

WETLANDS: TREASURE OF BANGALORE

[ABUSED, POLLUTED, ENCROACHED & VANISHING]

I. Executive Summary:

Status	Wetlands: Abused, encroached and polluted
Cause	<ol style="list-style-type: none"> 1. 98% lakes are encroached - Encroachment of lakebed, flood plains, etc., <ul style="list-style-type: none"> • Loss in lake interconnectivity - Encroachment of rajakaluvus / storm water drains and loss of interconnectivity; • Lake reclamation for infrastructure activities; • Topography alterations in lake catchment; • 38% is surrounded by slums and 82% showed loss of catchment area. • unauthorised dumping of municipal solid waste and building debris; 2. 90% lakes are sewage fed (sustained inflow of untreated sewage) and industrial effluents. <ul style="list-style-type: none"> • Sustained inflow of untreated or partially treated sewage and industrial effluents; • Removal of shoreline riparian vegetation; and unabated construction activities in the valley zone has threatened these urban wetlands. • Pollution due to enhanced vehicular traffic; 3. Very poor governance - too many para-state agencies and lack of co-ordination among them.
Solution	<ul style="list-style-type: none"> ❖ Good governance (too many para-state agencies and lack of co-ordination). Single agency with the statutory and financial autonomy to be the custodian of natural resources (ownership, regular maintenance and action against polluters (encroachers as well as those contaminate through untreated sewage and effluents, dumping of solid wastes). Effective judicial system for speedy disposal of conflicts related to encroachment; ❖ Digitisation of land records (especially common lands – lakes, open spaces, parks, etc.) and availability of this geo-referenced data with query based information system to public. ❖ Removal of encroachment of lakes / wetlands, lake beds and storm water drains (connecting feeders) after the survey based on reliable cadastral maps; ❖ Decentralised treatment of sewage and solid waste (preferably at ward levels). Letting only treated sewage into the lake (as in Jakkur lake model); Ensure that sewage generated in a locality /ward is treated locally. ❖ Restriction of the entry of untreated sewage into lakes; ❖ To make land grabbing cognizable non-bail offence;

	<ul style="list-style-type: none"> ❖ Regular removal of macrophytes in the lakes; ❖ Implementation of ‘polluter pays’ principle as per water act 1974; ❖ Plant native species of macrophytes in open spaces of lake catchment area; ❖ Stop solid wastes dumping into lakes / in the lake bed ❖ Ensure proper fencing of lakes ❖ Restrictions on the diversion of lake for any other purposes; ❖ Complete ban on construction activities in the valley zones. ❖ Decentralised management of lakes through local lake committees involving all stakeholders
<p>The restoration and conservation strategies has to be implemented for maintaining the ecological health of aquatic ecosystems, aquatic biodiversity in the region, inter-connectivity among lakes, preserve its physical integrity (shorelines, banks and bottom configurations) and water quality to support healthy riparian, aquatic and wetland ecosystems. The regular monitoring of water bodies and public awareness will help in developing appropriate conservation and management strategies.</p>	

1.1 WETLANDS: ESSENTIAL FOR BANGALOREANS’ SURVIVAL

Wetlands (and lakes) constitute the most productive ecosystems with a wide array of goods and services. These ecosystems serve as life support systems; serve as habitat for a variety of organisms including migratory birds for food and shelter. They aid in bioremediation and hence aptly known as ‘kidneys of the landscape’. Major services include flood control, wastewater treatment, arresting sediment load, drinking water, protein production, and more importantly recharging of aquifers apart from aiding as sinks and climate stabilizers. The wetlands provide a low cost way to treat the community’s wastewater, while simultaneously functioning as wild fauna sanctuary, with public access. These ecosystems are valuable for education and scientific endeavours due to rich biodiversity.

Bangalore city (Karnataka State, India) has been experiencing unprecedented urbanisation and sprawl due to concentrated developmental activities in recent times with impetus on industrialisation for the economic development of the region. This concentrated growth has resulted in the increase in population and consequent pressure on infrastructure, natural resources and ultimately giving rise to a plethora of serious challenges such as climate change, enhanced green-house gases emissions, lack of appropriate infrastructure, traffic congestion, and lack of basic amenities (electricity, water, and sanitation) in many localities, etc. Temporal data analysis reveals that that there has been a growth of 925% in urban areas of Bangalore across four decades (1973 to 2013). Sharp decline in natural resources – 78% decline in trees and 79% decline in water bodies highlight unplanned urbanisation process in the city. Urban heat island phenomenon is evident from large number of localities with higher local temperatures. The city once enjoyed salubrious climate (about 14-16 °C during peak summer – May month in early 18th century), now has been experiencing higher temperatures (34 to 37° C) with altered micro climate and frequent flooding during rainy days. The study reveals the pattern of growth in Bangalore and its implication on local climate (an increase of ~2 to 2.5 °C during the last decade) and also on the natural resources, necessitating

appropriate strategies for the sustainable management of natural resources (water bodies, tree cover, etc.). The frequent flooding (since 2000, even during normal rainfall) in Bangalore is a consequence of the increase in impervious area with the high-density urban development in the catchment and loss of wetlands and vegetation.

Urban ecosystems are the consequence of the intrinsic nature of humans as social beings to live together (Ramachandra *et al.*, 2012; Ramachandra and Kumar, 2008). The process of urbanisation contributed by infrastructure initiatives, consequent population growth and migration results in the growth of villages into towns, towns into cities and cities into metros. Urbanisation and urban sprawl have posed serious challenges to the decision makers in the city planning and management process involving plethora of issues like infrastructure development, traffic congestion, and basic amenities (electricity, water, and sanitation), etc. (Kulkarni and Ramachandra, 2006). Apart from this, major implications of urbanisation are:

- **Loss of wetlands and green spaces:** Urbanisation (925% concretisation or paved surface increase) has telling influences on the natural resources such as decline in green spaces (78% decline in vegetation) including wetlands (79% decline) and / or depleting groundwater table. Quantification of number of trees in the region using remote sensing data with field census reveal 1.5 million trees and human population is 9.5 million, indicating one tree for seven persons in the city. This is insufficient even to sequester respiratory carbon (due to breathing which ranges from 540 -900 g per person per day).
- **Floods:** Conversion of wetlands to residential and commercial layouts has compounded the problem by removing the interconnectivities in an undulating terrain. Encroachment of natural drains, alteration of topography involving the construction of high-rise buildings, removal of vegetative cover, reclamation of wetlands are the prime reasons for frequent flooding even during normal rainfall post 2000.
- **Decline in groundwater table:** Studies reveal the removal of wetlands has led to the decline in water table. Water table has declined to 300 m from 28 m over a period of 20 years after the reclamation of lake with its catchment for commercial activities. In addition, groundwater table in intensely urbanized area such as Whitefield, etc. has now dropped to 400 to 500m.
- **Heat island:** Surface and atmospheric temperatures are increased by anthropogenic heat discharge due to energy consumption, increased land surface coverage by artificial materials having high heat capacities and conductivities, and the associated decreases in vegetation and water pervious surfaces, which reduce surface temperature through evapotranspiration.
- **Increased carbon footprint:** Due to the adoption of inappropriate building architecture, the consumption of electricity has increased in certain corporation wards drastically. The building design conducive to tropical climate would have reduced the dependence on electricity. Adoption of building architecture unsuitable for Bangalore climate has contributed to higher electricity consumption and hence higher GHG (Greenhouse gases). Per capita electricity consumption in the zones dominated by high rise building with glass facades require 14000-17000 units (kWh) per year

compared to the zones with eco-friendly buildings (1300-1500 units/person/year). Higher energy consumption, enhanced pollution levels due to the increase of private vehicles, traffic bottlenecks have contributed to carbon emissions significantly. Apart from these, mismanagement of solid and liquid wastes has aggravated the situation.

Unplanned urbanisation has drastically altered the drainage characteristics of natural catchments, or drainage areas, by increasing the volume and rate of surface runoff. Drainage systems are unable to cope with the increased volume of water, and are often blocked due to indiscriminate disposal of solid wastes. Encroachment of wetlands, floodplains, etc. obstructs flood-ways causing loss of natural flood storage.

1.2 WETLANDS - VITAL FOR BANGALOREANS

Wetlands are the kidneys of landscape and are vital for human survival. Wetlands are most productive environments; cradles of biological diversity that provide the water and productivity upon which countless species of plants and animals depend for survival; help in remediation - bioremediation. The wetlands perform various ecological functions such as:

- 1) Wetlands act as kidneys of the landscape – aids in water purification (by uptake of nutrients and heavy metals).
- 2) Provide wide range of ecosystem services such as food, fiber and waste assimilation.
- 3) Support large biological diversity.
- 4) Maintain stream flow, mitigate floods, and control erosion.
- 5) Recharge ground water.
- 6) Regulate microclimate.
- 7) Mitigate floods and loss to human life s and properties
- 8) Enhance the aesthetics of the landscape and support many significant recreational, social, and cultural activities, aside from being a part of our cultural heritage

Wetlands are indispensable for the countless benefits or “ecosystem services” that they provide humanity, ranging from freshwater supply, food and building materials, and biodiversity, to flood control, groundwater recharge, and climate change mitigation (<http://www.ramsar.org/about/the-importance-of-wetlands>).

1.3 NORMS VIOLATIONS: PERSISTENT ABUSE AND MISUSE

Bangalore Wetlands have been facing persistent threats due to (i) encroachments and unauthorised construction in the lake bed, wetlands, (ii) violation of prohibited activities in the valley zone / sensitive zone and senseless development activities (contrary to the norms of **CDP: Comprehensive Development Plan/ RMP: Revised Master Plan, 2015**), (iii) violation of regulated activities in the buffer zone (30 m as per BDA), (iv) dumping of municipal solid wastes, demolished building debris, excavated earth, etc., (v) sustained inflow of partially

treated or untreated sewage (by BWSSB and high-rise buildings in the lake bed), (vi) disposal of industrial effluents into the drains connecting the lake, (vii) removal of interconnectivity among lakes – by encroachment of Rajakaluve and drains connecting lakes, (viii) dumping of untreated sewage through tankers, (ix) dumping of bio-medical waste, etc.

Major violations in Bellandur-Agara wetlands are:

- LAND USE CHANGES WITH THE CONSTRUCTION ACTIVITIES IN THE PRIMARY VALLEY – SENSITIVE REGIONS (as per RMP, 2015 of BDA: The Proposed SEZ in Agara-Bellandur region is located in the primary valley of the Koramangala Challaghatta valley. Primary valleys in Bangalore are sensitive regions as per sensitive zone notification - Circular/35/BBMP/2008, dated: 26/11/2008) and buffer zone for primary valley is 100 m.
- The region is a wetlands as per KARNATAKA LAKE CONSERVATION AND DEVELOPMENT AUTHORITY ACT, 2014 - **KARNATAKA ACT NO. 10 OF 2015; KAR. ACT 12, pg 462; National Wetland Atlas, SAC Ahmedabad, 2009; Wetland rules, MoEF, Govt of India, 2010; RAMSAR Definition of wetlands.**
- Removal of wetlands affects Intergeneration Equity.
- Depriving local residents of water: Wetlands helps in recharge of groundwater in the region.
- Encroachment of Rajakalve and streams (connecting Agara lake with Bellandur Lake).
- Deprives local residents of clean, air and water (as per Article 21 of the Constitution of India).
- Dumping of building debris and excavated earth in Wetlands and also in water-spread area of Bellandur Lake.
- Affects livelihood - Forceful eviction of local farmers due to acquisition of wetlands.
- Construction of compound wall depriving local fishermen of their fundamental right.
- Further encroachment of Bellandur Lake.
- Intimidation, threats and harassment of wetland researchers and conservationists.

1.4 WETLANDS – DEFINITIONS (CONVENIENTLY IGNORED BY BUREAUCRACY)

"Lake" means an inland water-body irrespective of whether it contains water or not, mentioned in revenue records as sarkari kere, kharab kere, kunte, katte or by any other name and includes the peripheral catchment areas, Rajakaluve main feeder, inlets, bunds, weirs, sluices, draft channels, outlets and the main channels of drainages to and fro; "Landscape" includes all forms of trees, shrubs, grasses whether naturally growing or planted in water bodies to enhance aesthetic value; [KARNATAKA LAKE CONSERVATION AND DEVELOPMENT AUTHORITY ACT, 2014, **KARNATAKA ACT NO. 10 OF 2015**].

STATEMENT OF OBJECTS AND REASONS Act 10 of 2015 - **It is considered necessary,-**

1. to protect, conserve, reclaim, regenerate and restore lakes to facilitate recharge of depleting ground water by promoting integrated approach with the assistance of concerned Government departments, local and other authorities;
2. to exercise regulatory control over all the lakes within the jurisdiction of all the Municipal Corporations and Bengaluru Development Authority including prevention and removal of encroachment of lake area and its natural drainage system.
3. to prepare a plan for integrated development of lakes and to improve and also to create habitat of wetland for aquatic biodiversity, water birds and aquatic plants controlling pollution of lakes from sewage and other industrial effluents.
4. to encourage participation of communities and voluntary agencies and to launch public awareness programmes for conservation, preservation and protection of lakes.

Wetlands defined as areas of land that are either temporarily or permanently covered by water exhibit enormous diversity according to their genesis, geographical location, water regime and chemistry – *National Wetland Atlas, SAC Ahmedabad, 2009*

Wetlands means an area or of marsh, fen, peatland or water, 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 and include all waters such as lakes, reservoirs, tanks, backwaters, lagoons, creeks, estuaries, and manmade wetland and the zone of direct influence on wetlands that is to say the drainage area or catchment region of wetlands as determined by the authority but does not include main river channels, paddy fields and the coastal wetland covered under the notification of the Government of India in the Ministry of

Environment and Forest, S.O number 114 (E) dated the 19th February, 1991 published in the Gazette of India, Extraordinary, Part II, Section 3, Subsection (ii) od dated the 20th February 1991 - **Wetland rules, MoEF, Govt of India, 2010**

Wetland means land in which wetcrops can be grown by use of rain water or water obtained from any source which is not the property of state government – **1964: KAR. ACT 12, pg 462.**

Ramsar Definition of a Wetland: Under the Convention on Wetlands (Ramsar, Iran, 1971) ‘wetlands’ are defined by Articles 1.1 and 2.1 as shown below:

Article 1.1: ‘For the purpose of this Convention wetlands are areas 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 metres.’

Article 2.1 provides that wetlands: ‘may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands’.

Wetlands means an area or of marsh, fen, peatland or water, 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 and include all waters such as lakes, reservoirs, tanks, backwaters, lagoons, creeks, estuaries, and manmade wetland and the zone of direct influence on wetlands that is to say the drainage area or catchment region of wetlands as determined by the authority but does not include main river channels, paddy fields and the coastal wetland covered under the notification of the Government of India in the Ministry of Environment and Forest, S.O number 114 (E) dated the 19th February, 1991 published in the Gazette of India, Extraordinary, Part II, Section 3, Subsection (ii) od dated the 20th February 1991 - **Wetland rules, MoEF, Govt of India, 2010**

Wetland means land in which wetcrops can be grown by use of rain water or water obtained from any source which is not the property of state government – **1964: KAR. ACT 12, pg 462.**

Wetlands defined as areas of land that are either temporarily or permanently covered by water exhibit enormous diversity according to their genesis, geographical location, water regime and chemistry – **National Wetland Atlas, SAC Ahmedabad, 2009**

"Lake" means an inland water-body irrespective of whether it contains water or not, mentioned in revenue records as sarkari kere, kharab kere, kunte, katte or by any other name and includes the peripheral catchment areas, Rajakaluve

main feeder, inlets, bunds, weirs, sluices, draft channels, outlets and the main channels of drainages to and fro; "Landscape" includes all forms of trees, shrubs, grasses whether naturally growing or planted in water bodies to enhance aesthetic value; [KARNATAKA LAKE CONSERVATION AND DEVELOPMENT AUTHORITY ACT, 2014, **KARNATAKA ACT NO. 10 OF 2015**].

Ramsar Wetland Classification: The wetland types listed below are from the 'Ramsar Classification System for Wetland Type as approved by Recommendation 4.7 and amended by Resolution VI.5 of the Conference of the Contracting Parties. The categories listed herein are intended to provide only a very broad framework to aid rapid identification of the main wetland habitats represented at each site'

(<http://www.fao.org/docrep/003/x6611e/x6611e03d.htm>;
http://www.lrm.nt.gov.au/__data/assets/pdf_file/0013/10462/appendix7.pdf).

Human-made wetlands

1. -- Aquaculture (e.g. fish/shrimp) ponds
2. -- **Ponds**; includes farm ponds, stock ponds, small tanks; (generally below 8 ha).
3. -- **Irrigated land; includes irrigation channels and rice fields**.
4. -- **Seasonally flooded agricultural land** (including intensively managed or grazed wet meadow or pasture).
5. -- Salt exploitation sites; salt pans, salines, etc.
6. -- **Water storage areas**; reservoirs/barrages/dams/impoundments (generally over 8 ha).
7. -- Excavations; gravel/brick/clay pits; borrow pits, mining pools.
8. -- Wastewater treatment areas; sewage farms, settling ponds, oxidation basins, etc.
9. -- **Canals and drainage channels**, ditches.

Inland Wetlands

- L -- Permanent inland deltas.
- M -- Permanent rivers/streams/creeks; includes waterfalls.
- N -- Seasonal/intermittent/irregular rivers/streams/creeks.
- O -- Permanent freshwater lakes (over 8 ha); includes large oxbow lakes.
- P -- Seasonal/intermittent freshwater lakes (over 8 ha); includes floodplain lakes.
- Q -- Permanent saline/brackish/alkaline lakes.
- R -- Seasonal/intermittent saline/brackish/alkaline lakes and flats.
- Sp -- Permanent saline/brackish/alkaline marshes/pools.
- Ss -- Seasonal/intermittent saline/brackish/alkaline marshes/pools.
- Tp -- Permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season.
- Ts -- Seasonal/intermittent freshwater marshes/pools on inorganic soils; includes sloughs, potholes, seasonally flooded meadows, sedge marshes.
- U -- Non-forested peatlands; includes shrub or open bogs, swamps, fens.

Va -- Alpine wetlands; includes alpine meadows, temporary waters from snowmelt.

Vt -- Tundra wetlands; includes tundra pools, temporary waters from snowmelt.

W -- Shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils.

Xf -- Freshwater, tree-dominated wetlands; includes freshwater swamp forests, seasonally flooded forests, wooded swamps on inorganic soils.

Xp -- Forested peatlands; peatswamp forests.

Y -- Freshwater springs; oases.

Zg -- Geothermal wetlands

Zk(b) – Karst and other subterranean hydrological systems, inland

Note: ‘floodplain’ is a broad term used to refer to one or more wetland types, which may include examples from the R, Ss, Ts, W, Xf, Xp, or other wetland types. Some examples of floodplain wetlands are seasonally inundated grassland (including natural wet meadows), shrublands, woodlands and forests. Floodplain wetlands are not listed as a specific wetland type herein.

1.5 THREATS: LOSS OF WETLANDS - ENCROACHMENTS

The rapid development of urban sprawl has many potentially detrimental effects including the loss of valuable agricultural and eco-sensitive (e.g. wetlands, forests) lands, enhanced energy consumption and greenhouse gas emissions from increasing private vehicle use (Ramachandra and Shwetmala, 2009). Vegetation has decreased by 32% (during 1973 to 1992), 38% (1992 to 2002) and 63% (2002 to 2010).

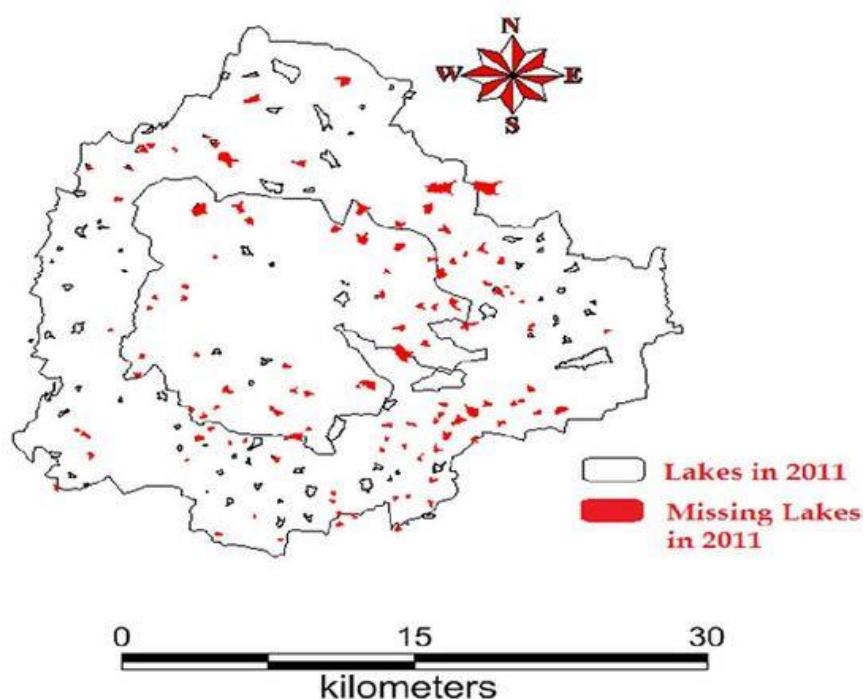


Figure 1: Lakes encroached by land mafia

Disappearance of water bodies or sharp decline in the number of water bodies in Bangalore is mainly due to intense urbanisation and urban sprawl. Latest field survey of 105 wetlands reveal that lakes (98%) have been encroached for illegal buildings (high raise apartment, commercial building, slums, etc.). Field survey of all lakes (in 2014-15) shows that nearly 90% of lakes are sewage fed, 38% surrounded by slums and 82% showed loss of catchment area. Also, lake catchments were used as dumping yards for either municipal solid waste or building debris. The surrounding of these lakes have illegal constructions of buildings and most of the times, slum dwellers occupy the adjoining areas. At many sites, water is used for washing and household activities and even fishing was observed at one of these sites. Multi-storied buildings have come up on some lake beds that have totally intervene the natural catchment flow leading to sharp decline and deteriorating quality of water bodies. This is correlated with the increase in built up area from the concentrated growth model focusing on Bangalore, adopted by the state machinery, affecting severely open spaces and in particular water bodies. Some of the lakes have been restored by the city corporation and the concerned authorities in recent times.

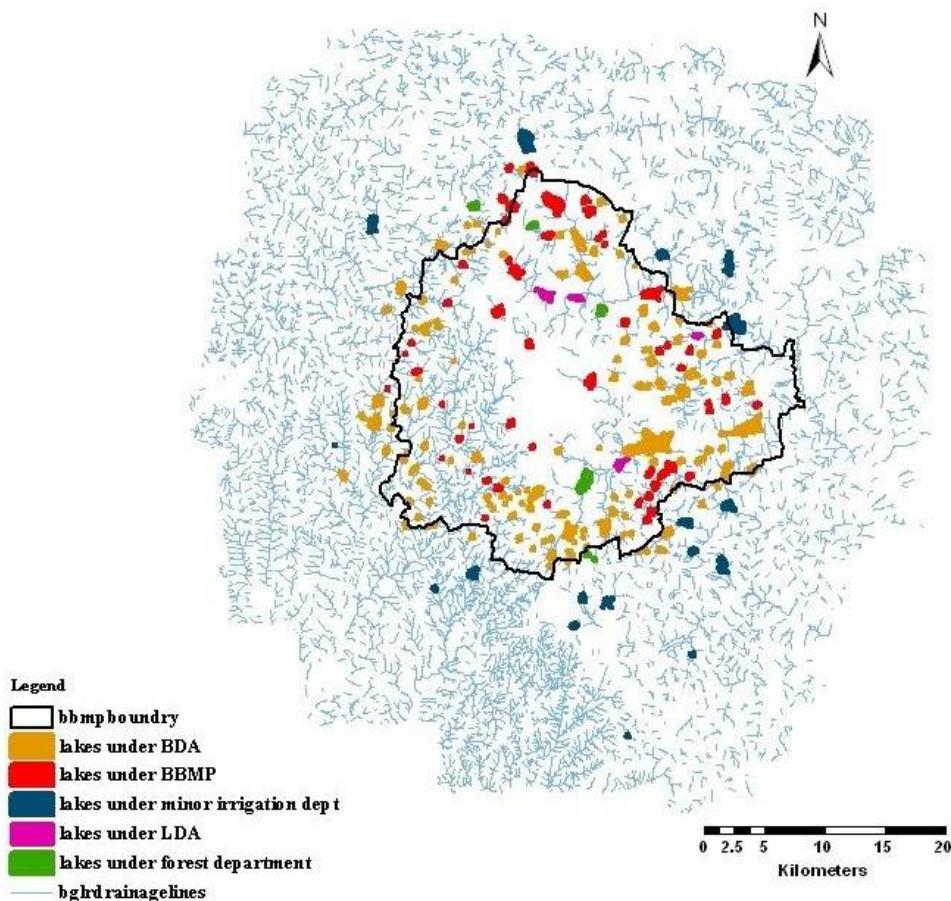


Figure 2: Spatial spread of lakes and custodians (too many – BBMP, BDA, LDA.... But too less effort to protect these lakes)

Threats faced by lakes and drainages of Bangalore:

1. Encroachment of lakebed, flood plains, and lake itself;
2. Encroachment of rajakaluves / storm water drains and loss of interconnectivity;
3. Lake reclamation for infrastructure activities;
4. Topography alterations in lake catchment;
5. Unauthorised dumping of municipal solid waste and building debris;
6. Sustained inflow of untreated or partially treated sewage and industrial effluents;
7. Removal of shoreline riparian vegetation;
8. Pollution due to enhanced vehicular traffic;
9. Too many para-state agencies and lack of co-ordination among them.
10. Different custodians for upstream and downstream lakes in the valley (Figure 2 and Table 1).

Table 1: Lakes with BBMP (A: Area in acres, G: Gunta, T: Total)

Sl.No	Name of the lake	Taluk	Hobli	Name of the village Survey No.	Extent (A-G) as per RTC
1	Agrahara Lake	B'llore North	Yelahanka	Agrahara -33	15-34
2	Allalasandra kere	B'llore North	Yalahanka	Allalsandra -15	41-23
3	Ambalipura Kelagina kere	B'llore East	Varthur	Ambalipura-40 & 41	3-0, 4-09 T-7-09
4	Amblipura Melinakere	B'llore East	Varthur	Ambalipura-36	12-16
5	Attur kere	B'llore North	Yalahanka	Attur kere-81 Ananthapura-92 Ramagondanahalli- 39 Kempanahalli-12	56-29 6-15 7-22 19-18 T-90-04
6	Avalahalli	B'llore North	Yalahanka	Avalahalli -10 & Singanayakanahalli 64	11-01 2-10 T-13-11
7	Bhimmana katte	B'llore South	Kengeri	Halagevaderahalli-138	1-23
8	Bayappanapalya Kunte (Munniyappana katte)	B'llore South	Uttarahalli	Vajarahalli -36	2-31
9	Challakere Lake	B'llore East	K.R. Puram	Challakere - 85	38-05
10	Chinnapanhalli kere	B'llore East	K.R. Puram	Chinnapanhalli 15 & 17	11-33 11-10
11	Chokkanahalli lake	B'llore North	Yelahanka	Chokkanahalli Sy-2	8-02
12	Dasarahalli kere (Chokkasandra)	B'llore North	Yeshwanthpura	Dasarahalli - 24 Chokkasandra - 5	3-29 24-04 T-27-33
13	Deepanjali kere	B'llore South	Kengeri	Devatige Ramanahalli-32	7-22
14	Devsandra kere	B'llore East	K.R. Puram	Devasandra 31	16-08
15	Doddabommasandra	B'llore North	Yelahanka	Dodda Bommasandra-56 Kodigehalli- 175 Thindlu - 53	39-10 49-21 35-28 T-124-19

16	Doddakanenahalli kere	B'lore East	Varthur	Doddakanenahalli - 109	18-14
17	Dore kere	B'lore South	Uttarahalli	Uttarahalli -22 Vasanthapura -06	19-11 '9-06 T-28-17
18	H Gollahalli Lake (Varahasandra Lake)	B'lore South	Kengeri	Kengeri Gollahalli-9 Varahasandra-9 Hemgepura-25	7-08 4-33 7-25 T-19-26
19	Halagevaderahalli Lake	B'lore South	Kengeri	Halagevaderahalli-1	17-10
20	Handrahalli	B'lore North	Yeshwanthapura	Handrahalli -8	16-06
21	Haraluru kere	B'lore East	Varthur	Haraluru-95	34-70
22	Herohalli	B'lore North	Yeshwanthapura	Herohalli-99	34-33
23	Harohalli lake	B'lore North	Yelahanka	Harohalli-91	74-32
24	Jogi kere	B'lore South	Uttarahalli	Mallasandra-30	3-20
25	J.P. Park (Mathikere)	B'lore North	Yeshwanthapura	Jalahalli-32 Mathikere-59 Thaniranahalli-01 Kasaba Yeshwanthpura-114	47-26 -- 20-39 -- T-
26	Kaikondanahalli kere	B'lore East	Varthuru	Kaikondanahalli -8 Kasavanahalli -70	18-18 30-05 T-48-23
27	Kalkere Agra kere	B'lore East	K.R. Puram & Bidarahalli	Kalkere-45 Kyalasanahalli-36 Beelisivale-101 & 106 Horamavu Agra-36	73-11 51-19 0-37 & 0-14 61-11 T-187-12
28	Kammagondanahalli	B'lore North	Yeshwanthapura	Kammagondanahalli-18 Shettyhalli-67 Myadarahalli (Medarahalli)-26	15-26 5-32 1-32 T-23-10
29	Kasavanahalli	B'lore East	Varthur	Kasavanahalli-50 Haralur-32	21-30 33-18 T-56-08
30	Kattiganahalli Kere-136	B'lore North	Jala	Kattiganahalli -136	25-28
31	Kattiganahalli Kere-31	B'lore North	Jala	Kattiganahalli -31	20-10
32	Kempambudhi Lake	B'lore North	B'lore	Kempambudhi-2	
33	Kodigehalli kere	B'lore North	Yeshwanthapura	Kodigehalli - 30	9-25
34	Kogilu Lake	B'lore North	Yelahanka Jala	Kogilu - 84 Kattigenahalli - 117	40-04 38-24 T-78-28
35	Koudenahalli kere	B'lore East	K.R. Puram	Koudenahalli -27	55-05
36	Kudlu Chikere	Anekal Taluk	Sarjapura	Koodlu-70	13-05
37	Kudlu doddakere	Anekal Talulk and B'lore South	Sarjapur & Begur	Koodlu-150 Parapanaagrahara-37	26-38 17-01 T-43-39
38	Kundalahalli Lake	B'lore East	K.R. Puram	Kundalahalli -05	30-20

39	Lingadiranahalli	B'lore North	Yeshwanthpura	Lingadiranahalli-2 & 4	5-32 4-08 T-10-00
40	Mahadevapura Lakde	B'lore East	K.R. Puram	Mahadevapura -7	26-23
41	Malgala kere	B'lore North	Yeshwanthpura	Malgala - 46	6-26
42	Munnekolalu kere	B'lore East	Varthur	Munnekolalu-25	15-38
43	Narasipura-20	B'lore North	Yelahanka	Narasipura-20	15-30
44	Narasipura-26	B'lore North	Yelahanka	Narasipura-26	9-07
45	Nayandanahalli kere	B'lore South	Kengeri	Nayadahalli -31	15-18
46	Parappana Agrahara	B'lore South	Beguru	Parappana Agrahara-23	16-11
47	Puttenahalli kere	B'lore South	Uttarahalli	Puttenahalli -42	13-25
48	Ramagondanahalli	B'lore North	Yelahanka	Ramagondanahalli-52	36-26
49	Sankey Tank	B'lore North	Vyalikaval	Vyalikaval - 21	35-00
50	Shilavantana kere	B'lore East	K.R. Puram	Whitefeild-41	19-32
51	Sigehalli	B'lore East	K.R Puram	Sigehalli-32	31-13
52	Singasandra Lake	B'lore South	Begur	Basapura-15 Singasandra -52	9-34 1-08 T-11-02
53	Sowl kere	B'lore East	Varthur	Bellandur-65 Doddakanelli-68 Kaigondanahalli-36	23-33 7-28 30-16 T-61-37
54	Thirumenahalli	B'lore North	Yelahanka	Thirumenahalli-63	7-10
55	Ulsoor	B'lore North	B'lore	Ulsoor	
56	Uttarahalli kere (Mogekere)	B'lore South	Uttarahalli	Uttarahalli -111	15-16
57	Veerasagara lake	B'lore North	Yelahanka	Veerasagara-26 Attur-25	'17-24 3-30 T-21-14
58	Vijanapura kere	B'lore East	K.R. Puram	Kowdenahalli -85 Krishnarajpura-97	11-28 2-07 T-13-35
59	Yediyur Lake	B'lore South	Utharahalli	Dasarahalli -01 Yediyur -59	No extent
60	Yelahanka kere (Kasaba Amanikere)	B'lore North	Yelahanka	Yelahanka-29 Kenchenahalli -15 Venkatala-39 Manchenahalli-19 Puttenahalli-49	53-36 30-23 199-31 7-34 18-04 T-310-08

Lakes with BDA

Sl. No.	Name of the Lake	Taluk	Hobli	Name of the village Sy No.	Extent (A-G) as per RTC
1	Abbigere kere	B'lore North	Yeshwanthpur	Abbigere-75 Singapura-95	26-06 21-7 T-47-13

2	Alahalli kere / Anjanapura	B'llore South	Uttarahalli	Allahalli -30 Gollahalli-3	15-35 5-30 T-21-25
3	Amruthalli kere	B'llore North	Yelahanka	Amruthalli-115	24-36
4	Annappahalli/ Yelachenahalli Lake	B'llore South	Uttarahalli	Yelachenahalli-06, Govinayakanahalli-14	4-39 1-33 T-6-32
5	Arakere	B'llore South	Beguru	Arakere-34	37-21
6	Avalahalli	B'llore North	Yelahanaka	Avalahalli-10 Shiganayakanahalli-64	11-01 2-10 T-13-11
7	B.Narayanapura	B'llore East	K.R. Puram	B.Narayanapura-109	15-06
8	Baiyappanahalli kere	B'llore East	K.R. Puram	Baiyappanahalli-61	8-09
9	Basapura Lake-2	B'llore South	Beguru	Basapura-66	10-29
10	Basavanapura Lake	B'llore South	Beguru	Basavanapura-14	7-34
11	Begur Lake	B'llore South	Begur	Begur-94	137-24
12	Bellahalli	B'llore North	Yelahanka	Bellahalli-68	18-32
13	Bellandur	B'llore East	Varthur	Yamaluru-62 Amanikere Bellandur Kahne-1 Ibbalur-12 Kempapura-6 Beluru-2	3-04 284-20 399-14 13-15 2-00 T-700-13
14	Beratena Agrahara Lake (Chowdeshwari Layout)	B'llore South	Begur	Beratena Agrahara (Chowdeshwari)-18	11-18
15	Bhattralli kere	B'llore East	Bidarahalli	Bhattralli-2	18-10
16	Bheemanakuppe	B'llore South	Kengeri	Bheemanakuppe-180	75-15
17	Bhoganalli kere	B'llore East	Varthur	Bhoganalli-21	12-24
18	Byrasandra	B'llore South	Utharahalli	Byrasandra-56	15-11
19	Byrasandra kere (Chikkepet) (Melinakere)	B'llore East	K.R. Puram	Byrasandra-109	14-19
20	Chennasandra-2	B'llore East	K.R. Puram	Banasawadi-211	47-38
21	Chikka Banavara	B'llore North	Yeshwanthpur	Chikka Banavara-3, Somashettyhalli-73, Kere gullada halli-22 and Ganigarahalli- 11,15	67-38 3-21 26-32 4-14 2-30 T-105-15
22	Chikka Bellandur kere	B'llore East	Varthur	Chikka Bellandur-9 Mullur -63	67-14 8-07 T-75-21
23	Chikkabasavanapura kere	B'llore East	K.R. Puram	Basavanapura-14	14-07
24	Chikkabasthi	B'llore South	Kengeri	Ramasandra-6	7-06
25	Chikkabettahalli	B'llore North	Yelahanka	Chikkabettahalli-52	1-32

26	Chick begur Lake	B'llore South	Begur	Begur-168, Singanadra-86	32-19 9-37 T-42-16
27	Chikkammanahalli Lake	B'llore South	Begur	Kammanahalli -22 Vamadevanahalli-	5-19
28	Chikkegowdara palya Lake	B'llore South	Kengeri	Hemmagepura-92	
29	Chunchanaghatta	B'llore South	Utharahalli	Chunchanaghatta-70, 70/2, 70/3	20-31 1-0 1-0 T-22-31
30	Chowdeshwari Layout Lake	B'llore South	Begur		
31	Devarakere Lake	B'llore South	Uttarahalli	Bikasipura-9	7-15
32	Doddabidarakallu	B'llore North	Yeshwanthpur	Doddabidarakallu-125 Nagasandra -06	23-21 16-36 T-40-17
33	Doddakallasandra	B'llore South	Uttarahalli	Doddakallasandra-27	21-16
34	Doddanakundi	B'llore East	K.R. Puram (village map) Varthur (In RTC-Bhoomi)	Doddanekundi -200 Kaggadasapura - 25 Vibhutipura -13	56-39 75-16 3-15 T-135-30
35	Dubasipalya Lake	B'llore South	Kengeri	Valagerehalli-43, 43/P1	23-35 1-0 T-24-35
36	Gangasetty kere (Diesel shed kere (Gangadhariahnakere) (Dyavasandrakunte kere)	B'llore East	K.R. Puram	KR Pura-58 Devasandra-46	18-32 2-35 T-21-27
37	Gandhinagara Lake	B'llore North			
38	Garudachar Palya Kere -1 (Achanakere)	B'llore East	K.R. Puram	Mahadevapura-31	5-36
39	Garudachar Palya Kere -2 (Goshala) Yekkalagatta kere	B'llore East	K.R. Puram	Mahadevapura-86	5-14
40	Garvebhavi Palya	B'llore South	Begur	Hongasandra -41	18-04
41	Gattigere palya Lake	B'llore South	Kengeri	Somapura-27/53	0-37
42	Gottigere Lake	B'llore South	Uttarahalli	Gottigere-71	37-13
43	Gowdana Palya Lake	B'llore South	Uttarahalli	Kadirenahalli-33	9-30
44	Gubbalala	B'llore South	Uttarahalli	Gubbalala-25 Vajarahalli-	8-10
45	Gunjur Kere (Carmelarm)	B'llore East	Varthur	Gunjur-95	9-17
46	Gunjur Mouji kere	B'llore East	Varthur	Gunjur-301, Kachamaranhalli-74	59-13 4-26 T- 63-39
47	Gunjur Palya kere	B'llore East	Varthur	Gunjur-83	36-27
48	Haralakunte Lake (Somasandrakere)	B'llore South	Begur	Haralakunte-51	16-29

49	Hoodi kere (GIDDANA KERE)	B'llore East	K.R. Puram	Hoodi-138	28-31
50	Hoodi kere -1	B'llore East	K.R. Puram	Hoodi-79	15-10
51	Horamavu Agara	B'llore East	K.R. Puram	Horamavu Agra-77	51-34
52	Horamavu kere	B'llore East	K.R. Puram	Horamavu-83	37-14
53	Hosakerehalli	B'llore South	Uttarahalli	Hosakerehalli-15	59-26
54	Hosakere	B'llore South			
55	Hulimavu	B'llore South	Beguru	Hulimavu-42 Kammanahalli -110	124-25 5-32 130-17
56	Ibbalur Lake	B'llore South	Beguru	Ibbalur-36	18-06
57	Jakkur & Sampigehalli	B'llore North	Yelahanka	Jakkur-15, 23 Yalahanka Amanikere-55 Sampigehalli-12 Agrahara-13	39- 21,36-33 58-16 19-25 3-17 T-157-32
58	Jaraganahalli/Sarakki/Puttenahalli Lake	B'llore South	Uttarahalli	Jaraganahalli-7 Sarrakki-26 Puttenahalli - 5 Kothanuru-103 Chunchaghatta-28	38-14 38-0 6-10 11-21 13-07 T-107-12
59	Jimkenalli kere	B'llore East	Bidarahalli	Varanasi-47	8-24
60	Junnsandra kere	B'llore East	Varthur	Junnsandra-32	24-33
61	Kadirenapalya kere	B'llore East	KR Puram	Binnamangala-99	
62	K R Puram (BEML) Bendiganahalli kere	B'llore East	K.R. Puram	Benniganahalli-47 & 55	18-24, 27-14 T- 45-39
63	Kaggadasanapura	B'llore East	K.R. Puram (village map) Varthur (In RTC-Bhoomi)	Byrasandra -5 Kaggadasapura-141 Bendiganahalli - 24/3	14-24 32-16 3-26 T-51-26
64	Kalena Agrahara Lake	B'llore South	Begur	Kalena Agrahara-43	7-30
65	Kalkere Rampura kere	Anekal Taluk (B'llore East)	Jigani Bidarahalli	Kalkere-162 Rampura-22 Maragondanahalli-71 Huvineane-86	64-25 3-04 11-35 108-07 T-187-31
66	Kalyani / Kunte (Next to Sai Baba Temple)	B'llore South	Uttarahalli	Vasanhpura-21	1-33
67	Kannenahalli	B'llore North (Bng South)	Kengeri Yeshwanthpur		
68	Kelagina kere / Byrasandra	B'llore East	K.R. Puram	Byrasandra-112	12-21
69	Kembatha halli	B'llore South	Uttarahalli	Kembathahalli-3 Kathnuru-32/3	5-16 1-33 T-7-20
70	Kenchanapura	B'llore South	Kengeri	Kenchanapura-10	17-20

71	Kengeri Lake	B'llore South	Kengeri	Kengeri-15, Valagerehalli-85	27-03 5-13 T-32-16
72	Kommaghatta	B'llore South	Kengeri	Komaghatta-03 Ramasandra-46	9-04 28-01 T-37-05
73	Konankunte	B'llore South	Uttarahalli	Konanakunte - 2	09-18
74	Konasandra	Anekal Taluk	Jigani	Dyavasandra-9 Bommmandahalli-18 Konasandra-17	21-13 7-39 3-20 T-32-32
75	Konnappana agrahara	B'llore South	Begur	Naganathpura (South)81	5-17
76	Kothnur	B'llore South	Utharahalli	Kothnur-54	18-09
77	Lakshmipura lake	B'llore North	Yeshwanthpur	Lakshmipura-25	10-06
78	Lingadheeranahalli	B'llore South	Kengeri	Lingadheeranahalli-13	5-22
79	Madavara	B'llore North	Dasanapura Yeshwanthpur	Madavara -48 Chikkabidarakallu-21 Tirumalapura-32 (from Yeshwanthpura hobli) Doddabidarakallu -98 (From Yeshwanthpura hobli)	35-31 20-20 8-36 2-39 T-68-06
80	Mahadevapura (Bandemahadevpura kere)	B'llore East	K.R. Puram	Mahadevapura-187	13-11
81	Mallasandra Gudde lake	B'llore North	Dasanapura	Mallasandra-49, Mallasandra-50	11-28 5-23 T-17-11
82	Mallathahalli	B'llore North	Yeshwanthpur	Mallathahalli-101 Giddadakonenahalli-6	50-38 20-08 T-71-06
83	Manganahalli	B'llore North	Yeshwanthpur	Manganahalli - 43	6-22
84	Medi Agrahara	B'llore North	Yelahanka	Medi Agrahara-33	13-15
85	Meenakshi Kere	B'llore South	Begur	Kammanahalli (Meenakshi)-38	18-37
86	Mesthripalya Lake	B'llore South	Begur	Jakkasandra- 30	11-21
87	Nagarabhavi	B'llore North (Bng South)	Yeshwanthpur	Nagarabhavi-17	17-39
88	Nagareshwara-Nagenahalli Lake	B'llore East	K.R. Puram	Nagareshwara-Nagenahalli -10	11-08
89	Nellagaderanahalli	B'llore North	Yeshwanthpur	Nallagaderanahalli - 62	19-22

90	Nalluralli tank	B'llore East	K.R. Puram	Nalluralli-4 Pantandur Agrahara-85	20-34 27-05 T-47-39
91	Narasappanahalli	B'llore North	Yeshwanthpur	Karivabanahalli-40 Nelagadiranahalli - 90 Nelagadiranahalli -89 Doddabidarakallu - 24	27-13 19-05 5-26 1-20 T-53-24
92	Nyanappanahalli Lake	B'llore South	Begur	Begur-344	6-07
93	Panathur kere -38	B'llore East	Varthur	Panathur - 38	27-17
94	Panathur kere -48	B'llore East	Varthur	Panathur - 48	6-30
95	Pattandur Agrahara	B'llore East	K.R. Puram	Pattandur Agrahara-124	16-35
96	Pattandur Agrahara	B'llore East	K.R. Puram	Pattandur Agrahara-54	12-37
97	Pattanagere Kenchenhalli	B'llore South		Kenchenahalli-33 Pattanagere-43	3-39 0-31 T-4-30
98	Rachenahalli	B'llore North B'llore East	Yelahanka K.R Puram	Dasarahalli-61 (Bng East- KR Puram) Jakkur - 82 (Bng North-Yelahanka) Rachenahalli - 69 (Bng East-KR Puram)	73-23 39-07 18-16 T-131-06
99	Ramsandra (Hirekere)	B'llore South B'llore North	Kengeri Yeshwanthpur	Ramasandra-159 Kenchanpura-36/* Kenchenapura - 36/ÉÉQ Kannahalli-37 (Bng north-Yeshwanthpura)	66-20 56-05 5-0 12-29 T-140-14
100	Sadaramangala kere	B'llore East	K.R. Puram	Sadaramangala-61, Kodigehalli-8	51-04 1-17 T-52-21
101	Shivanahalli	B'llore North	Yelahanka	shivanahalli-48 Allalasandra-38, 48	14-30 3-22 0-27 T-18-39
102	Siddapura kere	B'llore East	Varthur	Siddapura -18	27-38
103	Singapura Kere	B'llore North	Yelahanka	Singapura-102	66-18
104	Singasandra	B'llore South	Beguru	Singasandra -99, 100	10-14 0-34 T-11-08
105	Sitaram Palya	B'llore East	K R Puram	Sonnenahalli (Seetharmapalya)-33	23-37

106	Sompura	B'llore South	Kengeri	Sompura - 11	17-38
107	Srigandadakaval (near Rajivgandhi nagar)	B'llore North	Yeshwanthpur	Srigandakavalu-15	6-33
108	Srinivasapura Kere	B'llore North	Yelahanaka	Srinivasapura-2	3-14
109	Subbarayanakere	B'llore South	Uttarahalli	Gottigere-12	5-10
110	Subedeharanakere	B'llore South	Begur	Begur-48	6-05
111	Subramanyapura Lake	B'llore South	Uttarahalli	Uttarahalli-64	18-06
112	Sulekere (Soolikere)	B'llore South	Kengeri	Maragondanahalli Krishnasagara	
113	Swarnakunte gudda kere	B'llore South	Begur	Chandrashekarpura-1	09-05
114	Talaghattapura (Gowdarakere)	B'llore South	Uttarahalli	Talaghattapura -73	19-16
115	Ullal	B'llore North	Yeshwanthpur	Ullal-93	24-12
116	Vaderahalli	B'llore North	Yelahanka	Vaderahalli-32	9-34
117	Varahasandra Lake	B'llore South	Kengeri	Hemigepura-4, Varahasandra-24	4-11 13-09 T-17-20
118	Varthur	B'llore East	Varthur	Varthur-319	445-14
119	Vasanthapura (Janardhanakere)	B'llore South	Utharahalli	Vasanthpura-28	7-10
120	Venkateshpura	B'llore North	Yelahanka	Ventateshpura-12 Sampigehalli-37	6-35 11-29 T-18-24
121	Vibhuthipura kere	B'llore East	Varthur	Vibhuthipura-175	45-18
122	Vishwa nidam lake	B'llore North	Yeshwanthpur	Herohalli-50	4-30
123	Yellenhalli Lake (Elenahalli)	B'llore South	Begur	Yellenhalli-55	4-39

Lakes under Lake Development Authority (LDA)

Sl.No	Name of the Lake	Taluk	Hobli	Name of the village Sy No.	Extent (A-G) as per RTC
1	Agaram Lake	B'llore South	Kengeri	Agara-11 Venkojiraokhane-11	5-39 136-30 T-142-29
2	Hebbal Lake	B'llore North	Kasaba	Hebbla-38 Kodigehalli-37	92-26 99-33 T-192-19
3	Nagavara Lake	B'llore North	Kasaba	Nagawara-58 Vishwanatanagenahalli - 12,13	56-17 12-35 6-01 T-75-13
4	Vengaiahnakere	B'llore East	K.R. Puram	Krishnarajapura-9 Sannathammanahalli-46	38-12 26-23 T-64-35

Lakes - Karnataka Forest Department

Sl.No	Name of the Lake	Taluk	Hobli	Name of the village Sy No.	Extent (A-G) as per

					RTC
1	Hennur (K.R.Puram Range)	B'llore North	Kasaba	Hennur - 53 Nagawara - 13	58-30 14-11 T-73-01
2	J.B.Kaval Tank (Bangalore Range)	B'llore North	Yelahanka	Jyarakabande Kavalu-P1-36	44-21 2-04
3	Madiwala (K.R.Puram Range)	B'llore South	Begur	Madivala- 7 Kodichikkanhalli-23 Belekannahalli-64 Rupena Agrahara-11	166-39 80-09 21-35 6-10 T-275-13
4	Mylsandra (Kaggalipura Range) Gumaiahanakere (Mylsandra 1) Mylsandra 2	B'llore South	Kengeri	Mylsandra-37 Kasaba Kengeri-58 Mylsandra - 27 Kasaba Kengeri-66	6-24 6-02 T-12-26 10-14 5-28 T-16-02
5	Puttenahalli (Yelahanka Range)	B'llore North	Yelahanka	Puttenehalli - 36 Attur - 49	29-14 7-26 T-37-00

Lakes - Minor Irrigation Department

Sl.No	Name of the Lake	Taluk	Hobli	Name of the village Sy No.	Extent (A-G) as per RTC
1	Agara kere	Bangalore South	Kengeri	Agara - 103 Agara -102 Agara - 104	13-11 0-08 0-06 T-13-25
2	Alluru kere	Bangalore North	Dasanapura	Aluru-132 Vaderahalli - 8 Mathahalli - 25 Narasipura - 41	39-38 27-23 5-32 1-21 T-75-34
3	Bhimanakuppe kere	Bangalore South	Kengeri	Bheemanakuppe-180	75-15
4	Bidara Amanikere	Anekal			
5	Bidarahalli kere	Bangalore East	Bidrahalli	Bidarahalli-8 Byappanahalli - 21	15-10 81-16 T-96-26
6	Chikkanahalli	Bangalore East			
7	Doddagubbi kere	Bangalore East	Bidarahalli	Doddagubbi-38 NadagowdaGollahalli-39 Chikkagubbi-9	105-18 16-37 1-32 T-124-07
8	Ghattahalli Bommankere	Anekal	Sarjapura	Gattahalli-62 Rayasandra - 33	51-17 21-22 T-72-39

9	Hoskuru kere (Huskur Lake)	Anekal	Sarjapura	Huskur - 163 Harohalli - 51 Avalahalli - 50	91-10 23-0 --- T-114-10
10	Hulimangala Doddakere	Anekal	Jigani	Hulimangala - 22	67-07
11	Kodatikere	Bangalore East	Varthru	Kodati-8 Solikunte - 52	40-32 37-09 T-78-01
12	Margondanahalli kere	Bangalore South	Kengeri	Margondanahalli -45	5-33
13	Rampura kere	Bangalore East			
14	Sakalavara Bujangadasana kere	Anekal	Jigani	Sakalavara - 93	23-34
15	Singanayakana halli kere	Bangalore North			
16	Singena Agrahara kere	Anekal	Sarjapura	Singena Agrahara-94 Narayanaghatta - 128 Gottammanahalli - 13	95-39 19-32 8-04 T-123-35
17	Vaderahalli kere	Bangalore South	Kengeri	B.M.Kaval P1 -136	21-07
18	Yellemallappa Shetty kere	Bangalore East	K.R. Puram	Avalahalli -57 Avalahalli -12 Heerandahalli - 95 Heerandahalli -96 Kurudu Sonnenahalli -2 Medahalli -63 Veerenahalli -29	13-26 17-26 170-16 33-24 31-2 91-35 132-06 T-490-15

Source: <https://www.karnataka.gov.in/ldakarnataka/documents>Listof-210Lake-BDA, BBMP, LDA, KFD, MILIst.xlsx>

The anthropogenic activities particularly, indiscriminate disposal of industrial effluents and sewage wastes, dumping of building debris have altered the physical, chemical as well as biological integrity of the ecosystem. This has resulted in the ecological degradation, which is evident from the current ecosystem valuation of wetlands. Global valuation of coastal wetland ecosystem shows a total of 14,785/ha US\$ annual economic value. Valuation of relatively pristine wetland in Bangalore shows the value of Rs. 10,435/ha/day while the polluted wetland shows the value of Rs.20/ha/day (Ramachandra et al., 2005). In contrast to this, Varthur, a sewage fed wetland has a value of Rs.118.9/ha/day (Ramachandra et al., 2011). The pollutants and subsequent contamination of the wetland has telling effects such as disappearance of native species, dominance of invasive exotic species (such as African catfish, water hyacinth, etc.), in addition to profuse breeding of disease vectors and pathogens. Water quality analyses revealed of high phosphates (4.22-5.76 ppm) levels in addition to the enhanced BOD (119-140 ppm) and decreased DO (0-1.06 ppm). The amplified decline of ecosystem goods and services with degradation of water quality

necessitates the implementation of sustainable management strategies to recover the lost wetland benefits.

1.6 CONSERVATION AND MANAGEMENT OF WETLANDS

In recent years, there has been concern over the continuous degradation of wetlands due to unplanned developmental activities (Ramachandra, 2002). Urban wetlands are seriously threatened by encroachment of drainage through landfilling, pollution (due to discharge of domestic and industrial effluents, solid wastes dumping), hydrological alterations (water withdrawal and inflow changes), and over-exploitation of their natural resources. This results in loss of biodiversity of the wetland and loss of goods and services provided by wetlands (Ramachandra, 2009). The mitigation of frequent floods and the associated loss of human life and properties entail the restoration of interconnectivity among wetlands, restoration of wetlands (removal of encroachments), conservation and sustainable management of wetlands (Ramachandra et al., 2012).

Despite good environmental legislations, loss of ecologically sensitive wetlands is due to the uncoordinated pattern of urban growth happening in Bangalore. Principal reason is lack of good governance and decentralized administration evident from lack of coordination among many Para-state agencies, which has led to unsustainable use of the land and other resources. Failure to deal with water as a finite resource is leading to the unnecessary destruction of lakes and marshes that provide us with water. This failure in turn is threatening all options for the survival and security of plants, animals, humans, etc. There is an urgent need for:

- **Restoring and conserving the actual source of water** - the water cycle and the natural ecosystems that support it - are the basis for sustainable water management
- **Reducing the environmental degradation that is preventing us from reaching goals** of good public health, food security, and better livelihoods world-wide
- **Improving the human quality of life** that can be achieved in ways while maintaining and enhancing environmental quality
- **Reducing greenhouse gases to avoid the deleterious effects of climate change** is an integral part of protecting freshwater resources and ecosystems.
- **Maintaining intergeneration Equity**

A comprehensive approach to water resource management is needed to address the myriad water quality problems that exist today from non-point and point sources as well as from catchment degradation. Watershed-based planning and resource management is a strategy for more effective protection and restoration of aquatic ecosystems and for protection of human health. The watershed approach emphasizes all aspects of water quality, including chemical water quality (e.g., toxins and conventional pollutants), physical water quality (e.g., temperature, flow, and circulation), habitat quality (e.g., stream channel morphology, substrate composition, riparian zone characteristics, catchment land cover), and biological health and biodiversity (e.g., species abundance, diversity, and range). The suggestions to implement in lakes in order to maintain its healthy ecosystem include:

- ❖ **Good governance** (too many para-state agencies and lack of co-ordination) - Single agency with the statutory and financial autonomy to be the custodian of natural resources (ownership, regular maintenance) and action against polluters (encroachers as well as those let untreated sewage and effluents, dumping of solid wastes).
- ❖ **De-congest Bangalore:** Growth in Bangalore has surpassed the threshold evident from stress on supportive capacity (insufficient water, clean air and water, electricity, traffic bottlenecks, etc.) and assimilative capacity (polluted water and sediments in water bodies, enhanced GHG – Greenhouse gases, etc.). No new projects shall be sanctioned and the emphasis would be on increasing green cover and restoration of lakes.
- ❖ **Disband BDA** – creation of Bangalore Development Agency has given impetus to inefficient governance evident from Bangalore, the garden city turning into ‘dead city’ during the functional life of BDA.
- ❖ **Digitation of land records** (especially common lands – lakes, open spaces, parks, etc.) and availability of this geo-referenced data with query option (Spatial Decision Support System) to public.
- ❖ **Comprehensive development plan (CDP) for the city** has to be developed through consultative process involving all stakeholders and should not be outsourced to outside agencies / consultants (from other countries).
- ❖ **Removal of encroachment** near to lakes after the survey based on reliable cadastral maps;
- ❖ Remove all encroachments (without any mercy) of wetlands, lakes, rajjakaluvus (storm water drain) – encroachers have violated all humanitarian norms and deprived large section of the society of ecological services (provided by wetlands)
- ❖ Effective judicial system for speedy disposal of conflicts related to encroachment;
- ❖ Apply principles of ‘polluter pays’ principle to agencies responsible for contamination of Bangalore surface and ground water (Agency: BWSSB, industries);
- ❖ Action against regulatory agency (KSPCB) for dereliction of statutory duties and other responsibilities by allowing sustained contamination of water, land and air;
- ❖ Restriction of the entry of untreated sewage and industrial effluents into lakes;
- ❖ To make land grabbing cognizable non-bailable offence;
- ❖ Letting off only treated sewage into the lake through constructed wetlands and shallow algae ponds (as in Jakkur lake);
- ❖ Regular removal of macrophytes in the lakes;
- ❖ Implementation of ‘polluter pays’ principle as per water act 1974;
- ❖ Plant native species of macrophytes in open spaces of lake catchment area;
- ❖ Stop solid wastes (municipal and demolition debris) dumping into lakes; treatment and management of solid waste shall be as per MSW Rules 2000, GoI.
- ❖ Ensure proper fencing of lakes
- ❖ Restrictions on the diversion of lake for any other purposes - Lakes and wetlands provide ecological services (depending on the catchment integrity, duration may vary) – there are no dead lakes or wetlands
- ❖ Complete ban on construction activities in the valley zones;

- ❖ Monitoring of lakes through network of schools and colleges;
- ❖ Mandatory environment education at all levels (schools and colleges including professional courses).

Wetlands in Bangalore are to be restored considering:

Activities around lakes	Norms to protect and conserve Wetlands
Encroachment of lake bed and loss of interconnectivity among lakes	<p>The Hon'ble Supreme Court in Civil appeal number 1132/2011 at SLP (C) 3109/2011 on January 28, 2011 has expressed concern regarding encroachment of common property resources, more particularly lakes (and raja kaluves) and it has directed the state governments for removal of encroachments on all community lands.</p> <p>Eviction of encroachment: Need to be evicted as per Karnataka Public Premises (eviction of unauthorised occupants) 1974 and the Karnataka Land Revenue Act, 1964</p>
Buildings in the buffer zone of lakes	<p>In case of water bodies, a 30.0 m buffer of 'no development zone' is to be maintained around the lake (as per revenue records)</p> <ul style="list-style-type: none"> • As per BDA, RMP 2015 (Regional Master Plan, 2015) • Section 17 of KTCP (Karnataka Town and Country Planning) Act, 1961 and sec 32 of BDA Act, 1976 • Wetlands (Conservation and Management) Rules 2010, Government of India; Wetlands Regulatory Framework, 2008. • Valley zones are sensitive and are to be with any construction activities as per RMP 2015 of BDA
Valley Zones	<p>LAND USE CHANGES WITH THE CONSTRUCTION ACTIVITIES IN THE PRIMARY VALLIES – SENSITIVE REGIONS (as per RMP, 2015 of BDA). For example, the Proposed SEZ in Agara-Bellandur region is located in the primary valley of the Koramangala Challaghatta valley. Primary valleys in Bangalore are sensitive regions as per sensitive zone notification - Circular/35/BBMP/2008, dated: 26/11/2008) and buffer zone for primary valley is 100 m.</p>
Construction activities in the valley zone (SEZ by Karnataka Industrial Areas Development Board (KIADB)) in the valley zone	<p>This is contrary to sustainable development as the natural resources (lake, wetlands) get affected, eventually leading to the degradation/extinction of lakes. This reflects the ignorance of the administrative machinery on the importance of ecosystems and the need to protect valley zones considering ecological function and these regions are 'NO DEVELOPMENT ZONES' as per CDP 2005, 2015</p>
Alterations in topography	<p>Flooding of regions would lead to loss of property and human life and, spread of diseases.</p>

Increase deforestation in catchment area	in in	<p>Removing vegetation in the catchment area increases soil erosion and which in turn increases siltation and decreases transpiration</p>
Documentation of biodiversity	of	<ul style="list-style-type: none"> The biodiversity of every water body should form part of the School, College, People's Biodiversity Registers (SBR, CBR, PBR). The local Biodiversity Management Committees (BMC) should be given necessary financial support and scientific assistance in documentation of diversity. The presence of endemic, rare, endangered or threatened species and economically important ones should be highlighted A locally implementable conservation plan has to be prepared for such species
Implementation of sanitation facilities	of	<ul style="list-style-type: none"> The lakes are polluted with sewage, coliform bacteria and various other pathogens Preserving the purity of waters and safeguarding the biodiversity and productivity, dumping of waste has to be prohibited All the settlements alongside the water body should be provided with sanitation facilities so as not to impinge in anyway the pristine quality of water
Violation of regulatory and prohibitory activities as per Wetlands (Conservation and Management) Rules, 2010; Regulatory wetland framework, 2008		<p>Environment Impact Assessment (EIA) Notification, 2009. Wetlands (Conservation and Management) rules 2010, Government of India; Regulatory wetland framework, 2008</p> <p>Regulated activity</p> <ul style="list-style-type: none"> Withdrawal of water/impoundment/diversion/interruption of sources Harvesting (including grazing) of living/non-living resources (may be permitted to the level that the basic nature and character of the biotic community is not adversely affected) Treated effluent discharges – industrial/ domestic/agro-chemical. Plying of motorized boats Dredging (need for dredging may be considered, on merit on case to case basis, only in cases of wetlands impacted by siltation) Constructions of permanent nature within 50 m of periphery except boat jetties Activity that interferes with the normal run-off and related ecological processes – up to 200 m

	<p>Prohibited activity</p> <ul style="list-style-type: none"> i. Conversion of wetland to non-wetland use ii. Reclamation of wetlands iii. Solid waste dumping and discharge of untreated effluents
Damage of fencing, solid waste dumping and encroachment problems in Varthur lake series	<p>High Court of Karnataka (WP No. 817/2008) had passed an order which include:</p> <ul style="list-style-type: none"> • Protecting lakes across Karnataka, • Prohibits dumping of garbage and sewage in Lakes • Lake area to be surveyed and fenced and declare a no development zone around lakes • Encroachments to be removed • Forest department to plant trees in consultation with experts in lake surroundings and in the watershed region • Member Secretary of state legal services authority to monitor implementation of the above in coordination with Revenue and Forest Departments • Also setting up district lake protection committees • Implementation of Handling, Treatment and Management of Municipal Solid Waste as per MSW Rule 2000, GoI
Polluter Pays principle	<p>National Environment Policy, 2006</p> <p>The principal objectives of NEP includes :</p> <ul style="list-style-type: none"> • Protection and conservation of critical ecological systems and resources, and invaluable natural and man-made heritage • Ensuring judicious use of environmental resources to meet the needs and aspirations of the present and future generations • It emphasizes the “Polluter Pays” principle, which states the polluter should, in principle, bear the cost of pollution, with due regard to the public interest
Prevention of pollution of lake	<p>National Water Policy, 2002</p> <p>Water is a scarce and precious national resource and requires conservation and management.</p> <p>Watershed management through extensive soil conservation, catchment-area treatment, preservation of forests and increasing the forest cover and the construction of check-dams should be promoted.</p> <p>The water resources should be conserved by retention practices such as rain water harvesting and prevention of pollution.</p>
Discharge of untreated sewage into lakes	<p>The Environment (Protection) Act, 1986</p> <ul style="list-style-type: none"> • Lays down standards for the quality of environment in its various aspects • Laying down standards for discharge of environmental pollutants from various sources and no persons shall discharge any pollutant in excess of such standards

	<ul style="list-style-type: none"> • Restriction of areas in which industries, operations or processes shall not be carried out or carried out subject to certain safeguards
The water pollution, prevention and its control measures were not looked upon	<p>Water (Prevention and Control of Pollution) Act, 1974</p> <ul style="list-style-type: none"> • It is based on the “Polluter pays” principle. <p>The Pollution Control Boards performs the following functions :</p> <ul style="list-style-type: none"> • Advice the government on any matter concerning the prevention and control of water pollution. • Encourage, conduct and participate in investigations and research relating to problems of water pollution and prevention, control or abatement of water pollution. • Inspects sewage and effluents as well as the efficiency of the sewage treatment plants. • Lay down or modify existing effluent standards for the sewage. • Lay down standards of treatment of effluent and sewage to be discharged into any particular stream. • Notify certain industries to stop, restrict or modify their procedures if the present procedure is deteriorating the water quality of streams.
Pathetic water scenario and insufficient drinking water in Bangalore	<p>The depletion of ground water and drying up of lakes has affected the water availability to meet the current population. At the 4% population growth rate of Bangalore over the past 50 years, the current population of Bangalore is 8.5 million (2011). Water supply from Hesaraghatta has dried, Thippagondanahalli is drying up, the only reliable water supply to Bangalore is from Cauvery with a gross of 1,410 million liters a day (MLD). There is no way of increasing the drawal from Cauvery as the allocation by the Cauvery Water Disputes Tribunal for the entire urban and rural population in Cauvery Basin in Karnataka is only 8.75 TMC ft (one thousand million cubic – TMC ft equals 78 MLD), Bangalore city is already drawing more water-1,400 MLD equals 18 TMC—than the allocation for the entire rural and urban population in Cauvery basin</p>

The restoration and conservation strategies have to be implemented for maintaining the ecological health of aquatic ecosystems, aquatic biodiversity in the region, inter-connectivity among lakes, preserve its physical integrity (shorelines, banks and bottom configurations) and water quality to support healthy riparian, aquatic and wetland ecosystems. The regular monitoring of waterbodies and public awareness will help in developing appropriate conservation and management strategies (Ramachandra, 2005).

Ecological and Environmental Implications:

- Land use changes: Conversion of watershed area especially valley regions of the lake to paved surfaces would alter the hydrological regime.
- Loss of Drainage Network: Removal of drain (Rajakaluve) and reducing the width of the drain would flood the surrounding residential as the interconnectivities among lakes are lost and there are no mechanisms for the excessive storm water to drain and thus the water stagnates flooding in the surroundings.
- Alteration in landscape topography: This activity alters the integrity of the region affecting the lake catchment. This would also have serious implications on the storm water flow in the catchment.
- The dumping of construction waste along the lakebed and lake has altered the natural topography thus rendering the storm water runoff to take a new course that might get into the existing residential areas. Such alteration of topography would not be geologically stable apart from causing soil erosion and lead to siltation in the lake.
- *Loss of Shoreline:* The loss of shoreline along the lakebed results in the habitat destruction for most of the shoreline birds that wade in this region. Some of the shoreline wading birds like the Stilts, Sandpipers; etc will be devoid of their habitat forcing them to move out such disturbed habitats. It was also apparent from the field investigations that with the illogical land filling and dumping taking place in the Bellandur lakebed, the shoreline are gobbled up by these activities.
- *Loss of livelihood:* Local people are dependent on the wetlands for fodder, fish etc. estimate shows that wetlands provide goods and services worth Rs 10500 per hectare per day (Ramachandra et al., 2005). Contamination of lake brings down goods and services value to Rs 20 per hectare per day.

Decision makers need to learn from the similar historical blunder of plundering ecosystems as in the case of Black Swan event (http://blackswanevents.org/?page_id=26) of evacuating half of the city in 10 years due to water scarcity, contaminated water, etc. or abandoning of Fatehpur Sikri and fading out of AdilShahi's Bijapur (inputs from V.Balasubramanian), or ecological disaster at *Easter Island or Vijayanagara Empire*.

It is the responsibility of Bangalore citizens (to ensure intergeneration equity, sustenance of natural resources and to prevent human-made disasters such as floods, etc.) to stall the irrational conversion of land in the name of development and restrict the decision makers taking the system (ecosystem including humans) for granted as in the case of wetlands by KIADB, BDA, BBMP and many such para-state agencies.

1.7 Recommendations for Conservation and Sustainable Management of Wetlands

1. **Carrying capacity studies for all macro cities:** Unplanned concentrated urbanisation in many cities has telling impacts on local ecology and biodiversity, evident from decline of water bodies, vegetation, enhanced pollution levels (land, water and air), traffic bottlenecks, lack of appropriate infrastructure, etc. There is a

need to adopt holistic approaches in regional planning considering all components (ecology, economic, social aspects). In this regard, we recommend carrying capacity studies before implementing any major projects in rapidly urbanizing macro cities such as Greater Bangalore, etc. Focus should be on

- Good governance (too many para-state agencies and lack of co-ordination) - Single agency with the statutory and financial autonomy to be the custodian of natural resources (ownership, regular maintenance) and action against polluters (encroachers as well as those let untreated sewage and effluents, dumping of solid wastes).
- De-congest Bangalore: **Growth in Bangalore has surpassed the threshold evident from stress on supportive capacity** (insufficient water, clean air and water, electricity, traffic bottlenecks, etc.) **and assimilative capacity** (polluted water and sediments in water bodies, enhanced GHG – Greenhouse gases, etc.)
- Disband BDA – creation of Bangalore Development Agency has given impetus to inefficient governance evident from Bangalore, the garden city turning into ‘dead city’ during the functional life of BDA.
- Digitization of land records (especially common lands – lakes, open spaces, parks, etc.) and availability of this geo-referenced data with query option (Spatial Decision Support System) to public.

2. Demarcation of the boundary of water bodies:

- The existing regulations pertaining to boundary demarcations within different states need to be reviewed according to updated norms and based on geomorphology and other scientific aspects pertaining to individual water bodies.
- Maximum Water Level mark should form the boundary line of the water body.
- In addition, a specified width, based on historical records/ survey records etc. may be considered for marking a buffer zone around the water body. In case such records are not available, the buffer zones may be marked afresh considering the flood plain level and also maximum water levels.
- The width of the buffer zone should be set considering the geomorphology of the water body, the original legal boundaries, etc.
- The buffer zone should be treated as inviolable in the long term interests of the water body and its biodiversity.
- Declare and maintain floodplains and valley zones of lakes as no activity regions
- Remove all encroachments – free flood plains, valley zones, storm water drains, etc. of encroachments of any kind.
- Ban conversion of lake, lake bed for any other purposes.
- Urban wetlands, mostly lakes to be regulated from any type of encroachments.
- Regulate the activity which interferes with the normal run-off and related ecological processes – in the buffer zone (200 m from lake boundary / flood plains is to be considered as buffer zone)

3. **Mapping of water-bodies:** The mapping of water bodies should also include smaller wetlands, particularly streams, springs etc. The neglect of these hydrological systems could cause considerable impoverishment of water flow in the river systems as well as turn out to be threats to rare kinds of biodiversity. The waters of many of these streams are being diverted for private uses. This causes diminished water flow especially in the during the summer months. A judicious water sharing mechanism has to be worked out at the local level taking into account also the broader national interest as well as conservation of dependent biodiversity. The mapping of these smaller water-bodies, along with their catchments needs to be conducted involving also the local Biodiversity Management Committees. The jurisdictional agreements on the water usage and watershed protection need to be arrived at on a case to case basis involving all the stakeholders.

- Spatial Extent of Water bodies,
- Spatial extent of its catchment (watershed/basin),
- Demarcate Flood plains,
- Demarcate buffer zone – with a list of regulated activities,
- Land cover in the catchment,
- Ensure at least 33% of land cover is covered with natural vegetation (to ensure the lake perennial),
- Identify the natural areas in the catchment,
- Biodiversity inventory – capture entire food chain,
- The jurisdictional agreements on the water usage and watershed protection need to be arrived at on a case to case basis involving all the stakeholders,
- Develop a comprehensive database (spatial with attribute information) and available to public,
- Development of Spatial Decision Support System to aid decision makers,
- Identify and demarcate the region around the lake where all activities are to be prohibited (Flood plain)
- The biodiversity of every water body should form part of the Biodiversity Registers (BR),
- The local Biodiversity Management Committees (BMC) should be given necessary financial support and scientific assistance in documentation of diversity,
- The presence of endemic, rare, endangered or threatened species and economically important ones should be highlighted,
- A locally implementable conservation plan has to be prepared for such species.

4. **Holistic and Integrated Approaches – Conservation and Management:** Integration of the activities with the common jurisdiction boundaries of Government para-state Agencies for effective implementation of activities related to management, restoration, sustainable utilization and conservation. This necessitates:

- Common Jurisdictional boundary for all para-state agencies
- To minimise the confusion of ownership – assign the ownership of all natural resources (lakes, forests, etc.) to a single agency – **Lake Protection and Management Authority** (or Karnataka Forest Department). This agency shall be responsible for protection, development and sustainable management of water bodies).
- Custodian (single para-state agency) shall manage natural resources - let that agency have autonomous status with all regulatory powers to protect, develop and manage water bodies.
- All wetlands to be considered as common property resources and hence custodians should carefully deal with these ensuring security.
- Management and maintenance of lakes to be decentralized involving stakeholders, local bodies, institutions and community participation without any commercialization or commoditization of lakes.
- Integrated aquatic ecosystem management needs to be implemented to ensure sustainability, which requires proper study, sound understanding and effective management of water systems and their internal relations.
- The aquatic systems should be managed as part of the broader environment and in relation to socio-economic demands and potentials, acknowledging the political and cultural context.
- Wetlands lying within the protected area of National Parks and Wildlife Sanctuaries shall be regulated under the Wildlife Protection Act, 1972. Wetlands lying within the notified forest areas shall be regulated by the Indian Forest Act, 1927 and the Forest Conservation Act, 1980; and the relevant provisions of the Environment (Protection) Act, 1986. The Wetlands outside protected or notified forest areas shall be regulated by the relevant provisions of the Environment (Protection) Act, 1986.
- Immediate implementation of the regulatory framework for conservation of wetlands.
- Socio-economic studies with land use planning in and around the lakes can help in providing ecological basis for improving the quality of lakes.
- Prohibit activities such as conversion of wetlands for non-wetland purposes, dumping of solid wastes, direct discharge of untreated sewage, hunting of wild fauna, reclamation of wetlands.
- Maintain Catchment Integrity to ensure lakes are perennial and maintain at least 33% land cover should be under natural Vegetation.
- Plant native species of vegetation in each lake catchment.
- Create new water bodies considering the topography of each locality.
- Establish laboratory facility to monitor physical, chemical and biological integrity of lakes in each lake.

- Maintain physical integrity - Free storm water drains of any encroachments. Establish interconnectivity among water bodies to minimise flooding in certain pockets. The process of urbanization and neglect caused disruption of linkages between water bodies such as ancient lake systems of many cities. Wherever such disruptions have taken place alternative arrangements should be provided to establish the lost linkages.
- Encroachment of lake beds by unauthorized /authorized agencies must be immediately stopped. Evict all unauthorized occupation in the lake beds as well as valley zones.
- Restrictions on the diversion of lake for any other purposes - Lakes and wetlands provide ecological services (depending on the catchment integrity, duration may vary) – there are no dead lakes or wetlands
- Remove all encroachments (without any mercy) of wetlands, lakes, rajjakaluves (storm water drain) – encroachers have violated all humanitarian norms and deprived large section of the society of ecological services (provided by wetlands)
- Any clearances of riparian vegetation (along side lakes) and buffer zone vegetation (around lakes) have to be prohibited
- Penalise polluters dumping solid waste in the lake bed.
- Implement polluter pays principle for polluters letting liquid waste in to the lake either directly or through storm water drains.
- Lake privatized recently to be taken over and handed over to locals immediately thus restoring the traditional access to these lakes by the stakeholders.
- Restore surviving lakes in urban areas and strengthening their catchment area and allowing sloping shorelines for fulfilling their ecological functions.
- Alteration of topography in lake / river catchments should be banned.
- Appropriate cropping pattern, water harvesting, urban development, water usage, and waste generation data shall be utilized and projected for design period for arriving at preventive, curative and maintenance of aquatic ecosystem restoration action plan (AERAP).
- Desilting of lakes for removal of toxic sediment, to control nuisance macrophytes; further silting in the catchment should be checked by suitable afforestation of catchment areas and the provision of silt traps in the storm water drains.
- Maintaining the sediment regime under which the aquatic ecosystems evolve including maintenance, conservation of spatial and temporal connectivity within and between watersheds.
- Conversion of land around the lakes particularly in the valley zones and storm water drains for any kind of development must be totally banned.

- Flora in the catchment area should be preserved & additional afforestation programmes undertaken.
- Check the overgrowth of aquatic weeds like *Eichhornia*, *Azolla*, *Alternanthera* etc. through manual operations.
- Aquatic plants greatly aid in retarding the eutrophication of aquatic bodies; they are the sinks for nutrients & thereby play a significant role in absorption & release of heavy metals. They also serve as food and nesting material for many wetland birds. Therefore, knowledge of the ecological role of aquatic species is necessary for lake preservation.
- Adopt biomanipulation (Silver carp and Catla – surface phytoplankton feeders, Rohu – Column zooplankton feeder Gambusia and Guppies – larvivorous fishes for mosquito control), aeration, and shoreline restoration (with the native vegetation) in the management of lakes.
- Environmental awareness programmes can greatly help in the protection of the water bodies.
- Government Agencies, Academies, Institutions and NGO's must co-ordinate grass-root level implementation of policies and activities related to conservation of lakes and wetlands (both Inland and Coastal), their sustainable utilization, restoration and development including human health. There is also a need for management and conservation of aquatic biota including their health aspects. Traditional knowledge and practices have to be explored as remedial measures. Cost-intensive restoration measures should be the last resort after evaluating all the cost-effective measures of conservation and management of the wetlands.
- A Committee be constituted consisting of Experts, Representatives of Stakeholders (researchers, industrialists, agriculturists, fishermen, etc.) and Line Agencies, in addition to the existing Committee(s), if any, in order to evolve policies and strategies for reclamation, development, sustainable utilization and restoration of the wetlands and socio-economic development of the local people.
- At regional level, **Lake Protection and Management Authority (LPMA)** with autonomy, corpus funds from plan allocations of state and center and responsibility and accountability for avoiding excessive cost and time over runs. LPMA shall have stakeholders-representatives from central and state and local body authorities, NGO's and eminent people and experts shall be constituted
- Generous funds shall be made available for such developmental works through the Committee, as mentioned above. Local stakeholders be suggested to generate modest funds for immediate developmental needs in the aquatic systems in their localities.
- Provisions should be made for adoption of lakes and wetlands by the NGO's and Self-help groups for their conservation, management, sustainable utilization and restoration.

- Aquatic ecosystem restoration works taken up by any agency, Govt. or NGO's should have 10% of restoration costs (per annum) spent or set off for creating awareness , research and monitoring compulsorily in future.
- Public education and outreach should be components of aquatic ecosystem restoration. Lake associations and citizen monitoring groups have proved helpful in educating the general public. Effort should be made to ensure that such groups have accurate information about the causes of lake degradation and various restoration methods.

5. **Documentation of biodiversity:** The biodiversity of every water body should form part of the School, College, People's Biodiversity Registers (SBR, CBR, PBR). The local Biodiversity Management Committees (BMC) should be given necessary financial support and scientific assistance in documentation of diversity. The presence of endemic, rare, endangered or threatened species and economically important ones should be highlighted. A locally implementable conservation plan has to be prepared for such species.

- All kinds of introduction of Exotic species and Quarantine measures be done in consultation with the concerned Authorities and the data bank
- There is an urgent need for creating a 'Data Bank' through inventorisation and mapping of the aquatic biota.
- Identify water bodies of biodiversity importance and declare them as wetland conservation reserves (WCR)

6. Pollution Prevention:

- Letting only treated sewage into the lake (Integration of sewage treatment plant with the constructed wetlands and shallow algal pond would help in the removal of nutrients from the sewage).
- Complete restriction on disposal of industrial effluents into the lake directly or through drains to the lake.
- Handling, treatment and management of municipal solid waste as per MSW RULE 2000, GoI
- Ban on dumping building/construction debris, excavated earth in the drains as well as in the lake bed.

7. **Preparation of management plans for individual water bodies:** Most large water bodies have unique individual characteristics. Therefore it is necessary to prepare separate management plans for individual water bodies.

- Greater role and participation of women in management and sustainable utilization of resources of aquatic ecosystems.
- Impact of pesticide or fertilizers on wetlands in the catchment areas to be checked.
- Regulate illegal sand and clay mining around the wetlands.

7. **Implementation of sanitation facilities:** It was noted with grave concern that the water bodies in most of India are badly polluted with sewage, coliform bacteria and various other pathogens. This involves:
 - Preserving the purity of waters and safeguarding the biodiversity and productivity, dumping of waste has to be prohibited;
 - In addition to this, all the settlements alongside the water body should be provided with sanitation facilities so as not to impinge in anyway the pristine quality of water.
8. **Management of polluted lakes:** This programme needs priority attention. This involves:
 - Implementation of bioremediation method for detoxification of polluted water bodies.
 - The highly and irremediably polluted water bodies to be restored on priority to prevent health hazards.
 - Based on the concept of **polluter pays**, a mechanism be evolved to set up efficient effluent treatment plants [ETP], individual or collective, to reduce the pollution load. Polluting industries be levied **Environmental Cess**, which can be utilised for conservation measures by the competent authorities. A `waste audit' must be made compulsory for all the industries and other agencies.
9. **Restoration of lakes:** The goals for restoration of aquatic ecosystems need to be realistic and should be based on the concept of expected conditions for individual eco-regions. Further development of project selection and evaluation technology based on eco-region definitions and description should be encouraged and supported by the national and state government agencies.
 - Ecosystem approach in aquatic ecosystem restoration endeavor considering catchment land use plan as of pre-project status and optimal land use plan shall first be prepared for short term (10 to 30 years) and long term (>30) periods keeping in view developmental pressure over time span.
 - Research and development is needed in several areas of applied limnology, and this programme should take an experimental approach which emphasizes manipulation of whole ecosystems.
 - Appropriate technologies for point and non-point sources of pollution and *in situ* measures for lake restoration shall be compatible to local ethos and site condition as well as objectives of Aquatic Ecosystem Restoration Action Plan (AERAP).
 - Traditional knowledge and practices have to be explored as remedial measures. Cost-intensive restoration measures should be the last resort after evaluating all the cost-effective measures of conservation and management of ecosystems.
 - Public needs to be better informed about the rational, goal and methods of ecosystem conservation and restoration. In addition, the need was realized for

scientist and researchers with the broad training needed for aquatic ecosystem restoration, management and conservation.

- Improved techniques for littoral zone and aquatic macrophytes management need to be developed. Research should go beyond the removal of nuisance macrophytes to address the restoration of native species that are essential for waterfowl and fish habitat.
- Basic research is necessary to improve the understanding of fundamental limnological processes in littoral zones and the interactions between littoral and pelagic zones of lakes.
- Bio manipulation (food web management) has great potential for low-cost and long-term management of lakes, and research in this emerging field must be stimulated.
- Innovative and low-cost approaches to contaminant clean up in lakes need to be developed.
- The relations between loadings of stress-causing substances and responses of lakes need to be understood more precisely. Research should be undertaken to improve predictions of trophic state and nutrient loading relationships.
- Improved assessment programmes are needed to determine the severity and extent of damage in lakes and wetlands and a change in status over time. Innovative basic research is required to improve the science of assessment and monitoring.
- There is a great need for cost effective, reliable indicators of ecosystems function, including those that would reflect long-term change and response to stress.
- Research on indicators should include traditional community and ecosystem measurements, paleoecological trend assessments and remote sensing.
- Effective assessment and monitoring programme would involve network of local schools, colleges and universities.

10. Only treated sewage into the Lake: Prohibition on partially treated or untreated sewage getting into the lake. Integration of constructed wetlands and shallow algal ponds with the sewage treatment plant (as in JAKKUR LAKE) helps in the removal of nutrients and other contaminants. Treatment and management of treated sewage at decentralised levels would help in the prevention of groundwater contamination and also recharge of groundwater resources.

11. Valuation of goods and services : Goods and services provided by the individual water bodies and the respective species to be documented, evaluated through participatory approach and be made part of the Biodiversity Registers (PBR: People's Biodiversity Registers, SBR: School Biodiversity Registers). If in any case the traditional fishing rights of the local fishermen are adversely affected by lake conservation or by declaring it as a bird sanctuary, etc. they should be adequately compensated.

- Ecological values of lands and water within the catchment / watershed shall be internalised into economic analysis and not taken for granted. Pressure groups shall play as watchdogs in preventing industrial and toxic and persistent pollutants by agencies and polluters.

11. **Regulation of boating:** Operation of motorized boats should not be permitted within lakes of less than 50 ha. In larger lakes the number of such boats should be limited to restricted area and carrying capacity of the water body. In any case boating during the periods of breeding and congregations of birds should be banned.

12. **Protection of riparian and buffer zone vegetation:** Any clearances of riparian vegetation (along side rivers) and buffer zone vegetation (around lakes) have to be prohibited.

13. **Restoration of linkages between water bodies:** The process of urbanization and neglect caused disruption of linkages between water bodies such as ancient lake systems of many cities. Wherever such disruptions have taken place alternative arrangements should be provided to establish the lost linkages.

14. **Rainwater harvesting:** Intensive and comprehensive implementation of rain water harvesting techniques can reduce taxation of water bodies and also minimize electricity requirements. The country needs in principle a holistic rainwater harvesting policy aimed at directing water literally from “roof-tops to lakes” after catering to the domestic needs.

15. **Environment Education:** It was felt among the participants that public needs to be better informed about the rational, goal and methods of ecosystem conservation and restoration. In addition, the need was realized for scientist and researchers with the broad training needed for aquatic ecosystem restoration, management and conservation. Public education and outreach should include all components of ecosystem restoration. Lake associations and citizen monitoring groups have proved helpful in educating the general public. Effort should be made to ensure that such groups have accurate information about the causes of lake degradation and various restoration methods. Funding is needed for both undergraduate and graduate programmes in ecosystem conservation and restorations. Training programmes should cross traditional disciplinary boundaries such as those between basic and applied ecology: water quality management and fisheries or wildlife management: among lakes, streams, rivers, coastal and wetland ecology. In this regard the brainstorming session proposes:

- Environmental education program should be more proactive, field oriented and experiential (with real time examples) for effective learning.
- Environmental education should be made mandatory at all levels – schools, colleges, universities, professional courses, teachers and teacher educators at the teachers’ training institutes (C P Ed, B P Ed, B Ed, D Ed)

16. **Adopt Inter-disciplinary Approach:** Aquatic ecosystem conservation and management requires collaborated research involving natural, social, and interdisciplinary study aimed at understanding various components, such as monitoring of water quality, socio-economic dependency, biodiversity and other activities, as an

indispensable tool for formulating long term conservation strategies. This requires multidisciplinary-trained professionals who can spread the understanding of ecosystem's importance at local schools, colleges, and research institutions by initiating educational programmes aimed at rising the levels of public awareness of aquatic ecosystems' restoration, goals and methods. Actively participating schools and colleges in the vicinity of the water bodies may value the opportunity to provide hands-on environmental education, which could entail setting up of laboratory facilities at the site. Regular monitoring of water bodies (with permanent laboratory facilities) would provide vital inputs for conservation and management.

Wetland Protection Laws and Government Initiatives

The primary responsibility for the management of these ecosystems is in the hands of the Ministry of Environment and Forests. Although some wetlands are protected after the formulation of the Wildlife Protection Act, the others are in grave danger of extinction. Effective coordination between the different ministries, energy, industry, fisheries revenue, agriculture, transport and water resources, is essential for the protection of these ecosystems. Thus, wetlands were not delineated under any specific administrative jurisdiction. Recently the Ministry of Environment and Forests of the Government of India issued Notification 2010 Regulatory Framework for Wetlands Conservation (Wetland Conservation Rules). Wetlands in India are protected by an array of laws given below:

- The Indian Fisheries Act - 1857
- The Indian Forest Act - 1927
- Wildlife (Protection) Act - 1972
- Water (Prevention and Control of Pollution) Act - 1974
- Water (Prevention and Control of Pollution) Cess Act - 1977
- Forest (Conservation) Act - 1980
- The Environment (Protection) Act - 1986
- Wildlife (Protection) Amendment Act - 1991
- National Conservation Strategy and Policy Statement on Environment and Development – 1992
- Environment Impact Assessment Notification, 2009
- Wetlands Regulatory Framework, 2008
- Wetlands (Conservation and Management) Rules 2010, Government of India

In addition to the above laws, India is a signatory to the Ramsar Convention on Wetlands and the Convention of Biological Diversity. According to these formulations India is expected to conserve the ecological character of these ecosystems along with the biodiversity of the flora and fauna associated with these ecosystems. Despite these, there is no significant development towards sustaining these ecosystems due to the lack of awareness of the values of these ecosystems among the policymakers and implementation agencies. The effective management of these wetlands requires a thorough appraisal of the existing laws, institutions

and practices. The involvement of various people from different sectors is essential in the sustainable management of these wetlands.

Apart from government regulation, development of better monitoring methods is needed to increase the knowledge of the physical and biological characteristics of each wetland resources, and to gain, from this knowledge, a better understanding of wetland dynamics and their controlling processes. Discussions based on accurate knowledge and increased awareness of wetland issues can then begin to develop management strategies (to protect, restore and/or mitigate) that account for the function and value of all wetland resources in the face of natural and socioeconomic factors, while continuing to satisfy critical resource needs of the human population.

The Legal framework for the conservation and management of Wetland Ecosystems is provided by the following National and International Legal instruments:

The Wildlife Protection Act, 1972: This act provides for the protection of wild animals, birds and plants. For the purpose of this act, the state government constitutes the Wildlife Advisory board, which performs the following functions: It advises the state government:

- In the selection of areas to be declared as Sanctuaries, National Parks and Closed Areas.
- In the formulation of policy of protection and conservation of wildlife and specified plants.
- In relation to the measures to be taken for harmonizing the needs of the tribals and forest dwellers with the protection and conservation of wildlife.

This Act imposes prohibition on hunting of wild animals, their young ones as well as their eggs except with prior permission of the Chief Wildlife Warden. This act prohibits the picking, uprooting, destroying, damaging, possessing of any plant in a protected area, except with prior permission of the Chief Wildlife Warden. The State government may declare any area; which it considers to have adequate ecological, faunal, geomorphological, natural or zoological significance for the purpose of protecting, propagating or developing wildlife or its environment; to be included in a sanctuary or a National Park. No person shall, destroy, exploit or remove any wildlife from a National Park and Sanctuary or destroy or damage the habitat or deprive any wild animal or plant its habitat within such National Park and Sanctuary. The State government may also declare any area closed to hunting for a designated period of time if it feels the ecosystem of that area is disturbed by hunting.

Water (Prevention and Control of Pollution) Act, 1974: for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water. To carry out the purposes of this act, the Central and the State government constitutes the Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) respectively. The main functions of the pollution control boards include:

- Advise the government on any matter concerning the prevention and control of water pollution.
- Encourage, conduct and participate in investigations and research relating to problems of water pollution and prevention, control or abatement of water pollution.
- Lay down or modify standards on various parameters for the release of effluents into streams.
- Collect and examine effluent samples as well as examine the various treatment procedures undertaken by the industries releasing the effluent.
- Examine the quality of streams.
- Notify certain industries to stop, restrict or modify their procedures if it feels that the present procedure is deteriorating the water quality of streams.
- Establish or recognize laboratories to perform its functions including the analysis of stream water quality and trade effluents.

Forest (Conservation) Act, 1980: Without the permission of the Central government, no State government or any other authority can:

- Declare that any reserved forest shall cease to be reserved.
- Issue permit for use of forest land for non-forest purpose.
- Assign any forest land or portion thereof by way of lease or otherwise to any private person, authority, corporation, agency or any other organization, not owned, managed or controlled by government.
- Clear off natural trees from a forest land for the purpose of reafforestation.

The Biological Diversity Act, 2002: India is a signatory to the United Nations Convention on Biological Resources, 1992 and in accordance with that convention, brought into force The Biological Diversity Act, 2002. This act prohibits biodiversity related activities as well as transfer of the results of research pertaining to biodiversity to certain persons. It also necessitates the approval of National Biodiversity Authority before applying for Intellectual Property Rights on products pertaining to biological diversity. This act emphasizes the establishment of National Biodiversity Authority to carry out various functions pertaining to the Act, viz guidelines for approving collection, research and patents pertaining to biological diversity. It also notifies the central government on threatened species. The central government to develop plans, programmes and strategies for the conservation, management and sustainable use of the biodiversity. Where the Central Government has reason to believe that any area rich in biological diversity, biological resources and their habitats is being threatened by overuse, abuse or neglect, it shall issue directives to the concerned State Government to take immediate ameliorative measures.

Convention on Wetlands of International Importance, especially as Waterfowl habitats, (Ramsar) 1971: To stem the progressive destruction of the wetlands, Ramsar convention was signed. Waterfowls are birds ecologically dependent on the wetlands. The various points agreed under Ramsar convention includes:

- Each contracting party should nominate at least one wetland having significant value in terms of ecology, botany, zoology, limnology or hydrology to be included in the List of Wetlands of International Importance (Ramsar sites) and precisely describe its boundaries.
- The contracting parties will have right to add further wetland sites to the list, expand the boundaries of the existing sites and also to delete or minimize the boundaries of the existing sites.
- Each contracting party shall strive for the conservation, management and restoration of the wetlands in the list.
- Establishment of nature reserves in the area of wetlands thereby protecting it as well as the biological diversity it supports.
- Restriction of boundaries or deletion of a wetland listed as Ramsar sites should be immediately compensated by the creation of additional nature reserves for the protection of waterfowls and other species habiting that wetland.

International convention for the protection of Birds, 1950: To abate the ever dwindling number of certain bird species (particularly the migratory ones) as well as the other birds, this convention was made. This is an amendment to the “International Convention for the Protection of Birds useful to Agriculture, 1902”. The objectives of this convention include:

- Protection to all birds, their young ones and their eggs especially in their breeding season.
- Prohibit hunting, killing, mass capture or captivating birds, except those causing intense damage to crops or other components of the ecosystem, such so that the above said components is in the danger of extinction.
- Adopt measures to prohibit industries and other processes causing contamination of air and water that has adverse effects on the survival of birds.
- Adopt measures to prohibit the destruction of suitable breeding grounds and the bird habitat and also encourage the creation of suitable land and water habitat for the birds.

Bonn Convention on Conservation of Migratory Species, 1979: According to the Bonn Convention on Conservation of Migratory Species, the participating parties:

- Should promote, co-operate in and support research relating to migratory species.
- Shall endeavour to provide immediate protection for migratory species which are endangered.
- Shall strive to conserve and restore those habitats of the endangered species in an effort to eliminate the chances of extinction of that species.
- Shall prohibit or minimize those activities or obstacles that seriously impede or prevent the migration of the species.

Convention on Biological Diversity, 1992: The main objectives of this convention are the conservation of biological diversity, the sustainable use of its components and the fair and

equitable sharing of benefits arising out of the utilization of genetic resources. In accordance with this convention, each contracting party shall –

- Identify places supporting immense biological diversity.
- Monitor through sampling or other means the components of biological diversity identified and strive for the conservation of those components requiring urgent attention.
- Develop new or adapt existing strategies, plans and programmes for the conservation and sustainable use of biological diversity.
- Identify activities which have or may have significant adverse impact on the sustainability of the biodiversity in an area.
- It prescribes conservation of biological diversity by either *In situ* conservation mechanisms or *Ex situ* conservation mechanisms or both.

In situ conservation: Each contracting parties shall declare a region harbouring immense biological diversity as a protected area and develop various plans and strategies for the establishment, conservation and management of these protected areas and also strive to conserve biodiversity beyond these protected areas.

- Promote environmentally sound and sustainable development in the areas adjacent to the protected areas so as to further enhance the development and protection of these protected areas.
- Promote the protection of ecosystems, prevent the introduction of alien species likely to have an adverse effect on the existing ecosystem and also rehabilitate & restore degraded ecosystems.
- Enforce legislative measures for the protection of threatened species and population.

Ex situ conservation : Each contracting party shall establish facilities for ex situ conservation and for research on plants, animals and micro-organisms, especially the threatened species, augment their number and take steps for their reintroduction in their own natural habitat.

Relative merits and scope of the respective Indian laws with respect to the wetlands protection and conservation is given in Table 2.

Table 2: Sections applicable to Wetlands in the various environmental laws

No.	Act	Relevant Sections
1	The Wildlife (Conservation) Act, 1972	<p>Prohibits hunting of wild animals, their young ones as well as their eggs</p> <p>Prohibits the picking, uprooting, destroying, damaging, possessing of any plant in a protected area</p> <p>Can declare any area with high ecological significance as a national park, sanctuary or a closed area.</p>

2	The Biological Diversity Act, 2002	<p>Prior approval needed from National Biodiversity Authority for collection of biological materials occurring in India as well as for its commercial utilization.</p> <p>Panchayath to document biodiversity and maintain biodiversity registers</p>
3	Forest (Conservation) Act, 1980	<p>Without the permission of the Central government, no State government or any other authority can :</p> <ul style="list-style-type: none"> • Declare that any reserved forest shall cease to be reserved. • Issue permit for use of forest land for non-forest purpose. • Assign any forest land by way of lease or otherwise to any private person, authority, corporation, agency or any other organization, not owned, managed or controlled by government. • Clear off natural trees from a forest land for the purpose of re-afforestation.
4	Water (Control and Prevention of Pollution) Act, 1974	<p>It is based on the “Polluter pays” principle. The Pollution Control Boards performs the following functions :</p> <ul style="list-style-type: none"> • Inspects sewage and effluents as well as the efficiency of the sewage treatment plants. • Lay down or modifies existing effluent standards for the sewage. • Lay down standards of treatment of effluent and sewage to be discharged into any particular stream. • Notify certain industries to stop, restrict or modify their procedures if the present procedure is deteriorating the water quality of streams.
5	Wetlands (Conservation and Management) Rules, 2010	<p>Prohibited Activities</p> <ul style="list-style-type: none"> • Conversion of wetland to non-wetland use • Reclamation of wetlands • Solid waste dumping and discharge of untreated effluents.

		<p>Regulated activities</p> <ul style="list-style-type: none"> • Withdrawal of water, diversion or interruption of sources • Treated effluent discharges – industrial/domestic/agro-chemical. • Plying of motorized boats • Dredging • Constructions of permanent nature within 50 m • Activity which interferes with the normal run-off and related ecological processes – up to 200 m
6	National Environment Policy, 2006	<p>The principal objectives of NEP includes :</p> <ul style="list-style-type: none"> • Protection and conservation of critical ecological systems and resources, and invaluable natural and man made heritage. • Ensuring judicious use of environmental resources to meet the needs and aspirations of the present and future generations. • It emphasizes the “Polluter Pays” principle, which states the polluter should, in principle, bear the cost of pollution, with due regard to the public interest.
8	The Environment (Protection) Act, 1986	<p>Lays down standards for the quality of environment in its various aspects. Laying down standards for discharge of environmental pollutants from various sources and no persons shall discharge any pollutant in excess of such standards. Restrictions of areas in which industries, operations or processes shall not be carried out or carried out subject to certain safeguards.</p>
9	National Water Policy, 2002	<p>Water is a scarce and precious national resource and requires to be conserved and management. Watershed management through extensive soil conservation, catchment-area treatment, preservation of forests and increasing the forest cover and the construction of check-dams should be promoted. The water resources should be conserved by retention practices such as rain water harvesting and prevention</p>

		of pollution.
10	KARNATAKA LAKE CONSERVATION AND DEVELOPMENT AUTHORITY ACT, 2014, KARNATAKA ACT NO. 10 OF 2015 RMP 2015 (BDA)	<p>Conservation of lakes and wetlands</p> <p>Primary valleys in Bangalore are sensitive regions as per sensitive zone notification - Circular/35/BBMP/2008, dated: 26/11/2008) and buffer zone for primary valley is 100 m.</p> <p>NEEDS PROTECTION – possible only with the implementation of norms without any dilutions and violations.</p>