the local resident and degrading the quality of the lake water.
- There is a need to place aerators in the lake that may help to control the fish's death rates, because they are at extinct level.
- Other precautions need to be taken, then the lake water is use for some recreational purposes and the aquatic life of the lake will survive.

#### Management Plan:

The restoration programmes with an ecosystem approaches through the managements planning helps in correcting the point source and non-point source of pollution. The management planning includes:-

- Public participation
- Environmental Awareness
- Environmental Planners
- Research students' opportunities

- Shore line treatment of the Katraj Lake.
- Promoting public Education Programmers
- Awareness for zoo authorities' workers and members
- Removal of weeds from the Lake must be used for composting instead of These are solutions which can help for the recovery of the Katraj Lake.

**Reference:**

1. <https://www.irjet.net/archives/V6/i3/IRJET-V6I3881.pdf>

**10. JAMBHULWADI LAKE, PUNE**

Jambhulwadi lake is located at Ambegaon Khurd, Off Pune-Banglore Highway. It is about 15 km from the city.

**Population of the city:** 31.2 lakhs

**Area of Lake:** The lake having total area of land is 82 hectares out of these 66 hectares belongs to the Pune municipal corporation. The remaining 65 acres are under the lake water.

**Jambhulwadi Lake, Pune**



Source: Google maps

**Cost:** Rs. 5 crore

**Implementing Agency:** PMC

**Issues:**

- Ambegaon village has recently come under the jurisdiction of Pune Municipal Corporation (PMC), causing heavy urbanization in the area which has taken a toll on the lake, disturbing its equilibrium of self cleaning.
- Dumping of construction debris, a constant flow of sewage water from neighbouring areas and unkempt surroundings have already damaged the water body, reducing the size of the lake.
- Not enough water treatment measures being taken.

**Strategy:**

Rs 5 crores has been sanctioned for conservation and beautification of the lake. "All environmental aspects have been considered and hence the priority is setting up a water treatment plant and separate drainage lines.

**Reference:**

1. <https://punemirror.indiatimes.com/pune/civic/development-of-jambhulwadi-lake-might-affect-the-ecosystem/articleshow/68432530.cms>

**11. MANSAGAR LAKE, JAIPUR**

**Population of the city:** 30.7 lakhs

**Area of lake:** 121.4 ha

**Depth of lake:** 3 metre

**Time Frame:** 2007 - 2015

**Cost:** Rs. 20 Crores

**Implementing Agency:** Jaipur Development Authority (under NLCP), Jal Mahal Resorts Pvt. Ltd.

**Key Stakeholders:** Jal Tarang, JDA, Forest Department, Irrigation Department

The lake was built by constructing a dam on river Darbhawati, to address the drought in the surrounding lands. The catchment area of the lake covers an area of 23 – 24 km<sup>2</sup> and has hills surrounding the lake on three sides and the Jaipur city on the fourth side (south of the lake).

**Mansagar Lake, Jaipur**



Source: Google maps

**Issues:**

- Heavy pollution load is carried by Nagtalai and Brahmapuri drains from this urbanized catchment.
- Growth of aquatic weed like water hyacinth suppressed the algal growth and added dead organic pollution load leading to decrease in the fish count in the water body.
- The aquatic life of the lake deteriorated, and migratory birds stopped arriving to this natural habitat.
- An unbearable stench emanated from the lake and the lakebed got filled with sewage-soaked silt, which posed an environmental and health hazard.
- The lake turned into a mosquito breeding ground.

### Strategy:

- The strategy to restore the lake was based on a public-private model, wherein the private player would clean and maintain the lake and the palace, and the government would lease out 100 acres of land in the vicinity of the lake to the private player to develop it for tourism and recreation activities and recover the invested amount.
- The first step taken was to check the sewage and solid waste from entering the lake through drains. A 1.5-km channel was constructed as part of the initiative to divert drain and storm water into a 7-metre-deep sedimentation basin constructed on the east side of the lake (towards dam). This led to the physical screening of water and removal of solid waste and pollutants from the water (primary screening).
- Simultaneously, second step taken up by the private player was the dredging of the lake bed. This increased the lake's depth from 1.5 meter to more than 3 meters, which helped in increasing the storage capacity of the lake.
- Apart from these two major steps, two sewage treatment plants were also constructed to treat 7 million litres of wastewater daily and discharge the treated water into the lake. This source of water helped in ensuring supply of water to the lake.
- To attract flora and fauna, five nesting islands were created to attract migratory birds, fishes were introduced, and giant bubblers were installed for aeration of the lake.

### Mansagar Lake Layout



Source: <https://niti.gov.in/writereaddata/files/bestpractices/>

### Challenges:

At present that the lake front is not clean. The water at the edges of the lake, near the promenade, is littered and solid waste is visible, which is visually an unpleasant sight. The practice of feeding breadcrumbs to fishes in the lake is partly to be blamed for the littering.

Lack of dustbins along the promenade, despite many street vendors and food stalls, is another reason for poor solid waste management in the area.

### Reference:

<https://niti.gov.in/writereaddata/files/bestpractices/>

## 12. THANE, MAHARASHTRA

**Population of the city:** 18.9 lakhs

### **Implementing Agencies and Funding:**

Lakes within the municipal area were leased out on BOT (Build Operate and Transfer) purpose for 25 years to private contractors in 2004. The funding was done under NLCP.

There are over all 35 lakes in the district of Thane, Maharashtra. The lakes are fed by the run off from the surrounding highlands. These lakes help in the overall recharge of the groundwater in the district.

There are over all 35 lakes in the district of Thane, Maharashtra. The lakes are fed by the run off from the surrounding highlands. These lakes help in the overall recharge of the groundwater in the district.

### **Thane, Maharashtra**



Source: Google maps

### **Issues:**

- Encroachment and unplanned development
- Deforestation and flow of silt into the water body
- Solid waste disposal

### **Interventions:**

- Identification and demarcation of lake boundaries.
- Short reinforced cement concrete walls were raised around the water bodies. This measure prevented further encroachment into the lake beds.
- Lake beds were desilted.
- The pollution level of the lakes was tackled through bioremediation and surface aeration processes.
- Filter beds, comprising of small irregular rocks have been put around lakes. These rock pieces give a primary level filtration to the impurities entering into the lakes.
- The corporation has implemented a three- level plantations around the lake peripheries. Vativar and typha plantations have been planted at the lowest level followed by flowering plants and big trees along the jogging track.



- The concept of “Nirmalya Kalash” has been introduced by the TMC around each lake bed to collect the solid waste. The waste collected is further sent for vermi composting. The compost thus generated is used as manure for landscaping purposes and is also sold to the city’s nurseries.

#### Thane, Maharashtra



Source: [https://www.indiawaterportal.org/sites/indiawaterportal.org/files/churning-still-water\\_briefing-paper\\_cse\\_2012.pdf](https://www.indiawaterportal.org/sites/indiawaterportal.org/files/churning-still-water_briefing-paper_cse_2012.pdf)

#### Reference:

[https://www.indiawaterportal.org/sites/indiawaterportal.org/files/churning-still-water\\_briefing-paper\\_cse\\_2012.pdf](https://www.indiawaterportal.org/sites/indiawaterportal.org/files/churning-still-water_briefing-paper_cse_2012.pdf)

### 13. HUBLI DHARWAD, KARNATAKA

The city is blessed with hillocks, lakes, plains and also a salubrious climate. The urban pressure was resulting in encroachment of lakes, the water bodies were dying.

**Population of the city:** 9.44 lakhs

#### Objective:

To give the city a unique identity and consciousness, which was healthy, sustainable, improved the quality of life the people and dispelled the feeling of neglect.

#### Issues:

- Entry of sewerage into the lakes
- Encroachment
- Parks were getting covered with unhealthy vegetation, urban garbage, and becoming haven for anti-social elements.

#### Hubli Dharwad, Karnataka



Source [http://www.itpi.org.in/uploads/journalfiles/oct\\_13.pdf](http://www.itpi.org.in/uploads/journalfiles/oct_13.pdf)

#### Interventions:

- Boundary fixation of lakes and encroachment removal.
- Diversion of sewerage water entering the lakes.
- New bund formation, strengthening of existing bund, waste weir improvement and de-silting to increase water storage
- Providing fencing, water supply and electrification

- Afforestation, Landscaping, pathways and associated amenities.
- Developing parks and lakes as recreational and cultural centres for all age groups.

**Examples:**

**Sadhan Kere (Lake):**

**Area:** 5.5 ha

The lake had turned into a cess pool and anti-social activities were rampant around the lake. The possession of lake was taken from the Police Department and developed by converging funds of tourism department and special grants from Urban Development Department at a cost of Rs.3 crore. The lake now has boating facilities, amusement area and musical fountain and has a footfall of more than 20000 people every month.

**Jaynagar Kere (Lake):**

**Area:** 2.42 ha

This lake is located in the heart of Dharwad city. Major issues concerning the lake were siltation, entry of sewerage water and loss of its basic features.

Convergence of the amount from the Municipal Corporation, special grants from the Urban Development Department and the funds under Legislators' Local Area Development Scheme to undertake work for desilting, bund development, waste weir development, landscaping, pathway formation, fencing and other amenities was taken up at a cost of Rs.1.20 crores.

**Sadhan Kere (Lake)**



Source: Google maps

## 14. KARANJI LAKE, MYSORE

**Population of the city:** 8.87 lakhs

**Area:** 90 ha

**Ownership:** Mysore Zoo

**Implementing Agencies:** Karnataka Urban Infrastructure Development and Finance Corporation, Zoo Authority of Karnataka,

**Cost:** Rs.1.2 Crores by Asian Development Bank

### Karanji Lake, Mysore



Source: Google maps

### Issue:

The major issue is the entry of sewage in the lake from the nearby residential area.

### Strategy:

- The first step undertaken was to stop sewage from entering the lake.
- Other restoration activities included removal of polluted silt, de-weeding of the entire lake surface, removing 30 cm of silt from the lake, restoration of feeder channels, construction of a jetty to start boating facility and the construction of a bridge to the newly created 'butterfly park'.
- A watch tower was also constructed for viewing the birds and studying their behavior.
- A giant fountain which can spew water up to height of 40 feet was added as an attraction.
- In this eco-complex, a nursery of medicinal plants has also been raised.

### Karanji Lake, Mysore



Source: [http://www.itpi.org.in/uploads/journalfiles/oct\\_13.pdf](http://www.itpi.org.in/uploads/journalfiles/oct_13.pdf)

## References:

<http://www.siudmysore.gov.in/w&wwm/sep14/Day1.pdf>

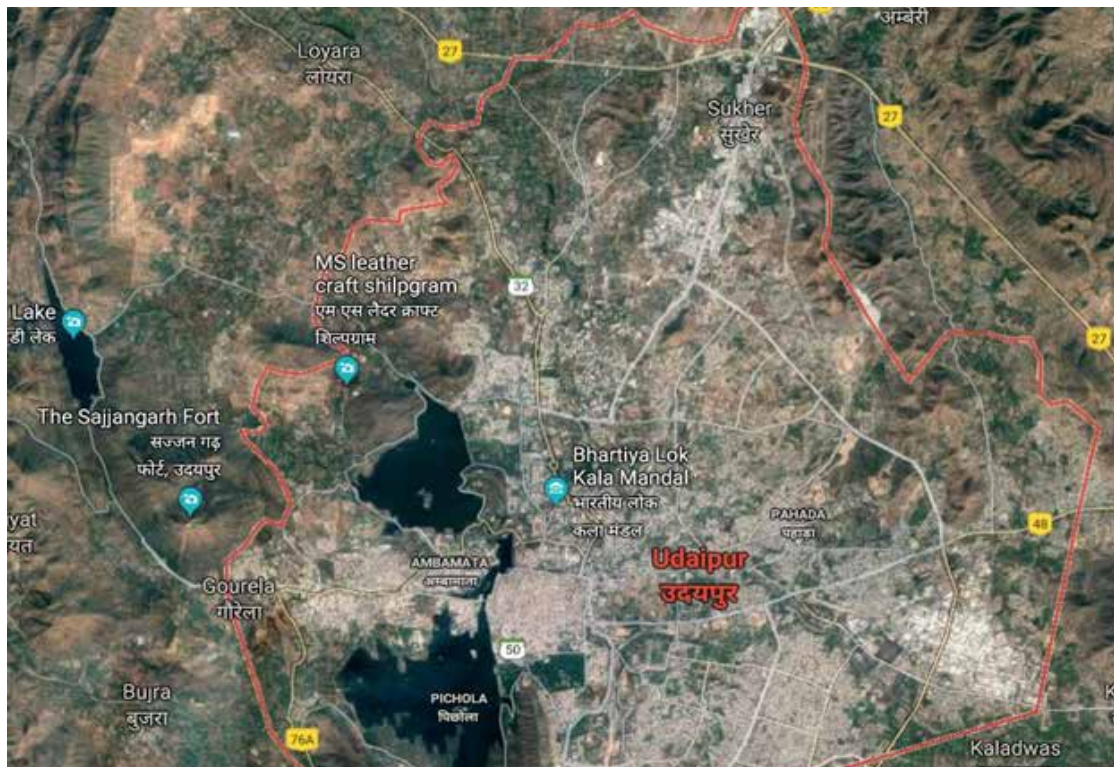
[http://www.itpi.org.in/uploads/journalfiles/oct\\_13.pdf](http://www.itpi.org.in/uploads/journalfiles/oct_13.pdf)

## 15. UDAIPUR, RAJASTHAN

Lakes are the lifeline and identity of Udaipur. These are also the most preferred places for denizens of the city for regular stroll/ outings.

**Population of the city:** 4.51 lakhs

### Udaipur, Rajasthan



Source: Google Map

## Issues:

The main contributing factor being, discharge of sewage water into the lakes; and pollution by local lake side activities like throwing of garbage etc. The discharges also contributed to siltation of the lakes.

## Interventions:

- The sewage discharge points closure and commissioning of sewage treatment plants
- Prohibition of idol immersion in the lakes
- Deployment of de-weeding machines for regular clearing of weeds from the lake
- Patrolling as well as CCTV based surveillance of the lakes
- Commissioning of Open Gyms

## Funding:

Project components are accessing funding from various sources including the Smart Cities Mission (SCM) funds, Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and National Lake Conservation Program (NLCP).

## Outcomes:

- Sewage discharge in the lakes has been stopped almost completely.
- Idol immersion in the lakes has now completely stopped, the separate tank provided for the purpose is being used by devotees.
- De-weeding is being done regularly in the lakes, contributing to its beauty
- Adverse local activities contributing to lake pollution/ detonation has been severely curtailed due to robust surveillance

- Open Gyms is being regularly used by citizens/ tourists

**Reference:**

<https://smartnet.niua.org/sites/default/files/resources/22.pdf>

**16. NAINI LAKE, UTTARAKHAND**

**Population of the city:** 41,377

**Area:** 49 Ha

**Depth:** 19.6 meter

**Implementing Agencies:** National Lake Region Special Area Development Authority supported by National River Conservation Directorate (MOEF).

Naini Lake is a natural freshwater lake, of tectonic origin, located amidst Nainital city of Uttarakhand. Naini Lake is one of the four lakes in Kumaon hills. Balia Nala is the main feeder-stream of the lake. Other than this, 26 major drains, including the three perennial ones, feed it.

**Naini Lake, Uttarakhand**



Source: Google Maps

**Issues:**

- Degradation in water quality due to large scale tourist influx
- Encroachment in catchment
- Siltation
- Increase in BOD levels due to municipal and domestic sewage dumping causing eutrophication
- Decrease in fish population and increase in harmful fish species harmful for the lake ecosystem

**Interventions:**

Bio-manipulation – Increasing the DO levels through aeration.

**17. UMIAM LAKE, MEGHALAYA (RURBAN)**

Umiam Lake is also known as Barapani or Big Water and is a scenic place tucked away amidst the hills of Meghalaya, around 15 Km from Shillong.

**Area:** The lake is spread over an area of 10 square km and the principal catchment area of the lake and dam is spread over 220 square km, which includes Shillong and its adjoining areas, besides a portion of Ri Bhoi district.

**Time Frame:** The origin of Umiam Lake in 1965 due to the Umiam Umtru Hydro Electric Power Project.  
**Implementing Agency:** The lake has been developed by the Meghalaya Tourism Department in spite of the fact that the management of the lake lies completely with the Meghalaya State Electricity Board.

### Umiam Lake, Meghalaya



Source: Google Images

#### Issues:

- Rapid urban growth has transformed Umiam into a sink for Shillong's waste and natural streams/ rivers feeding the lake into open drains.
- Recent research by Central Pollution Control Board (CPCB) confirms that the water is contaminated with sewage and alter its biological character.
- As per CPCB norms for lakes and other surface water bodies, Umiam is polluted and water is unfit for any domestic use except irrigation without conventional primary treatment.
- The pollution problem is further compounded increasing levels of silt in the streams & rivers and resultantly in Umiam. An estimated 40,000 cubic metres of silt enter Umiam Lake every year and has lowered the lake's storage.
- Causes range between upstream encroachments, deforestation, blockage of natural drainage systems and unscientific mining et al in the catchment area.

#### Strategy:

The North East Council had submitted a proposal of Rs. 19.92 crores to revive the lake after going through the report. The proposal has not been implemented till date. The life of the dam was estimated to be around 200 years at the time of commissioning. Yet hydrographic survey, water-quality analysis and catchment assessment, including sediment flow rate data, reveal the astounding fact that Umiam Lake will not survive for more than 30 to 35 years if the existing situation continues unabated. Recently the Union Minister of Environment and Forest, Jairam Ramesh, has assured of visiting Shillong and discuss the details of the steps to be taken to revive the lake's ecology.

#### References:

[http://www.rainwaterharvesting.org/umiam\\_lake.htm](http://www.rainwaterharvesting.org/umiam_lake.htm)

## 19. THENDRAL LAKE PROJECT, NARASIMAN KADU VILLAGE (RURBAN)

A village nestled in the foothills of the Kolli Malai in Tamil Nadu, is a predominantly tribal area.

**Time Frame:** 2017

**Implementing Agency:** Wake Our Lake, an organisation which has actively revived the water resources in Kolli Hills.

#### Issues:

- Once covered with lush green, the area had turned into parched lands.
- The area was drought-ridden.

- The groundwater level in the area had depleted drastically, with 800-1000 feet deep borewells gone dry.
- Most of the natural vegetation in the area has dried up, forests were dying, and the crops were failing.
- Drinking water was becoming scarce.
- There was not a drop of water in the lake, and its wide catchment area had shrunken in the absence of an inlet channel.

**Key Stakeholders:** Tribal, students, activists

### Inlet channel to the lake



Source: <https://thelogicalindian.com/my-social-responsibility/wake-our-lake>

### Strategy:

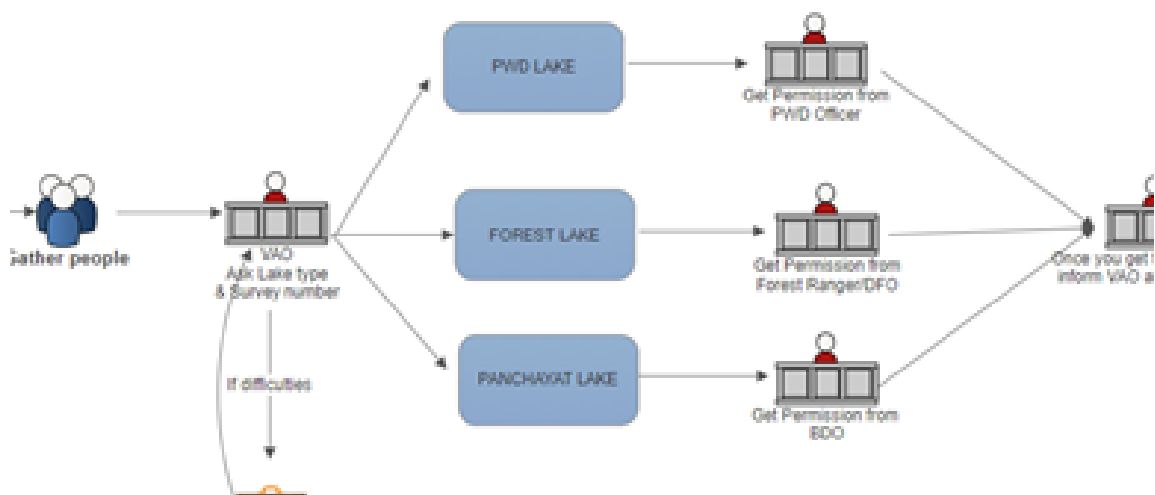
- To rejuvenated the water bodies and relieved the local communities of a drought-like situation.
- Started digging a 1 km long canal manually from the adjacent hills to the lake.
- When the rains came, the lake was filled overnight.

### Lake rejuvenation, Thendral Lake



Source: <https://thelogicalindian.com/my-social-responsibility/wake-our-lake>

### Lake Permission flow chart



**Challenges:**

Getting permission from the Forest Department was a major challenge, as they were apprehensive about the efficiency of the local people, and so were the villagers

**Reference:**

1. <https://thelogicalindian.com/my-social-responsibility/wake-our-lake/>

## 20. PANJAPATTI LAKE REJUVENATION (RURBAN)

The most notable project of Wake Our Lake has to be the Panjapatti Lake rejuvenation.

**Implementing Agency:** Wake Our Lake.

**Issues:**

Due to the overabundance of a flowering weed, the entire catchment area and natural flora were slowly drying up.

**Key Stakeholders:** With the help of experts and NSS students.

**Strategy:**

Spread awareness among the villagers, and every weekend they actively participated in manual weeding. Teaming up with a green power generation company, they deployed a special crawler machine that uproots, crushes and converts the weed into reusable biomass.

**Challenges:**

The strenuous efforts failed to be at par with the vigorous growth rate of the plant.

**Reference:**

- <https://thelogicalindian.com/my-social-responsibility/wake-our-lake/>

### Panjapatti Lake





## 21. PUNNAGAI LAKE REJUVENATION (RURBAN)

**Implementing Agency:** Wake Our Lake.

**Issues:**

Due to the overabundance of a flowering weed, the entire catchment area and natural flora were slowly drying up.

### Punnagai Lake



Source: <https://thelogicalindian.com/my-social-responsibility/wake-our-lake/>

**Key Stakeholders:** Tribal, students, activists

**Strategy:**

- Guided by ISRO soil scientist Dr P. Velmurugan, the team turned towards groundwater restoration.
- Beside the withering Punnagai Lake, they constructed a deep rainwater recharge pit, while also building check dams and bunds in the connecting streams, all from locally available resources. The rainwater recharge pit worked beyond their expectations to replenish the groundwater levels. Their success inspired the neighboring villagers to implement similar projects.

**Challenges:**

The strenuous efforts failed to be at par with the vigorous growth rate of the plant.

**Reference:**

<https://thelogicalindian.com/my-social-responsibility/wake-our-lake/>

# GLOSSARY



## A

**Aquaculture ponds (Man-made Coastal Wetlands):** Aquaculture is defined as “The breeding and rearing of fresh-water or marine fish in captivity. Fish farming or ranching”. The water bodies used for the above are called aquaculture ponds (Encyclopaedic Directory of Environment, 1988). Aquaculture ponds are geometrical in shape usually square or rectangular. Tone is blue.

## B

**Backwater (Natural Coastal Wetlands):** A creek, arm of the sea or series of connected lagoons, usually parallel to the coast, separated from the sea by a narrow strip of land but communicating with it through barred outlets (Margarate et al, 1974).

**Barrage (Man-made Inland Wetlands):** Dykes are constructed in the plain areas over rivers for creating Irrigation/water facilities. Such water storage areas develop into wetlands (Harike Barrage on Satluj – a Ramsar site, Okhla barrage on the Yamuna etc. – a bird sanctuary). Water appears in dark blue tone with a smooth texture. Aquatic vegetation appears in pink colour, which is scattered, or contiguous depending on the density. Reservoirs formed by barrages will be annotated as reservoir/barrage.

## C

**Coral reefs (Natural Coastal Wetlands):** Consolidated living colonies of microscopic organisms found in warm tropical waters. The term coral reef, or organic reef is applied to the rock-like reefs built-up of living things, principally corals. They consist of accumulations of calcareous deposits of corals and corraline algae with the intervening space connected with sand, which consists largely of shells of foraminefera. Present reefs are living associations growing on this accumulation of past (Clark, 1977). Reefs appear in light blue shade.

**Creek (Natural Coastal Wetlands):** A notable physiographic feature of salt marshes, especially low marshes. These creeks develop as do rivers “with minor irregularities sooner or later causing the water to be deflected into definite channels” (Mitsch and Gosselink, 1986). Creeks will be delineated, however, their area will not be estimated.

**Cultural services:** Ecosystems are a source of inspiration to human culture and education throughout recreation, cultural, artistic, spiritual and historic information, science and education.

## E

**Ecological character:** Ecological character means the sum of ecosystem components, processes and services that characterize the wetlands.

**Ecosystem Services:** Ecosystem Services are the benefits people get from nature. Tangible benefits include supplies of food and freshwater, flood mitigation and improvements to water quality. Less tangible benefits include contributions to cultures. (Ecosystems and Human Well-Being: Wetlands and Water, Synthesis Report, Millennium Ecosystem Assessment)

## H

**High Altitude lakes (Natural Inland Wetlands):** These lakes occur in the Himalayan region. Landscapes around high lakes are characterized by hilly topography. Otherwise they resemble lakes in the plain areas. For keeping uniformity in the delineation of these lakes contour line of 3000 m above msl will be taken as reference and all lakes above this contour line will be classified as high altitude lakes.

## I

**Integrated management plan:** Integrated management plan means a document which describes strategies and actions for achieving wise use of the wetland and the plan shall include objectives of site management; management actions required to achieve the objectives; factors that affect, or may affect, the various site features; monitoring requirements for detecting changes in ecological character and for measuring the effectiveness of management; and resources for management implementation.

**Intertidal mudflats (Natural Coastal Wetlands):** Most non-vegetated areas that are alternately exposed and inundated by the falling and rising of the tide. They may be mudflats or sand flats depending on the coarseness of the material of which they are made (Clark, 1977).

## L

**Lagoons/Backwaters (Natural Coastal Wetlands):** Such coastal bodies of water, partly separated from the sea by barrier beaches or bars of marine origin, are more properly termed lagoons. As a rule, lagoons are elongate and lie parallel to the shoreline. They are usually characteristic of, but not restricted to, shores of emergence. Lagoons are generally shallower and more saline than typical estuaries (Reid et al, 1976).

**Lakes (Natural Inland Wetlands):** Larger bodies of standing water occupying distinct basins (Reid et al, 1976). These wetlands occur in natural depressions and normally fed by streams/streams. On satellite images lakes appear in different hues of blue interspersed with pink (aquatic vegetation), islands (white if non-vegetated, red in case of terrestrial vegetation). Vegetation if scattered make texture rough.

## M

**Mangroves (Natural Coastal Wetlands):** The mangrove swamp is an association of halophytic trees, shrubs, and other plants growing in brackish to saline tidal waters of tropical and sub-tropical coastlines (Mitsch and Gosselink, 1986). On the satellite images mangroves occur in red colour if in contiguous patch. When mangrove associations are scattered or are degraded then instead of red colour, brick red colour may be seen.

**Marsh (Natural Inland Wetlands):** A frequently or continually inundated wetland characterized by emergent herbaceous vegetation adapted to saturated soil conditions. In European terminology a marsh has a mineral soil substrate and does not accumulate peat (Mitsch and Gosselink, 1986). Tone is grey blue and texture is smooth.

## O

**Ox-bow lakes/ Cut off meanders (Natural Inland Wetlands):** A meandering stream may erode the outside shores of its broad bends, and in time the loops may become cut-off, leaving basins. The resulting shallow crescent-shaped lakes are called oxbow lakes (Reid et al, 1976). On the satellite image Ox-bow lakes occur near the rivers in plain areas. Some part of the lake normally has aquatic vegetation (red/pink in colour) during pre-monsoon season.

## P

**Provisioning services:** The resources or products provided by ecosystems, such as food, raw materials (wood), genetic resources, medicinal resources, ornamental resources (skin, shells, flowers).

## R

**Ramsar Convention:** Ramsar Convention means the Convention on Wetlands signed at Ramsar, Iran in 1971.

**Regulating services:** Ecosystems maintain the essential ecological processes and life support systems, like gas and climate regulation, water supply and regulation, waste treatment, pollination, etc.

**Reservoir (Man-made Inland Wetlands):** A pond or lake built for the storage of water, usually by the construction of a dam across a river (Margarate et al, 1974). On RS images, reservoirs have irregular boundary behind a prominent dyke. Wetland boundary in case of reservoir incorporates water, aquatic vegetation and footprint of water as well. In the accompanying images aquatic vegetation in the reservoir is seen in bright pink tone. Tone is dark blue in deep reservoirs while it is ink blue in case of shallow reservoirs or reservoirs with high silt load. These will be annotated as Reservoirs/Dam.

**Riverine Wetlands (Natural Inland Wetlands):** Along the major rivers, especially in plains water accumulates leading to formation of marshes and swamp. Swamps are 'Wetland dominated by trees or shrubs' (U.S. Definition). In Europe, a forested fen (a peat accumulating wetland that has no significant inflows or outflows and supports acidophilic mosses, particularly Sphagnum) could be called a swamp. In some areas reed grass - dominated wetlands are also called swamps). (Mitsch and Gosselink, 1986).

**River/stream (Natural Inland Wetlands):** Rivers are linear water features of the landscape. Rivers that are wider than the mapping unit will be mapped as polygons. Its importance arises from the fact that many stretches of the rivers in Indo-Gangetic Plains and peninsular India are declared important national and international wetlands (Ex. The river Ganga between Brajghat and Garh Mukteshwar, is a Ramsar site, Ranganthattu on the Cavery river is a bird sanctuary etc.). Wherever, rivers are wide and features like sand bars etc. are visible, they will be mapped.

## S

**Salt Marsh (Natural Coastal Wetlands):** Natural or semi-natural halophytic grassland and dwarf brushwood on the alluvial sediments bordering saline water bodies whose water level fluctuates either tidally or non- tidally (Mitsch and Gosselink, 1986). Salt marshes look in grey blue shade when wet.

**Salt pans (Man-made Coastal Wetlands):** An undrained usually small and shallow rectangular, man-made depression or hollow in which saline water accumulates and evaporates leaving a salt deposit (Margarate et al, 1974). Salt pans are square or rectangular in shape. When water is there appearance is blue while salt is formed tone is white.

**Salt pans (Man-made Inland Wetlands):** Inland salt pans in India occur in Rajasthan (Sambhar lake). These are shallow rectangular man-made depressions in which saline water is accumulated for drying in the sun for making salt.

**Sand/Beach (Natural Coastal Wetlands):** Beach is an non-vegetated part of the shoreline formed of loose material, usually sand that extends from the upper berm (a ridge or ridges on the backshore of the beach, formed by the deposit of material by wave action, that marks the upper limit of ordinary high tides and wave wash to low water mark(Clark,1977).Beach comprising rocky material is called rocky beach.

**Supporting services:** Ecosystems provide habitat for flora and fauna in order to maintain biological and genetic diversity.

## T

**Tanks/Ponds (Man-made Inland Wetlands):** A term used in Ceylon and the drier parts of Peninsular India for an artificial pond, pool or lake formed by building a mud wall across the valley of a small stream to retain the monsoon (Margarate et al, 1974). Ponds generally, suggest a small, quiet body of standing water, usually shallow enough to permit the growth of rooted plants from one shore to another (Reid et al, 1976). Tanks appear in light blue colour showing bottom reflectance. In this category Industrial ponds/mining pools mainly comprising Abandoned Quarries are also included (Quarry is defined as “An open or surface working or excavation for the extraction of stone, ore, coal, gravel or minerals.” In such pits water accumulate (McGraw Hill Encyclopaedia of Environmental Sciences, 1974), Ash pond/Cooling pond (The water body created for discharging effluents in industry, especially in thermal power plants (Encyclopaedic Directory of Environment, 1988) and Cooling pond: An artificial lake used for the natural cooling of condenser-cooling water serving a conventional power station (Encyclopaedic Directory of Environment, 1988). These ponds can be of any shape and size. Texture is rough and tonal appearance light (quarry) to blue shade (cooling pond).

## W

**Waterlogged (Man-made Inland Wetlands):** Man-made activities like canals cause waterlogging in adjacent areas due to seepage especially when canals are unlined. Such areas can be identified on the images along canal network. Tonal appearance is in various hues of blue. Sometimes, such waterlogged areas dry up and leave white scars on the land. Texture is smooth.

**Waterlogged (Natural Inland Wetlands):** Said of an area in which water stands near, at, or above the land surface, so that the roots of all plants except hydrophytes are drowned and the plants die (Margarate et al, 1974). Floods or unlined canal seepage and other irrigation network may cause waterlogging. Spectrally, during the period when surface water exists, waterlogged areas appear more or less similar to lakes/ponds. However, during dry season large or all parts of such areas dry up and give the appearance of mud/salt flats (grey bluish).

**Wetland:** Wetland means an area of marsh, fen, peatland or water; whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters, but does not include river channels, paddy fields, human-made water bodies/tanks specifically constructed for drinking water purposes and structures specifically constructed for aquaculture, salt production, recreation and irrigation purposes.

**Wetlands complexes:** Wetlands complexes means two or more ecologically and hydrologically contiguous wetlands and may include their connecting channels/ducts.

**Wise use of wetlands:** Wise use of wetlands means maintenance of their ecological character, achieved through implementation of ecosystem approach within the context of sustainable development.

## Z

**Zone of influence:** Zone of influence means that part of the catchment area of the wetland or wetland complex, developmental activities in which induce adverse changes in ecosystem structure, and ecosystem services.

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# **NAMAMI GANGE**

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