DETRIMENTAL LANDUSE CHANGES IN AGARA-BELLANDUR WETLAND

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LANDUSE CHANGES IN AGARA-BELLANDUR WETLAND

1.0 WETLANDS VIOLATIONS: PERSISTENT ABUSE AND MISUSE

Bangalore Wetlands have been facing persistent threats due to (i) encroachments and unauthorised construction in the lake bed, wetlands, and rajakaluves (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.

2.0 WETLANDS - VITAL FOR BANALOREANS

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).

3.0 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 2.1provides 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***

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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.

4 LAND USE CHANGES IN THE VALLEY ZONE: AGARA-BELLANDUR WETLAND

Comprehensive development plan for Bangalore city (CDP 2015; RMP) delineates the region to be protected in Bangalore. Valley zones which are essentially flood plain region with wetlands are protected as per this norm. Figure 1 maps the valley zone in Bangalore while Figure 2 identifies the proposed SEZ in Agara Bellandur wetland (valley zone). This region is earmarked for SEZ is identified in CDP for setting up of treatment plant (solid and liquid waste), parks, and other public utilities.

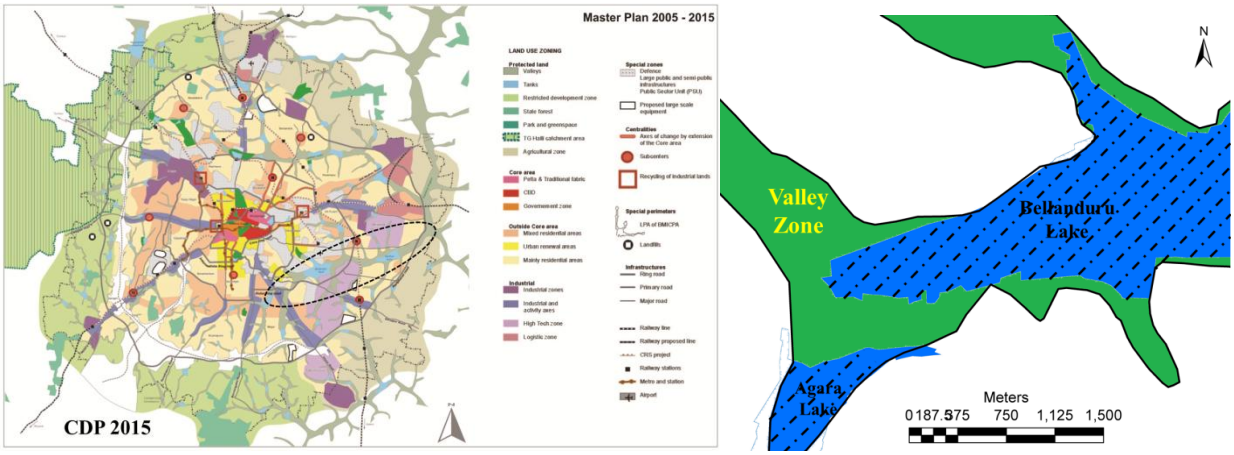


Figure 1: Bangalore City Development plan 2005 - 2015

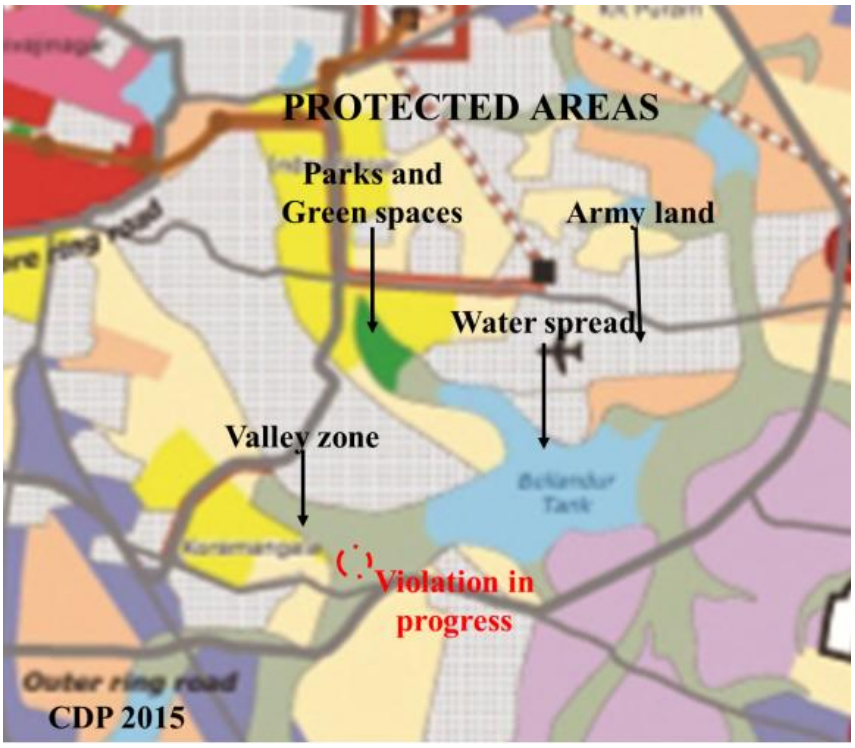


Figure 2: Violations in the valley zone as per the City Development Plan 2005- 2015

Fig 3 depicts the landscape dynamics during 2000 to 2015 (mapped on temporal Google Earth data – http://earth.google.com). Landscape alterations gained momentum with land acquisition by KIADB (through the project proponents). The remote sensing data of 2009 – 2015 substantiates the unabated construction activities in the valley zone (without proper compliance and gross violations of environmental norms). Table 1 highlights extent of landscape alterations and unauthorized occupation of wetlands (Agara-Bellandur wetland).

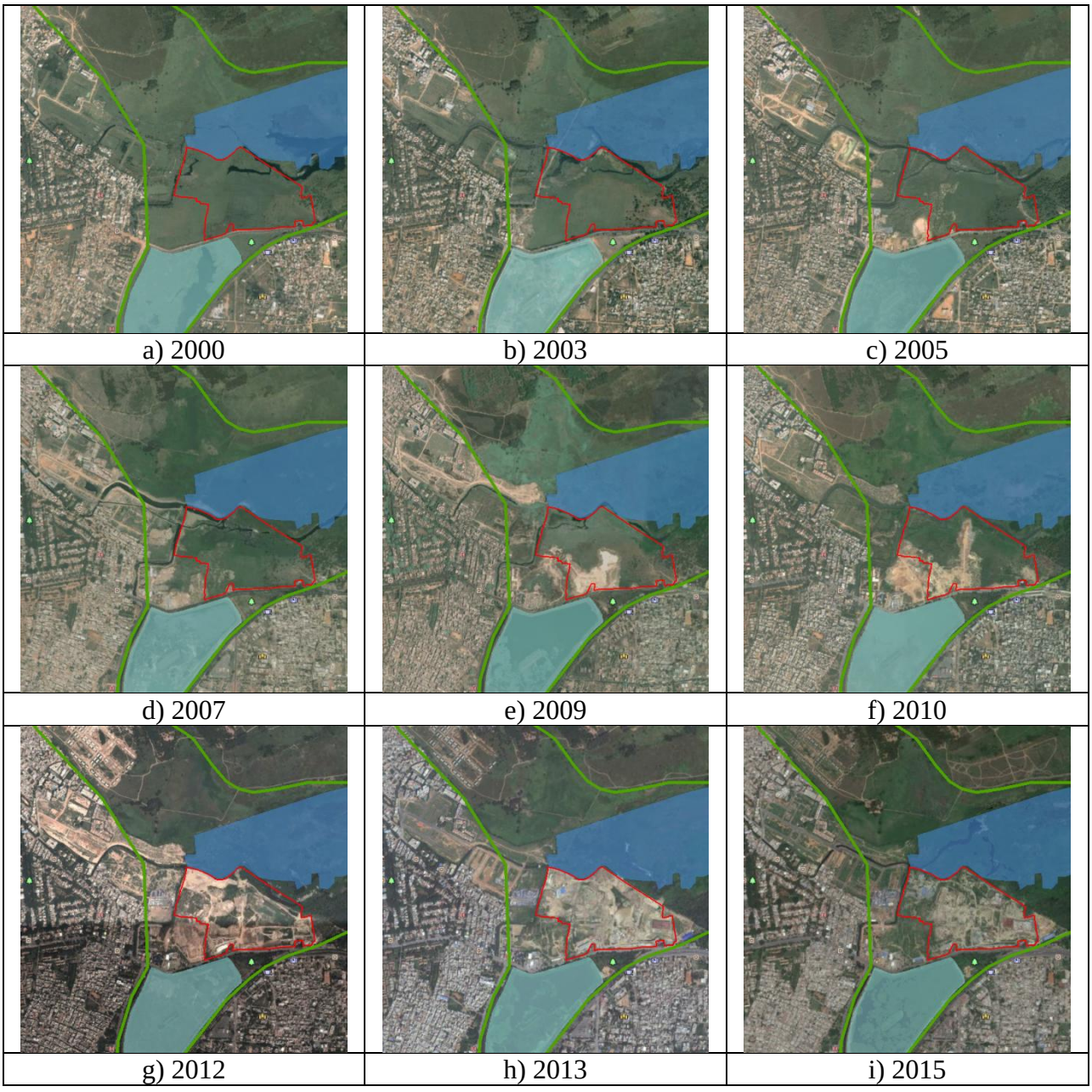


Figure 3: Landscape dynamics in the valley zone

Figure 4 gives cadastral map (1904, scale: 1 in 7920) of the region with land uses - drainage network, agriculture land parcels, tank boundaries, etc. Figure 5 gives the region (with land parcels) for the proposed SEZ.

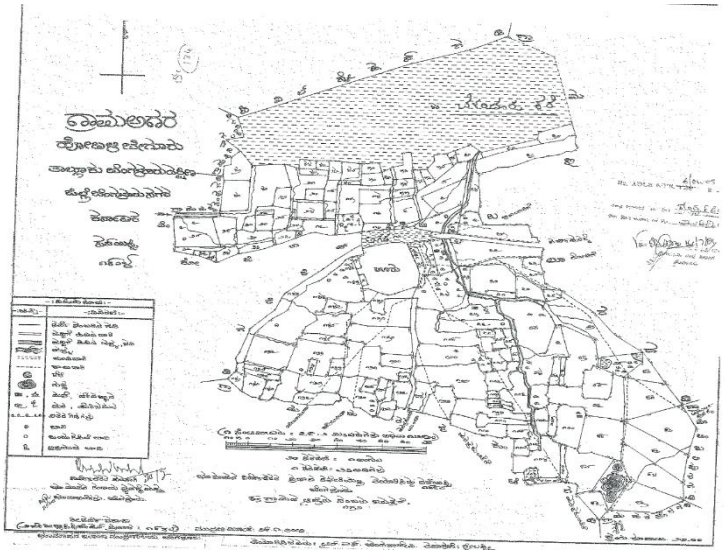


Figure 4: Cadastral Map with lakes (1904)

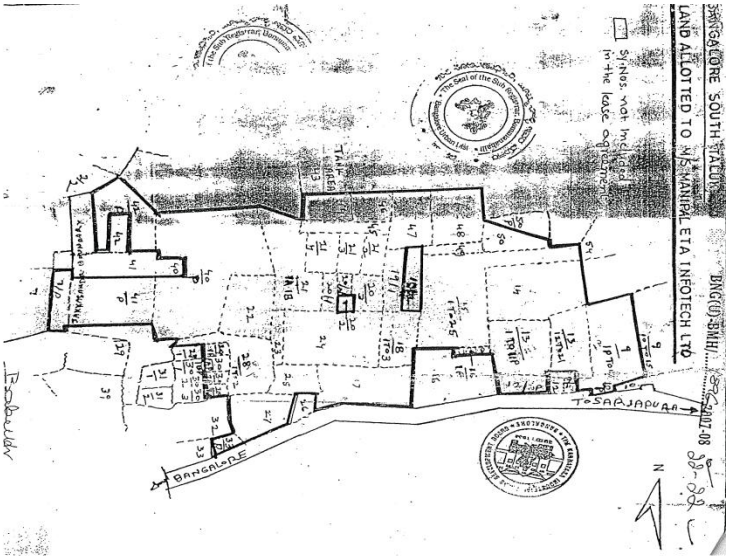


Figure 5: Land allocated for SEZ in 2007.

Figure 6 gives the boundary with respective survey numbers of land parcels. Figure 7 is an overlay of figure 6 on the Google earth (http://earth.google.com). This reveals an initiation of construction activities during 2010 – construction of compound walls, filling up of low lying

areas with building debris and excavated earth. Figure 8 gives the current spatial extent of construction activities (with compound wall) as on 2015 which is given in Figure 9a and 9b (current boundary and boundary as per KIADB, overlaid on Google earth). This also highlights encroachments of a portion of Rajakaluves and also lake bed. Figure 10a to 10g illustrates changes in the landscape analysed using temporal remote sensing data, which indicates:

1) landscape alterations in the wetland region (identifies for SEZ in 2007).
2) Cement walls were erected along the boundary (Fig 4) in 2010.
3) Rampant dumping of building debris in rajakaluve, low lying areas of the wetlands and digging work for construction of 3 basement floors.

Table 1 lists the spatial changes during 2007 to 2010, which indicates an encroachment to an extent of 10 acres 14.61 guntas in the region (lake bed 3 acre 30 guntas, Rajakaluves)

Table 1: Extent of encroachment and illegalities in the SEZ

Year	Land allocated	Encroachment	Total land
2007	63 Acres 37.5 Guntas	-	63 Acres 37.5 Guntas
2010	63 Acres 37.5 Guntas	2 Acres 34.86 Guntas	66 Acres 32.3 Guntas
2012	63 Acres 37.5 Guntas	8 Acres 14.21 Guntas	72 Acres 15.9 Guntas
2013	63 Acres 37.5 Guntas	10 Acres 14.61 Guntas	74 Acres 12.1 Guntas
2015	63 Acres 37.5 Guntas	10 Acres 14.61 Guntas	74 Acres 12.1 Guntas

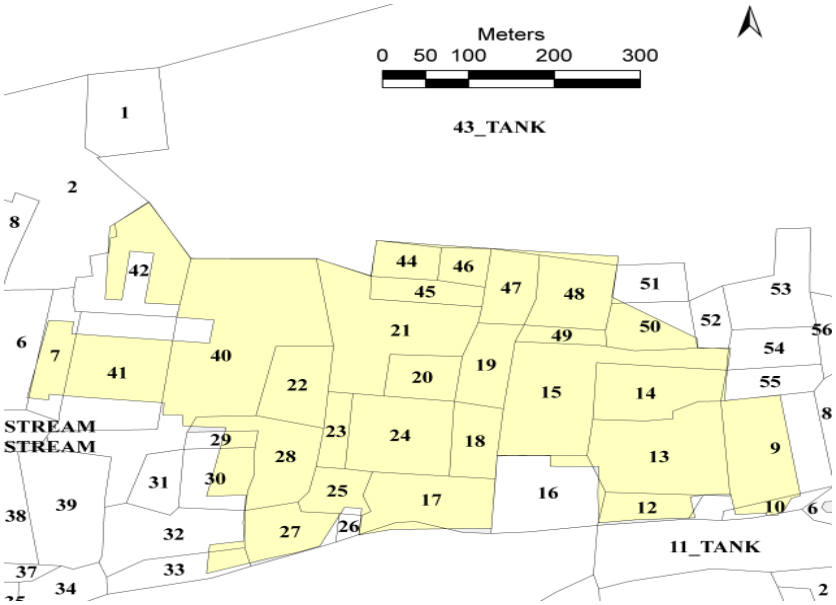


Figure 6: Allocated land for Mantri developers by KIADB overlaid on Cadastral Map

Figure 7: Compound walls built in 2010

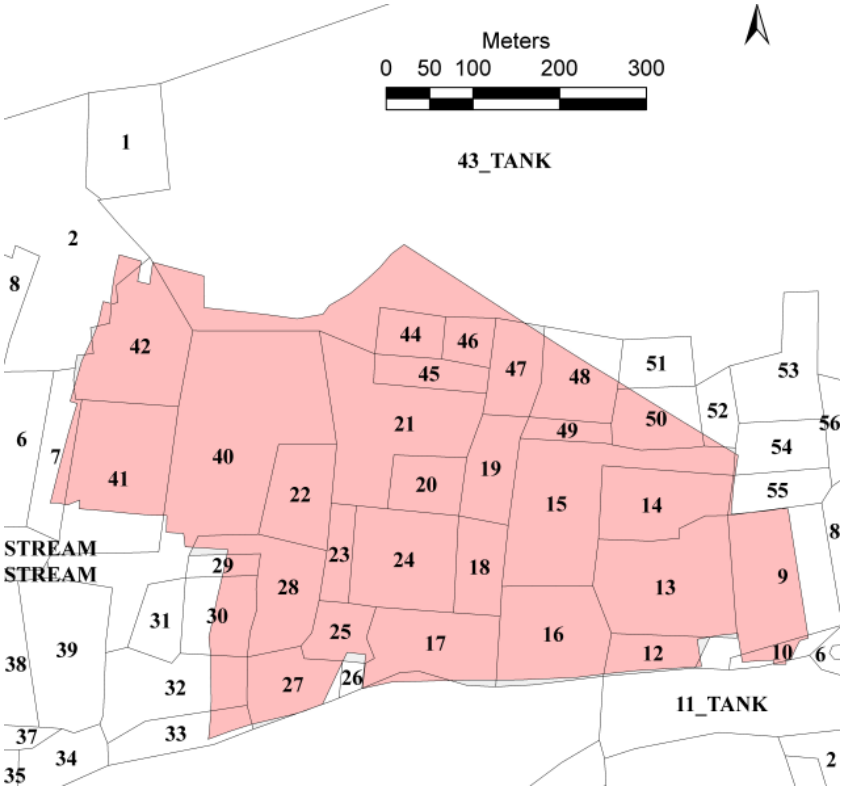


Figure 8: The region with construction activities with compound wall on the cadastral map.

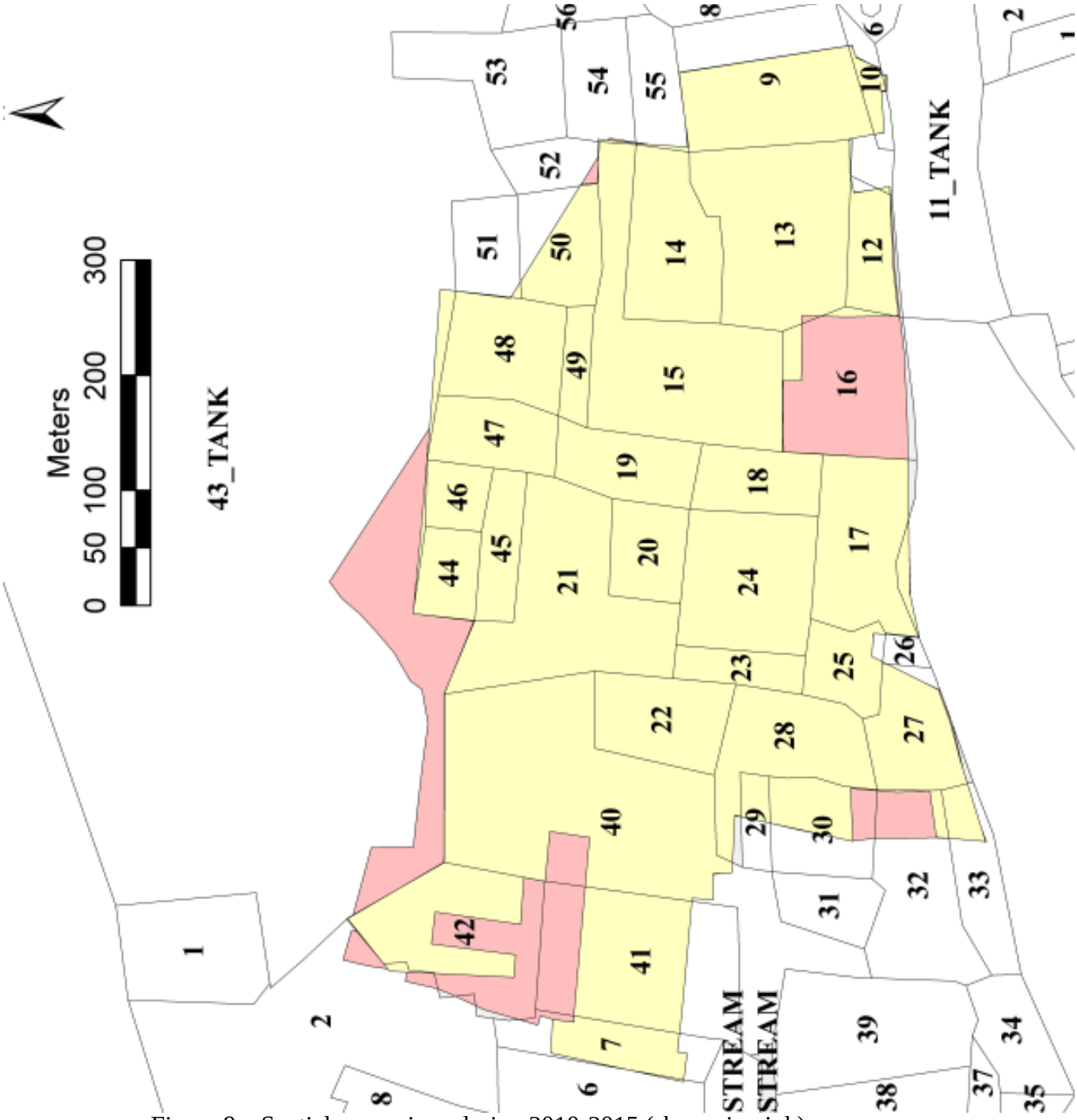


Figure 9a: Spatial expansions during 2010-2015 (shown in pink)

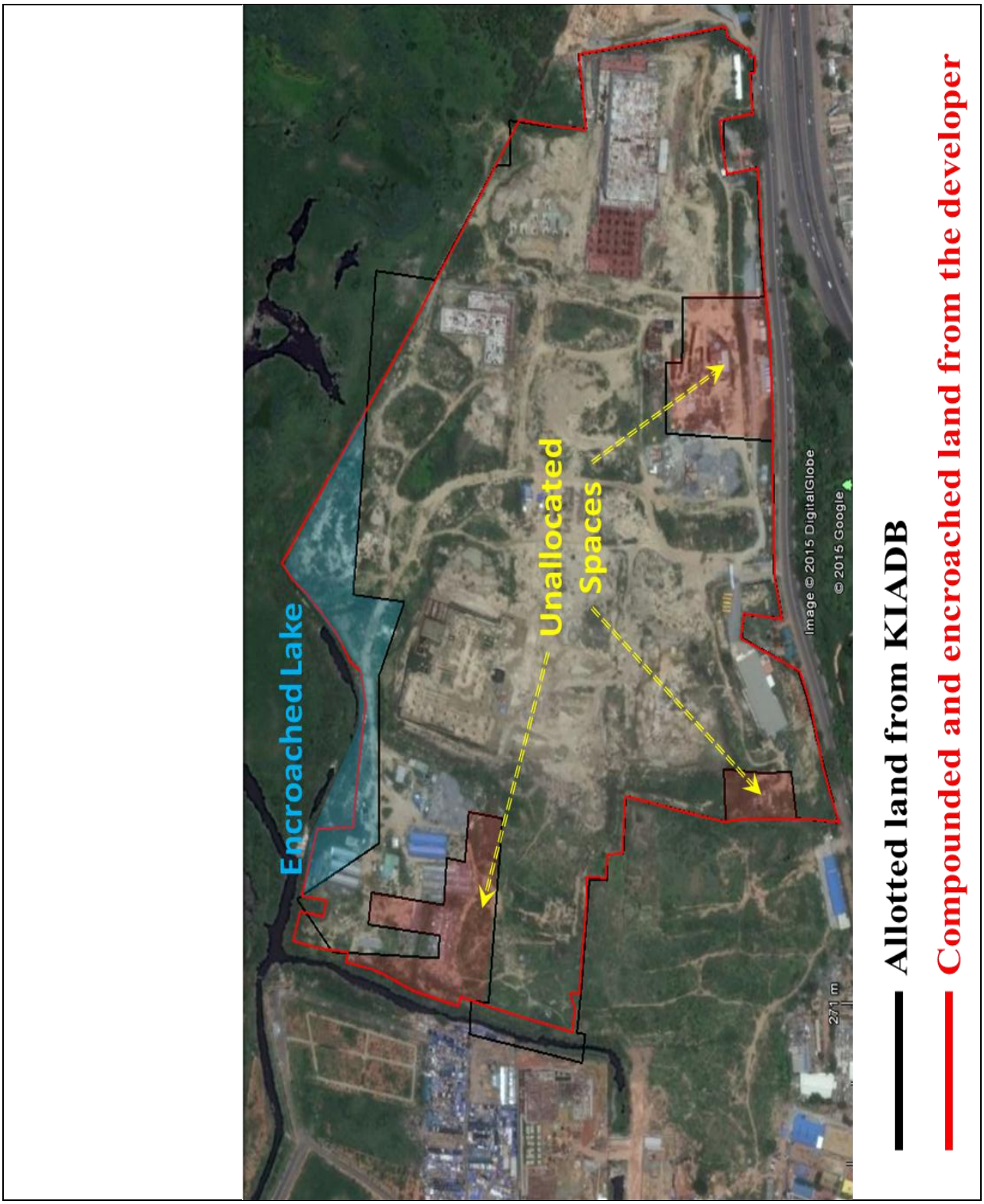


Figure 9b: Land use alterations in the region (on map and on Google earth)

a) 2000

b) 2005

c) 2007

d) 2010

e) 2012

f) 2013

g) 2015

Figure 10: Landscape dynamics

5.0 LANDSCAPE DYNAMICS AND ALTERATIONS IN RAJAKALUVE

Wetlands in Bangalore are inter connected and these inter connected systems facilitate transfer of water from one lake to other lake via wetlands. Figure 11 highlights interconnected lake system in Agara-Bellandur region with rajakaluves and stream network. Figure 11 also indicates the narrowing down of rajakaluves which is explained in figure 12 (12a to 12 c) for the period 2000 to 2015, (for the cross sections A, B, C, D are marked in figure 11 and figure 12 respectively). Table 2 provides the declining width of rajakuluve with the progress of construction activities in the region. Rajakauluves have declined between 23% and 57% of the original width during the year 2000 to 2015.

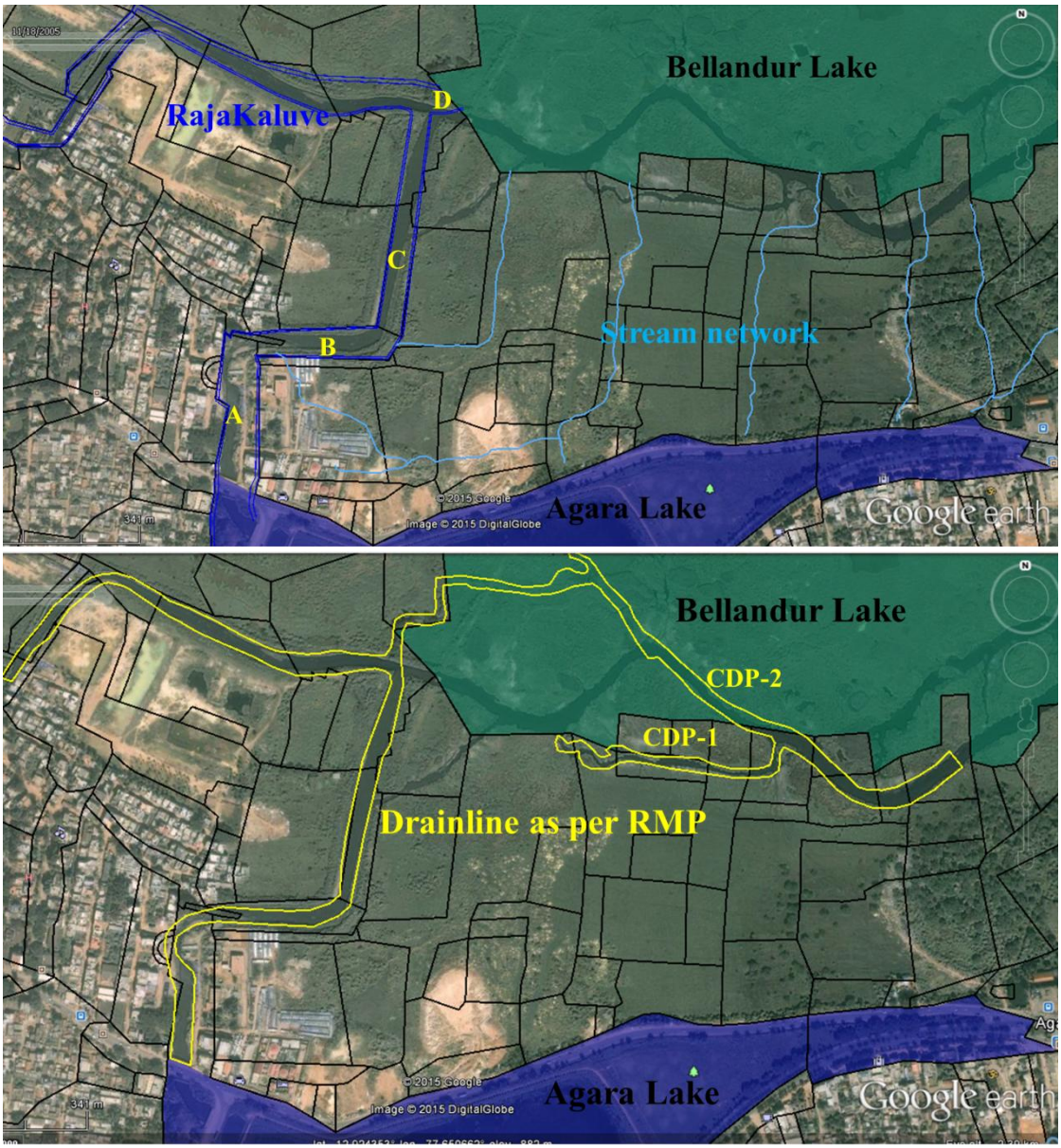
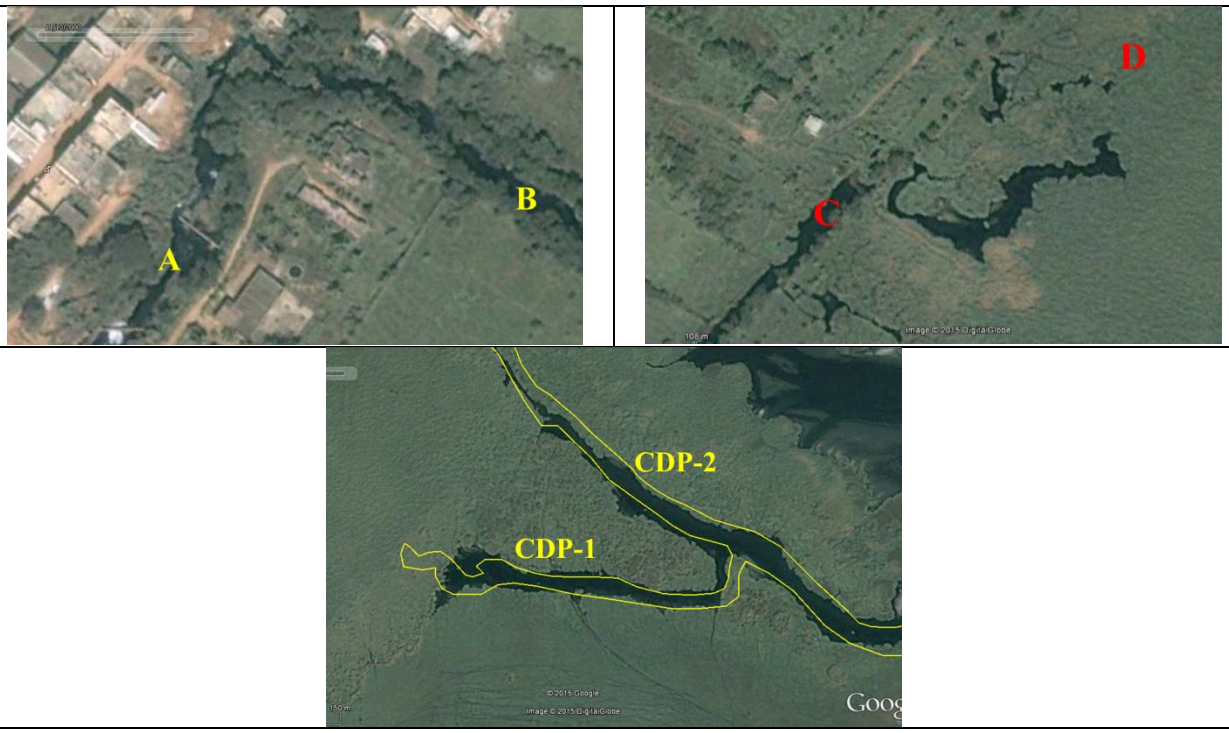
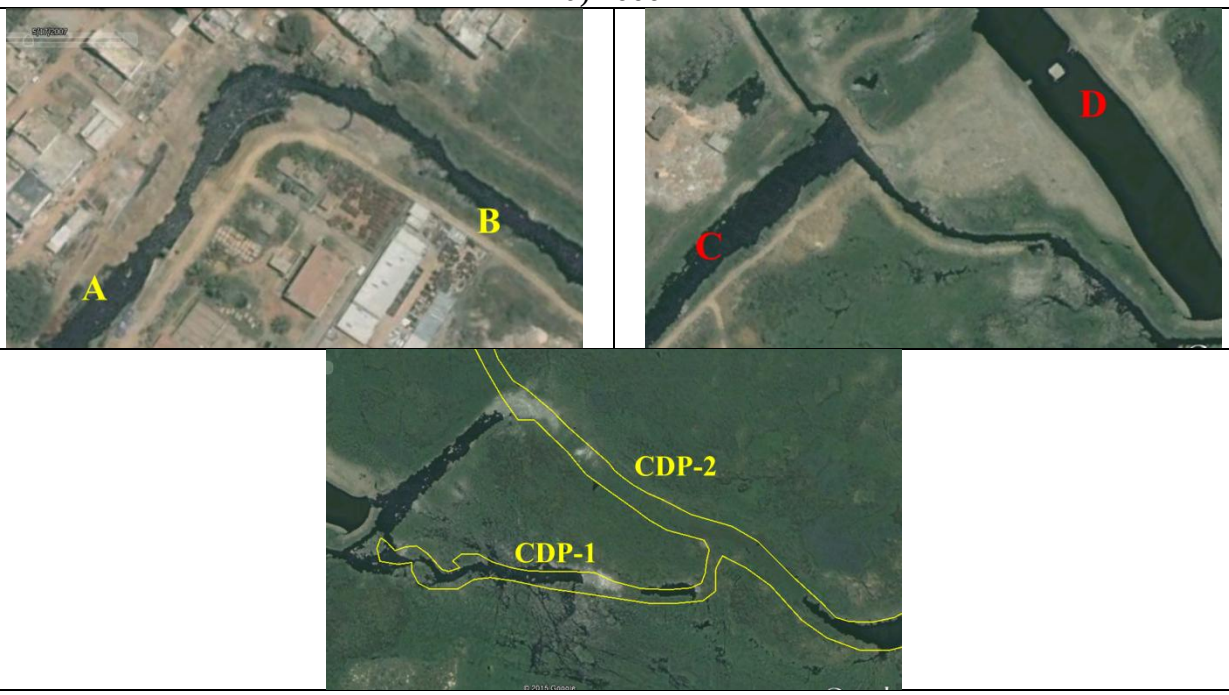


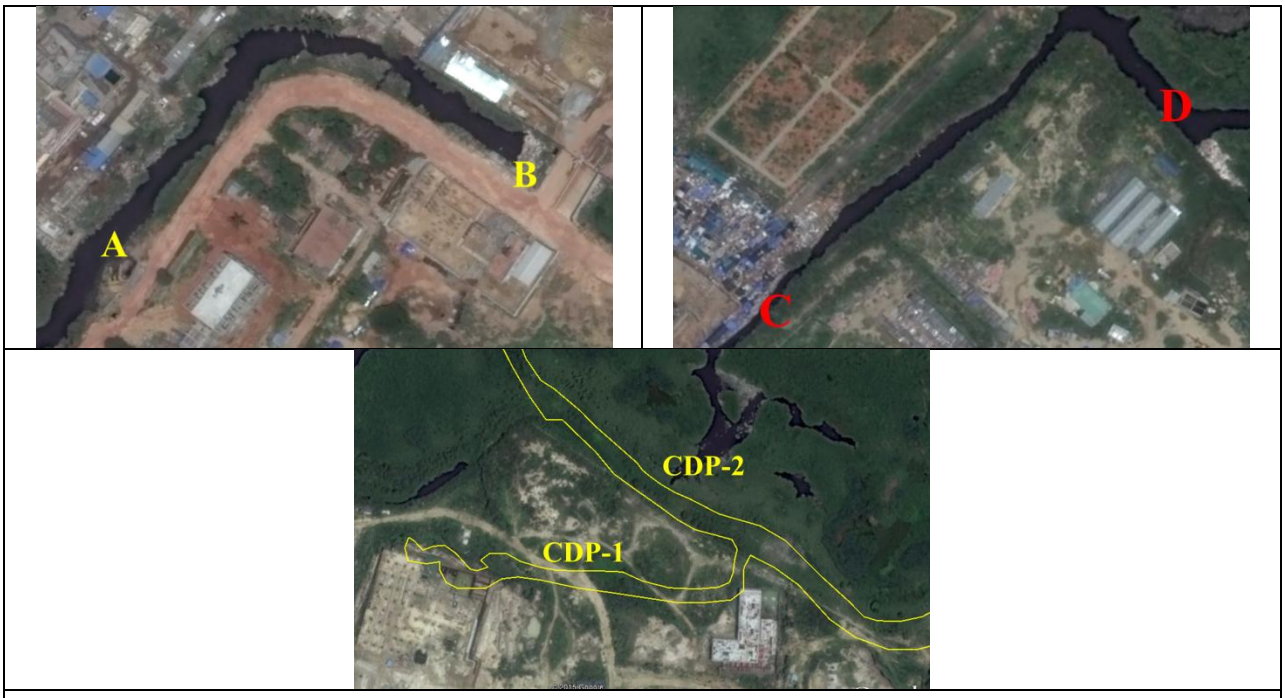
Figure 11: Rajakaluve, streams and lakes as per cadastral maps, satellite data and RMP 2015



a) 2000



b) 2007



c) 2015

Source : Google earth

Figure 12: Alterations in the rajakaluve/storm water drain since 2000

Table2: Shrinking width of the rajakaluve (all unit in metres)

Year	A	B	C	D	CDP 1	CDP 2
Cadastral Map	45	40	35	-	-	-
2000	30	30	30	-	22.53	23.89
2005	25	22	30	21#	14.95	21.27
2007	23	22	30	35	14.95*	21.27*
2010	23	22	21	35	Filled	21.27
2012	23	15	18	16	Filled	21.27
2015	23	18	18	15	Filled	21.27*

not accurately measurable due to wetlands vegetation along the flood plain

* Macrophyte cover

CONCLUSION:

Pristine Agara-Bellandur wetland ecosystem has been experiencing threat due to the large scale catchment alterations with changes in the land use land cover. The region forms a part of primary valley, which is sensitive regions as per the revised master plan 2015 (RMP 2015 of BDA). The landscape forms an integral part of the protected area (as it is in valley zone) as per the CDP 2015. This wetlands is now being converted with mixed land use i.e., Built-up with both residential and office complexes. Alterations in the wetland began in 2005 and aggravated post 2007 with KIADB (Karnataka Industrial development Board) identifying this region violating the environment norms for the construction of SEZ in an area of **63 Acres 37.5 Guntas. Now the spatial extent of the land for** SEZ project has increased to **74 Acres 12.1 Guntas** due to encroachment of Rajakaluves and a portion of Bellandur lake (by filling the lakebed with construction debris and excavated earth). O**f 10 Acres 14.6 Guntas** about **3 Acres 30.1 Guntas** is part of water spread and lakebed of Bellandur lake. The alterations of these wetlands initiated by filling the low lying areas with excavated earth debris, followed by other construction activities. The land fillings have breached both rajakaluve and Bellandur lake. Rajakaluve have reduced from as high as 35 to about 15 in width apart from the loss of stream network connecting Agara to Bellandur lake.

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6.0 CONSERVATION OF BELLANDUR WETLANDS: OBLIGATION OF DECISION MAKERS TO ENSURE INTERGENERATIONAL EQUITY

Executive Summary:

Bellandur lake catchment is located between 77° 35´ west and 77° 45´ east and latitude 12° 50´ south and 13° 00´ north (The Survey of India topographic map 57 H/9, scale: 1:50,000). The overall catchment area is about 287.33 sq. km with a water spread area of 361 ha. The terrain of the region is relatively flat and sloping towards south of Bangalore city. Relative slope of the region is found to be very gentle to gentle slope. The relative contour height is 930 m above mean sea level and the lowest is 880 m. The height is found to be 870 m above mean sea level near the tank. The drainage pattern is dendrite type and is characterized by gneiss and gneiss granite rocks. This water body has been a lifeline sustaining the livelihood of settlements in the catchment and command areas. Agriculture (rice and vegetables) practiced since many centuries in the downstream continues even today. Three main streams join the tank, which form the entire watershed. Three chain of lakes in the upstream joins Bellandur lake with a catchment area of about 148 square kilometres (14979 Hectares) and overflow of this lake gets into Varthur lake and from where it flows down the plateau and joins Pinakini river basin.

One of the streams originates at the northern part of the region, Jayamahal and known as eastern stream. Another stream originates from the central part of the city, Krishna Raja Market and covers the central part of the region before joining the tank and is called the central stream. Another stream commands southwestern part of the region called the western stream. Further, before the confluence with Bellandur Tank, all the streams come across two to three tanks. The rainfall data is available for the last 100 to 110 years. Rainfall varies from 725.5 mm to 844.8 mm. The district receives 51 % of the total annual rainfall in the southwest monsoon period, i.e. June to September. The average annual rainfall in the catchment was 859 mm in 1999. April is usually the hottest month with the mean daily maximum and minimum temperature of 33.4° C and 21.2° C respectively. December is generally the coolest month with the mean daily maximum and minimum temperature of 25° C and 15.3° C respectively. The temperature drops down to 8° C during January nights. Relative humidity is high from June to October (80 to 85 %). Thereafter, it decreases and from February to April becomes 25 to 35%. The relative humidity in the morning is higher than in the evening, giving rise to the formation of fog.

Unplanned rapid urbanisation during post 2000 witnessed large scale conversion of watershed area of the lake to residential and commercial layouts. This has altered the hydrological regime and enhanced the silt movement in the catchment. Declining vegetation cover has lowered water yield in the catchment, affecting the groundwater recharge. Alterations in ecological integrity is evident from reduced water yield, flash floods,

contaminated water, obnoxious odour, copious growth of invasive floating macrophytes, disappearance of native fish species, breeding ground for mosquito and other disease vectors, etc. A major portion of untreated city sewage (500+ million liters per day) is let into the lake, beyond the neutralizing ability of the lake, which has hampered the ecological functioning of the lake.

Significance of wetlands: Wetlands are lands transitional between terrestrial and aquatic eco-systems where the water table is usually at or near the surface or the land is covered by shallow water. **Wetlands are the most productive and biologically diverse but very fragile ecosystems. They function as kidneys of landscape due to remediation of contaminants (which include nutrients, heavy metals, etc.). These fragile ecosystems are vulnerable to even small changes in their biotic and abiotic factors. In recent years, there has been concern over the continuous degradation of wetlands due to unplanned developmental activities** (Ramachandra, 2002)**.**

Policy and legislative measures for Wetlands conservation in India are:

- The Indian Forest Act - 1927
- Forest (Conservation Act) - 1980
- Wildlife (Protection) Act - 1972
- Water (Prevention and Control of Pol1ution)Act - 1974
- Water (Prevention and Control of Pollution) Act - 1977
- Environmental (Protection) Act - 1986
- Wildlife (Protection) Amendment Act - 1991
- National Conservation Strategy and Policy Statement on Environment and I Development - 1992
- National Policy And Macro level Action Strategy on Biodiversity-1999
- Biological Diversity Act, 2002, areas rich in biodiversity, cultural importance, etc.
- Wetlands (Conservation and Management) rules 2010, Government of India

The proposed plan to set up SEZ by KIADB needs to be stopped and wetland to be restored considering

Activities	Norms
Location of the project (SEZ by Karnataka Industrial Areas Development Board (KIADB)) **in the valley zone**	This is contrary to sustainable development as the natural resources (lake, wetlands) get affected due to this decision. Eventually this kills the lake. This reflects the ignorance of the administrative machinery on the importance of ecosystems and the need to protect valley zones
The proposed activity is in valley	To be protected considering ecological function

zone	And are 'NO DEVELOPMENT ZONES' as per CDP 2005, 2015
Location of SEZ in flood prone zone of the lake and in wetland - 30 m buffer zone of the water body is to be no development zone	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) ✓ As per BDA, RMP 2015 ✓ section 17 of KTCP Act, 1961 and sec 32 of BDA Act, 1976 ✓ Wetlands (Conservation and Management) rules 2010, Government of India
Alterations in topography	Adjacent localities would be vulnerable to floods
Removal of rajakaluve (storm water drain) and gradual encroachment of rajakaluve as well as lake bed	Removal of lake connectivity enhances the episodes of flooding and associated disasters The Hon'ble Supreme Court in Civil appeal number 1132/2011 at SLP (C) 3109/2011 on January 28,2011 has ex-pressed concern regarding encroachment of common property resources, more particularly lakes and it has directed the state governments for removal of encroachments on all community lands. Eviction of encroachment: Need to be evicted as per Karnataka Public Premises (eviction of unauthorised occupants) 1974 and the Karnataka Land Revenue Act, 1964.
The proposed action by KIADB to set up SEZ violates Hon'ble High Court of Karnataka's verdict to protect, conserve, rehabilitate and wisely use lakes and their watersheds in Bangalore all lakes in Karnataka and their canal networks (about 38,000)	High Court of Karnataka (WP No. 817/2008) • Protects 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 set up district lake protection committees
Additional 10000 to 14000 vehicles	Increases traffic bottleneck in the region and air pollution (with the increase in density of vehicles)
Increase in vehicular traffic and enhanced pollutants	Traffic congestion (due to additional vehicle movement). The density of traffic would increase, the road's current level of service (LOS) is under category **C** , the increase in vehicles upto 14000+ would worsen the traffic condition with LOS under category **F.** enhanced levels of vehicular pollutants; likely increase in respiratory diseases;
Water shortage The estimate shows that SEZ requires 4587 Kilo Liters per day (4.58 MLD – Million liters per day)	Bangalore is already experiencing severe water shortages as water yield in rivers (Cauvery, etc.) has come down due to large scale land cover changes. Neither Cauvery, T G Halli nor groundwater can sustain Bangalore's growing water demand. BWSSB has not given NOC and has indicated inability to supply such huge quantity of water on regular basis.
Pathetic water scenario and insufficient drinking water in Bangalore	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 Hessarghatta has dried, Tippegondahanally 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.

Ecological and Environmental Implications:

- *Land use change:* 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).

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 Sikhri and fading out of Adil Shahi's Bijapur, or ecological disaster at *Easter Island or* Vijayanagara empire

It is the responsibility of Bangalore citizens (for intergenerational 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 Bellandur wetlands by KIADB.

Keywords: Wetlands, Urbanisation, wetlands, intergenerational equity, Bellandur

CONSERVATION OF BELLANDUR WETLANDS: OBLIGATION OF DECISION MAKERS TO ENSURE INTERGENERATIONAL EQUITY

Introduction

Wetlands constitute vital components of the regional hydrological cycle, highly productive, support exceptionally large biological diversity and provide a wide range of ecosystem services, such as food and fibre; waste assimilation; water purification; flood mitigation; erosion control; groundwater recharge; microclimate regulation; enhance aesthetics of the landscape; support many significant recreational, social and cultural activities, besides being a part of our cultural heritage. It was acknowledged that most of urban wetlands are seriously threatened by conversion to non-wetland purposes, encroachment of drainage, through landfill, pollution (discharge of domestic and industrial effluents, disposal of solid wastes), hydrological alterations (water withdrawal and inflow changes), and over-exploitation of their natural resources resulting in loss of biodiversity and disruption in goods and services provided by wetlands (Ramachandra, 2002; 2009a,b; Ramachandra et al., 2012a,b). This report addresses the implications of setting up SEZ in an ecologically fragile wetlands. Also, provides insights to the strategies considering the current trends in aquatic ecosystem conservation, restoration and management including the hydrological and the biophysical aspects, peoples' participation and the role of non-governmental, educational and governmental organisations' needs for the restoration, conservation and management.

Urbanisation is a form of metropolitan growth that is a response to often bewildering sets of economic, social, and political forces and to the physical geography of an area. It is the increase in the population of cities in proportion to the region's rural population. The 20th century is witnessing "the rapid urbanisation of the world's population", as the global proportion of urban population rose dramatically from 13% (220 million) in 1900, to 29% (732 million) in 1950, to 49% (3.2 billion) in 2005 and is projected to rise to 60% (4.9 billion) by 2030. Urban ecosystems are the consequence of the intrinsic nature of humans as social beings to live together (Ramachandra et al., 2012a; 2012b; 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. (Ramachandra and Shwetmala, 2009; Ramachandra, 2009c). Land use analyses show 584% growth in built-up area during the last four decades with the decline of vegetation by 66% and water bodies by 74%. Analyses of the temporal data reveals an increase in urban built up area of 342.83% (during 1973 to 1992), 129.56% (during 1992 to 1999), 106.7% (1999 to 2002), 114.51% (2002 to 2006) and 126.19% from 2006 to 2010 (Ramachandra et al., 2012a). The major implications of unplanned urbanisation are:

- **Loss of wetlands and green spaces:** Urbanisation has telling influences on the natural resources such as decline in green spaces (vegetation) including wetlands and / or depleting groundwater table (Ramachandra, 2002).
- **Floods:** Common consequences of urban development are increased peak discharge and frequency of floods as land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Conversion of water bodies to residential 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 (Ramachandra et al., 2012a).
- **Decline in groundwater table:** Studies reveal the removal of water bodies 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. Also, groundwater table in intensely urbanized area such as Whitefield, etc. has now dropped to 400 to 500m (Ramachandra et al., 2002).
- **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 (Ramachandra and Kumar 2009).
- **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. 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 (Ramachandra and Shwetmala, 2009; Ramachandra et al., 2012a; 2012b).

Bangalore Lakes and Bellandur

Greater Bangalore is the administrative, cultural, commercial, industrial, and knowledge capital of the state of Karnataka, India with an area of 741 sq. km. and lies between the latitude 12°39'00'' to 13°13'00'' N and longitude 77°22'00'' to 77°52'00'' E (Figure 1). Bangalore city administrative jurisdiction was redefined in the year 2006 by merging the existing area of Bangalore city spatial limits with 8 neighbouring Urban Local Bodies (ULBs) and 111 Villages of Bangalore Urban District. Bangalore has grown spatially more than ten times since 1949 (~69 square kilometres to 716 square kilometres) and is the fifth largest metropolis in India currently with a population of about 9 million (Ramachandra and Kumar, 2008; Ramachandra et al., 2012a; 2012b). Bangalore city population has increased enormously from 65,37,124 (in 2001) to 95,88,910 (in 2011), accounting for 46.68 % growth in a decade. Population density has increased from as 10732

(in 2001) to 13392 (in 2011) persons per sq. km. The per capita GDP of Bangalore is about $2066, which is considerably low with limited expansion to balance both environmental and economic needs.

Bangalore once a garden city, became garbage city and now in the verge of becoming a dead city due to consistent mismanagement of natural resources. The transition from garden city to dead city has taken place because of the unplanned rapid urbanisation involving concentrated growth. Bangalore witnessed the software industry boon during early 2000. Due to this, there is drastic increase in population with the enhanced demand for water and electricity. Apart from this, lack of infrastructure is evident from traffic bottlenecks, etc.

About 80% of water supplied as demand turns as liquid waste either as domestic waste water or industrial waste water that contain high amounts of toxic, organic, inorganic wastes. Most of the sewage and wastewater generated is discharged directly into storm water drains that ultimately link to water bodies. The undulating terrain in the region facilitated the creation of a large number of tanks in the past, providing for the traditional uses of irrigation, drinking, fishing and washing. This led to Bangalore having hundreds of such water bodies through the centuries. In 1961, the number of lakes and tanks in the city stood at 262. A large number of water bodies (locally called lakes or tanks) in the City had ameliorated the local climate, and maintained a good water balance in the neighborhood. Since Bangalore is located on a ridge with natural water courses along the three directions of the Vrishabhavaty, Koramangala-Challaghatta (K&C) and Hebbal-Nagavara valley systems (Figure 2), these water courses are today being used for the transport and disposal of the city's sewage. The shortfall or lack of sewage treatment facilities have contaminated the majority of surface and ground waters.

The Koramangala Chalaghatta valley (Figure 2, Figure 3), tributary of Periayar River, located towards the south east of Greater Bangalore. The following are lakes along the valley: Varthur, Bellandur, Agaram, Puttenahalli, Chalaghatta, Madivala, Sarakki, Hhulimavu, Lalbhag, Bayappanahalli, Vibuthipura, Kundalhalli, Ibburu, Ulsoor, Beguru, etc.

Bellandur Lake located in the south-eastern portion of Greater Bangalore is towards the upstream of Varthur lake, the drainage network for Bellandur lake has 3 drainage network:

i. In the north originating at Jayamahal covering eastern portion of the City;
ii. Drains originating from the central part near K R Market covering the central portion of the City;
iii. Originating from the southern part of the city near Hulimavu.

Bellandur lake has a history over 130 years, post 1980's the drainage chains feeding the lakes were broken due to unchecked industrial, residential as well as commercial development in the region, the lands near the lake were allotted for development of ring road post 1990 during which there was industrial development

The Bellandur catchment extends from $12^0$50'N to $13^0$1'47"N in latitude and $77^0$33'14" E to $77^0$41'1"E in longitude with an area of 171.17 $km^{2.}$. The Bellandur Lake itself encompasses

an area of 338.29 hectares. Bellandur lake catchment and its drainage network are represented in figure 3. The false colour satellite composite of Bellandur catchment (Figure 4) highlight the heterogeneity of the landscape. The digital elevation model (figure 4) depicts the undulating terrain with interconnected water bodies. The terrain altitude gradually varies from City center (North western part of catchment) 962m to 850m above MSL at the lake. Population in the catchment given in Table 1 show an increase from 1425105 (1991) to 3410383 (2011)

The population density (figure 5) in the Bellandur catchment has shown a sharp increase from 100 persons per hectare (2001) to over 141.96 (2011) and 750 persons per hectare (in 2011) in certain wards, mainly due to migration.

Table 1: Population of all the wards under Bellandur catchment

Year	Population	Population density persons / ha
1991	1425105	59.32
2001	2417744	100.63
2011	3410383	141.96

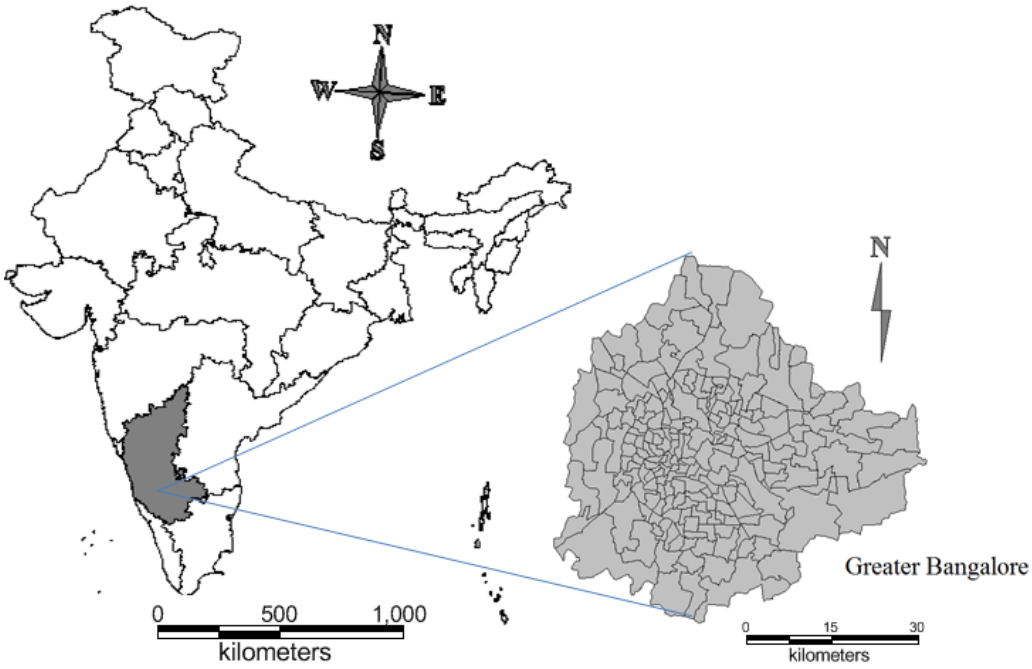


Figure 1: Greater Bangalore

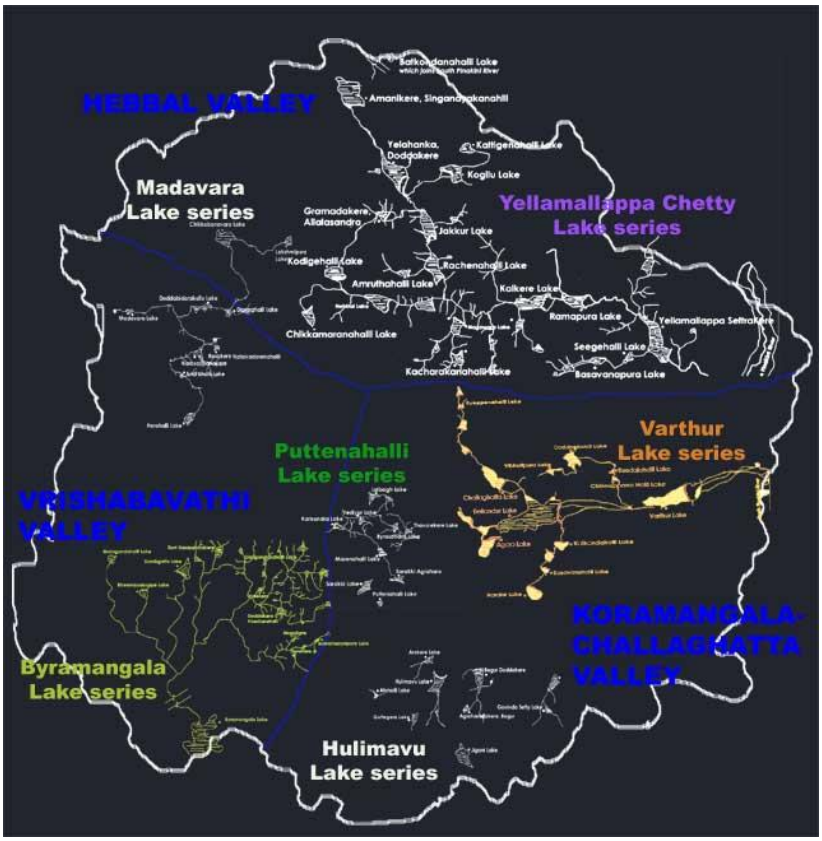


Figure 2: Lake Series in Bangalore

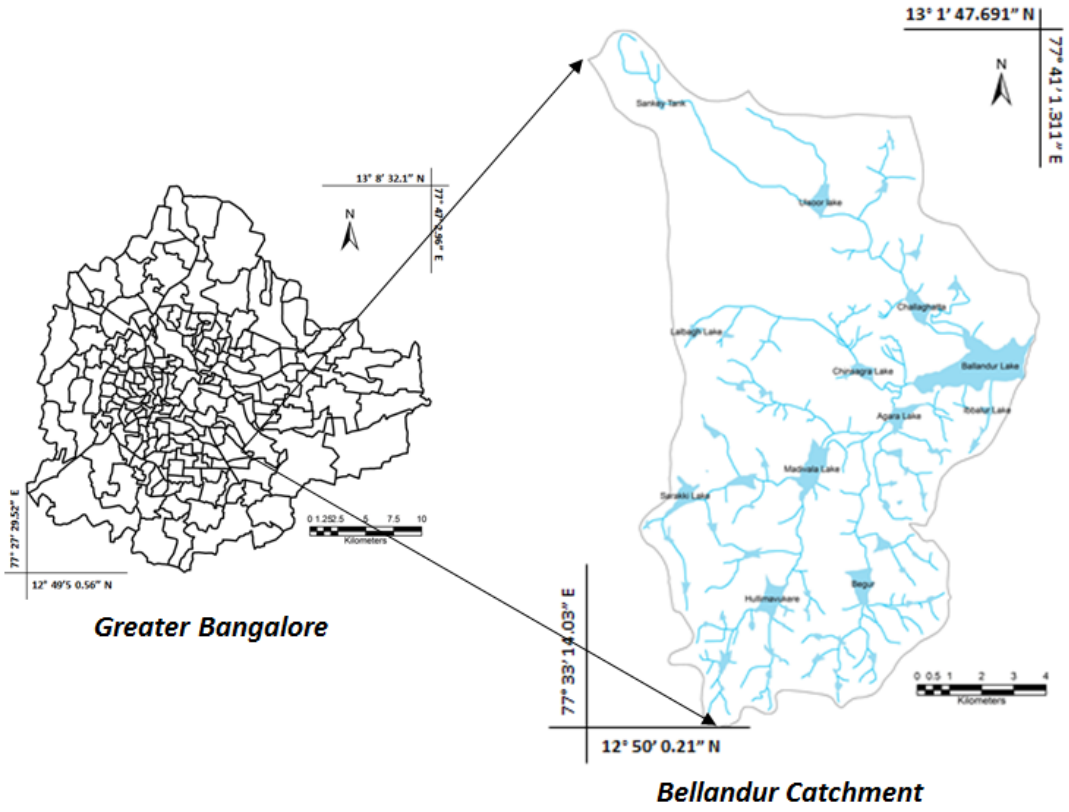


Figure 3: Bellandur Drainage Network

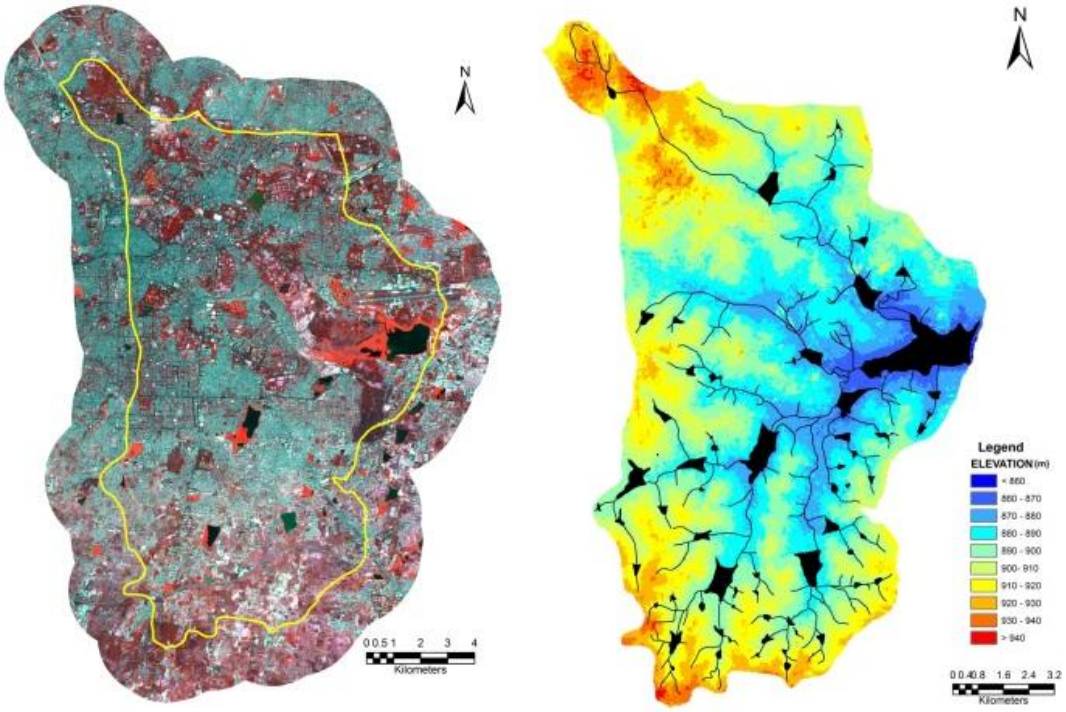


Figure 4: FCC and DEM

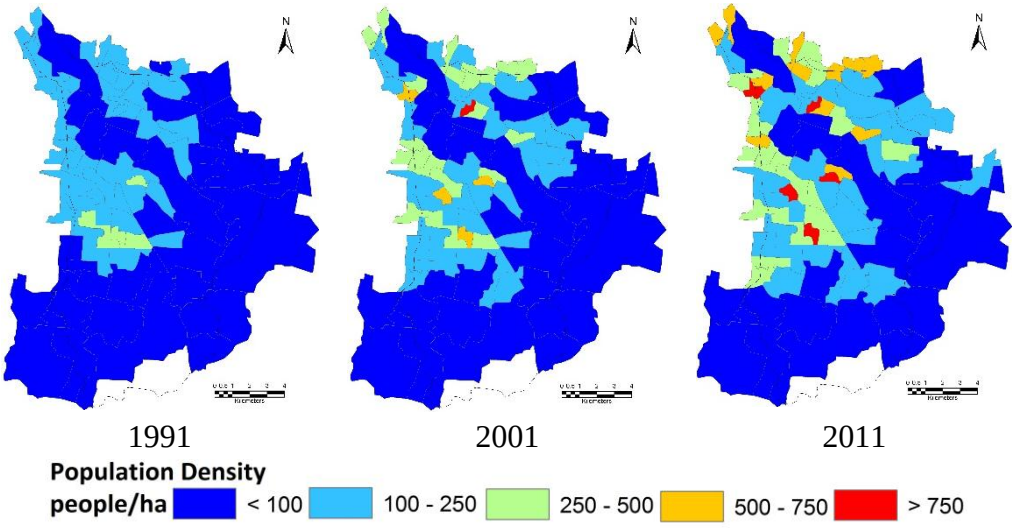


Figure 5: Population Density

Threats faced by Wetlands in Bangalore: Greater Bangalore had 207 water bodies in 1973 (Figure 6), which declined to 93 (in 2010). 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).

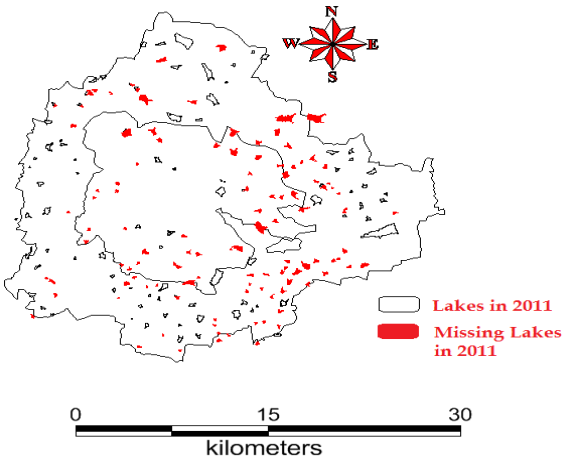


Figure 6: Lakes encroached by land mafia

Disappearance of water bodies or sharp decline in the number of water bodies in Bangalore is mainly due to intense urbanisation and urban sprawl. Many lakes (54%) were encroached for illegal buildings. Field survey of all lakes (in 2007) shows that nearly 66% of lakes are sewage fed, 14% surrounded by slums and 72% showed loss of catchment area. Also, lake catchments were used as dumping yards for either municipal solid waste or building debris (Ramachandra, 2009a; 2012a). 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. 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.

These 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.

SEZ in Bellandur Wetlands: Irrational decision of setting up SEZ at Bellandur wetland would affect the lake. The Mixed Use Development Project - SEZ (figure 6) is proposed along Sarjapur Road in a wetland between Bellandur and Agara Lake, extending from 77°38'28.96" E to 77°38'57.99" E of Longitude and 12°55'24.98" N to 12°55'44.43" N of Latitude with an area of 33 hectare. The proposal of the project is to construct residential areas, offices, and retail and hotel buildings in this area.

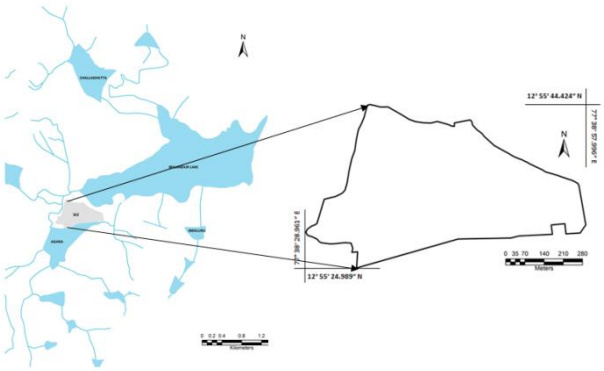


Figure 6: SEZ

Significance of the Region:

1. Wetlands with remediation functional ability (function as *kidneys* of the landscape). Removal of wetlands will affect the functional ability of the lake and would result in the death of Bellandur lake;
2. Considering severe water shortage to meet the drinking water requirement in Bangalore, there is a need to remove deposited silt in the Bellandur lake, which will enhance the storage capacity and in turn helps in mitigating the water requirement;

3. Wetlands aid in recharging groundwater as soil are permeable;
4. Belanduru lake provide food (fish, etc.) and fodder;
5. Retain the excess water and prevent flooding in the vicinity;
6. Large number of farmers in the downstream is dependent on Belanduru lake water for agriculture, vegetable, etc.

Realizing these, BDA has aptly earmarked these regions in CDP 2005 for "ENVIRONMENT PROTECTION AND HERITAGE CONSERVATION". The masterplan includes the protection of valleys and tanks as part of the vision and enforcing the ban on construction over protected areas. CDP 2015: As per CDP 2015, valley region are "No Development Zone"

1) 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) with exception of activities associated with lake and this buffer may be taken into account for reservation of park while sanctioning plans.
2) If the valley portion is a part of the layout/ development plan, then that part of the valley zone could be taken into account for reservation of parks and open spaces both in development plan and under subdivision regulations subject to fulfilling section 17 of KTCP Act, 1961 and sec 32 of BDA Act, 1976.
3) Rajakaluve/ storm water drains categorized into 3 types namely primary, secondary and tertiary. These drains will have a buffer of 50, 25 and 15m (measured from the centre of the drain) respectively on either side. No activities shall be permitted in the buffer zone.

SEZ in the wetland and assessment of damages

Drainage network and Land cover of the wetland region were mapped using temporal Google earth (http://www.googleearth.com) for the period 2007 to 2012, and the changes in land use and drainages (network as well as width of the channel/drain). Figure 7 depicts drastic land use changes evident from the conversion of wetland to open land (at the proposed SEZ site) during 2000 to 2012. Temporal change analysis done for the region is given in Table 1. Figure 8 illustrates land use changes between 2007 and 2012. Wetlands have decreased from 32.8 Ha to 5.95 Ha whereas the Open land (Conversion of Wetlands to SEZ Construction site) has increased from 0.6 Ha to 27.46 Ha.

Table1: Change in Land use

Year	Wetland in Ha	Open land in Ha
2007	32.80	0.60
2008	30.22	3.18
2009	24.31	9.10
2010	19.17	14.23
2011	16.63	16.77
2012	5.95	27.46

2000	2012

Figure 7: land use in the SEZ region during 2000 and 2012

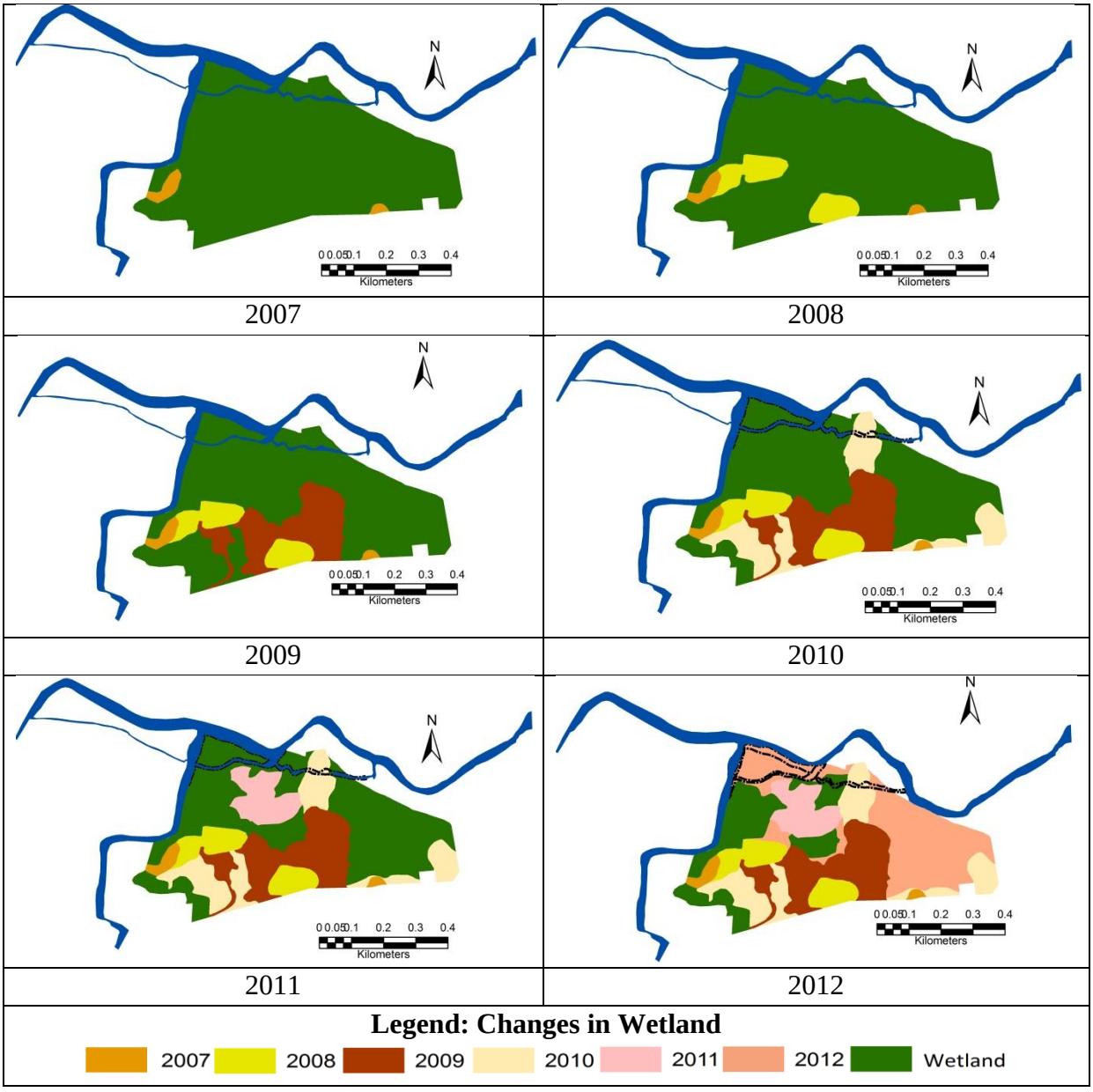
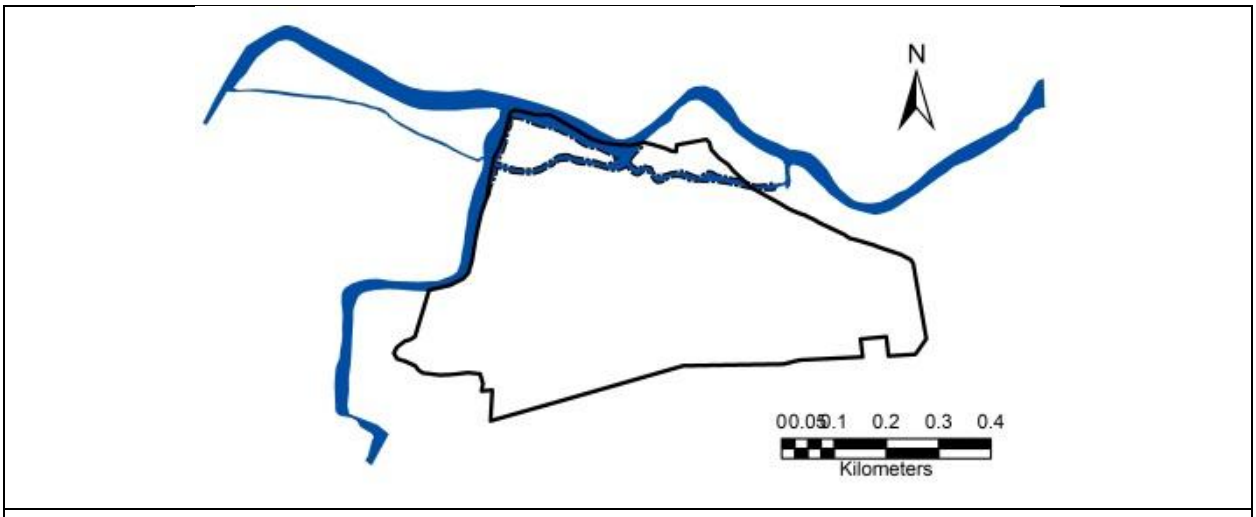
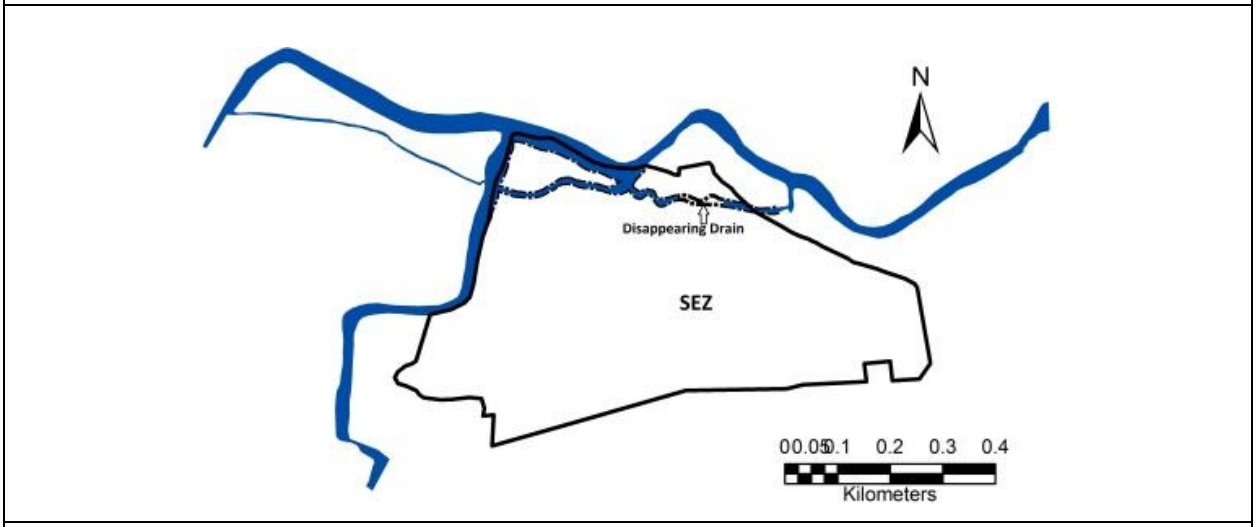


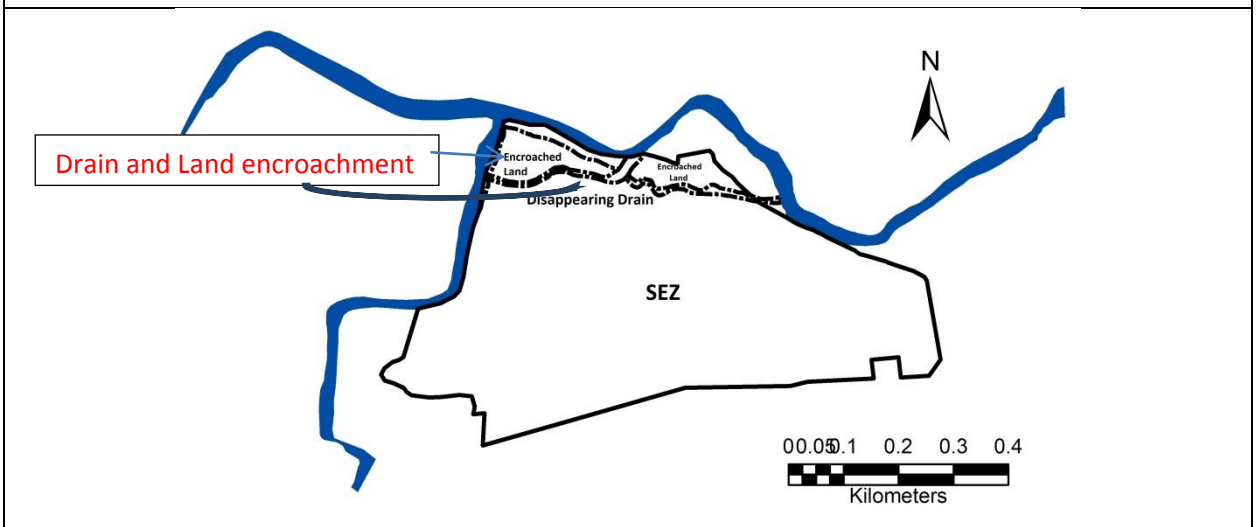
Figure 8: Change in wetland between 2007 to 2012



2007 - 2009



2010 - 2011



2012

Figure 9: Change in drain network

The change in drainage pattern between 2007 and 2012 is shown in figure 9 and table 2 gives the extent of encroachment of drainage and wetland.

Table2: Encroachment of drainage and wetland

Description	Area in Ha	Length in m
Altered drain width and encroachment	0.5	390
Encroached a drain	0.56	586
Encroached Wetland	2.06	-

Effect on vehicle traffic in the region: Figure 10 gives the existing road network (Main Roads) in the region; the length between 2 signals on either side of the SEZ is approximately 1.88 km (Google Earth) the width of road is 15.5 m, 4 lanes and two ways. The capacity of urban roads is listed in table 3.

Table 3: Capacity of urban Roads as per IRC

No. of Traffic Lanes and width	Traffic Flow	Capacity in PCU per hour for traffic condition		
		Roads with no frontage access, no standing vehicles, very little cross traffic	Roads with frontage access, but no standing vehicle and high capacity intersections	Roads with free frontage access, parked vehicles and heavy cross traffic
Two lane 7.0-7.5 m	One way	2400	1500	1200
Two lane 7.0-7.5 m	Two way	1500	1200	750
Three lane 10.5 m	One way	3600	2500	2000
Four lane 14.0 – 15.5 m	One way	4800	3000	2400
Four lane 14.0 – 15.5 m	Two way	4000	2500	2000
6 lane 21 m	Two way	6000	4200	3600

Source: S.K.Khanna & C.E.G.Justo, (2005). Highway Engineering, 8th Edition, Table 5.8,pp 185-211

Road maximum capacity: As per IRC (*http://*www.irc.org.in - Indian Road Congress) for a 4 lane road with traffic flow on both sides, for roads with no frontage access, no standing vehicles, very little cross traffic (intersection) capacity is 4000 PCU/hour (PCU-Passenger Car Unit). The capacity for Sarjapur road was estimated to be **3500 PCU/hour**, on either side of the road, with average length of a PCU as 4 m at an average speed of 45 kmph and driver reaction time of 0.7 seconds. Along sarjapur road, during the highest peak hour traffic, the number of vehicles is approximately 2000 PCU's/hour. With this the level of service (LOS) based on the **ratio of observed to maximum capacity** is

V/C = 2000/3500 = 0.571

For the ratio of 0.57, the current Level of service in under category **"C" as per Table 4.**

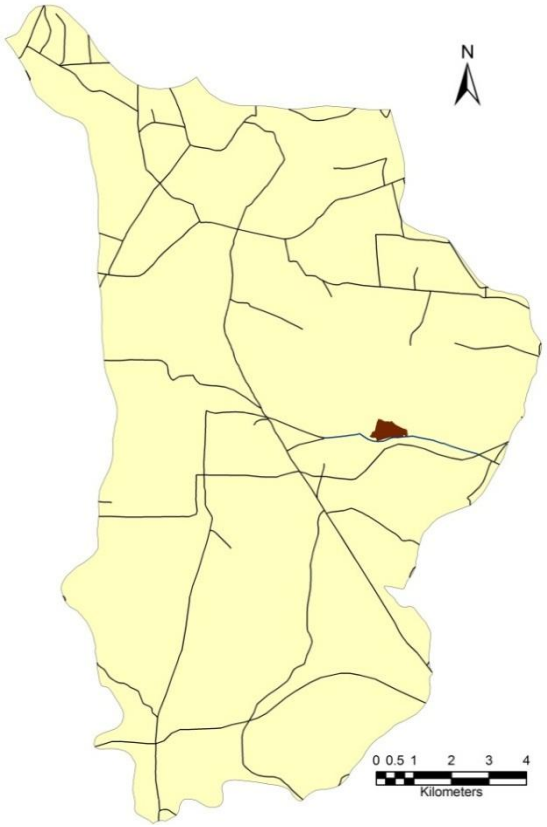


Figure 10: Bellandur Catchement Road Network

Table 4: Category of Roads based on traffic and service

V/C ratio	LOS	Performance
0.0 – 0.2	A	Excellent
0.2 – 0.4	B	Very Good
0.4 – 0.6	**C**	**Average / Fair**
0.6 – 0.8	D	Poor
0.8 – 1.0	E	Very Poor
1.0 – 1.2	**F**	**Very Very Poor**

Source: IRC

The SEZ has a capacity of over 14000 Car units, in addition to this because of the Floating population that travel in their own mode of transit yields an additional vehicular population.

With added 14000 cars, assuming 8 hour of traffic in a day, the density of car units would increase by **1750** units per hour increasing the traffic to **3750PUC's/hour**. Then the V/C ratio is

V/C = (2000 + 1750) / 3500 = 1.07

The ratio of 1.07 is equivalent to an LOS category of **"F"** indicating very very poor traffic conditions indicating higher chances of traffic congestion. The current bottle necks along the Sarjapur Road is as depicted in figure 10(a) and likely bottleneck due to the addition of 14000+ vehicles, is depicted in figure 10(b). Traffic bottlenecks also have higher levels of pollutants such as particulate matter, CO_2, NO_x, SO_2.

a. Existing bottlenecks	b. Likely bottlenecks after SEZ

Figure 11: Traffic bottlenecks

Major Violations:

i). Development in the wetland - Violation of CDP 2015 as valley zone is supposed to be protected as the region is "No Development Zone";

ii). the wetland removal wit vegetation effects the ecological functioning. The plants and algae in wetlands aids in bioremediation by uptake of nutrient and heavy metals;

iii). this activity enchases flooding in the vicinity due to
   a. Encroachment of drains / rajakaluves;
   b. Alterations in topography;
   c. encroachment of lakebed; and
   d. encroaching of lake itself by dumping debris and filling up of same

iv). construction activity in the lake floodplain;

v). violation of 30 m buffer (lake floodplain);

vi). encroachment of a drain and land (2.06 hectares);

vii). gradual encroachment of another drain (by filling with building debris);

viii). filling of a portion of lake with building debris;

ix). alterations in topography;

x). traffic congestion (due to additional vehicle movement). The density of traffic would increase, the road's current level of service (LOS) is under category **C** , the increase in vehicles upto 14000+ would worsen the traffic condition with LOS under category **F.** enhanced levels of vehicular pollutants; likely increase in respiratory diseases;

xi). insufficient drinking water in Bangalore (how decision makers can make provision for large quantity of water requirement during construction and operation phase);

The proposed plan to set up SEZ by KIADB needs to be stopped and wetland to be restored considering

Activities	**Norms**
Location of the project (SEZ by Karnataka Industrial Areas Development Board (KIADB)) **in the valley zone**	This is contrary to sustainable development as the natural resources (lake, wetlands) get affected due to this decision. Eventually this kills the lake. This reflects the ignorance of the administrative machinery on the importance of ecosystems and the need to protect valley zones
The proposed activity is in valley zone	To be protected considering ecological function And are 'NO DEVELOPMENT ZONES' as per CDP 2005, 2015
Location of SEZ in flood prone zone of the lake and in wetland - 30 m buffer zone of the water body is to be no development zone	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) ✓ As per BDA, RMP 2015 ✓ section 17 of KTCP Act, 1961 and sec 32 of BDA Act, 1976 ✓ Wetlands (Conservation and Management) rules 2010, Government of India
Alterations in topography	Adjacent localities would be vulnerable to floods
Removal of rajakaluve (storm water drain) and gradual encroachment of rajakaluve as well as lake bed	Removal of lake connectivity enhances the episodes of flooding and associated disasters The Hon'ble Supreme Court in Civil appeal number 1132/2011 at SLP (C) 3109/2011 on January 28,2011 has ex-pressed concern regarding encroachment of common property resources, more particularly lakes and it has directed the state governments for removal of encroachments on all community lands. Eviction of encroachment: Need to be evicted as per Karnataka Public Premises (eviction of unauthorised occupants) 1974 and the Karnataka Land Revenue Act, 1964.
The proposed action by KIADB to set up SEZ violates Hon'ble High Court of Karnataka's verdict to protect, conserve, rehabilitate and wisely use lakes and their watersheds in Bangalore all lakes in	High Court of Karnataka (WP No. 817/2008) • Protects lakes across Karnataka, • Prohibits dumping of Garbage and Sewage in Lakes • Lake area to be surveyed and fenced and

Karnataka and their canal networks (about 38,000)	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 set up district lake protection committees
Additional 10000 to 14000 vehicles	Increases traffic bottleneck in the region and air pollution (with the increase in density of vehicles)
Increase in vehicular traffic and enhanced pollutants	Traffic congestion (due to additional vehicle movement). The density of traffic would increase, the road's current level of service (LOS) is under category **C** , the increase in vehicles upto 14000+ would worsen the traffic condition with LOS under category **F.** enhanced levels of vehicular pollutants; likely increase in respiratory diseases;
Water shortage The estimate shows that SEZ requires 4587 Kilo Liters per day (4.58 MLD – Million liters per day)	Bangalore is already experiencing severe water shortages as water yield in rivers (Cauvery, etc.) has come down due to large scale land cover changes. Neither Cauvery, T G Halli nor groundwater can sustain Bangalore's growing water demand. BWSSB has not given NOC and has indicated inability to supply such huge quantity of water on regular basis.
Pathetic water scenario and insufficient drinking water in Bangalore	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 Hessarghatta has dried, Tippegondahanally 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.

Ecological and Environmental Implications:

- *Land use change:* 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).

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 Sikhri and fading out of Adil Shahi's Bijapur, or ecological disaster at *Easter Island or* Vijayanagara empire.

It is the responsibility of Bangalore citizens (for intergenerational 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 Bellandur wetlands by KIADB.

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7.0 Bangalore to Bengaluru (transition from green landscape to brown landscape)

Status	**Disappearing water-bodies and vegetation**
Cause:	**Unplanned urbanisation**
Recommendation	"**Decongest and decontaminate Bangalore**" so that at least next generation enjoys better environment in Bangalore Need to ensure the ecosystem integrity to sustain goods and services for maintaining inter-generation equity. **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.
Action Plan	• 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. • 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. • Threshold on high raise building in the region. Need to protect valley zones considering ecological function and these regions are 'NO DEVELOPMENT ZONES' as per CDP 2005, 2015 • Evict all encroachments from wetlands, lake bed, lakes and raja kaluves • Reestablish interconnectivity among lakes • Restoration of lakes

1.0 Bangalore to Bengaluru (transition from green landscape to brown landscape)

Bangalore (77°37'19.54'' E and 12°59'09.76'' N), is the principal administrative, cultural, commercial, industrial, and knowledge capital of the state of Karnataka. With an area of 741 sq. km., Bangalore's city administrative jurisdiction was widened in 2006 (Greater Bangalore) by merging the existing area of Bangalore city spatial limits with 8 neighbouring Urban Local Bodies (ULBs), and 111 Villages of Bangalore Urban District (Ramachandra and Kumar, 2008; Ramachandra et al., 2012). Thus, Bangalore has grown spatially more than ten times since 1949 (69 square kilometres) and is a part of both the Bangalore urban and rural districts (figure 1.1). The mean annual total rainfall is about 880 mm with about 60 rainy days a year over the last ten years. The summer temperature ranges from 18° C – 38° C, while the winter temperature ranges from 12° C – 25° C. Bangalore is located at an altitude of 920 meters above mean sea level, delineating three watersheds, viz. Hebbal, Koramangala-Challaghatta and Vrishabhavathi watersheds (Figure 1.2). The undulating terrain in the region has facilitated creation of a large number of tanks providing for the traditional uses of irrigation, drinking, fishing, and washing. Bangalore had the distinction of having hundreds of water bodies through the centuries. Even in early second half of 20th century, in 1961, the number of lakes and tanks in the city stood at 262 (and spatial extent of Bangalore was 112 sq. km). However, number of lakes and tanks in 1985 was 81 (and spatial extent of Bangalore was 161 sq. km). This forms important drainage courses for the interconnected lake system (Figure 1.2), which carries storm water beyond the city limits. Bangalore, being a part of peninsular India, had the tradition of harvesting water through surface water bodies to meet the domestic water requirements in a decentralised way. After independence, the source of water for domestic and industrial purpose in Bangalore is mainly from the Cauvery River and ground water. Untreated sewage is let into the storm water drains, which progressively converge at the water bodies. Now, Bangalore is the fifth largest metropolis in India currently with a population of about 8.72 million as per the latest population census. Spatial extent of the city has increased from 69 (1941) to 161 (1981), 226 (2001) and 745 (2011) sq.km. Due to the changes in the spatial extent of the city, the population density varies from 5956 (1941) to 18147 (1981), 25653 (1991), 25025 (2001) and 11704 (2011) persons per sq.km.

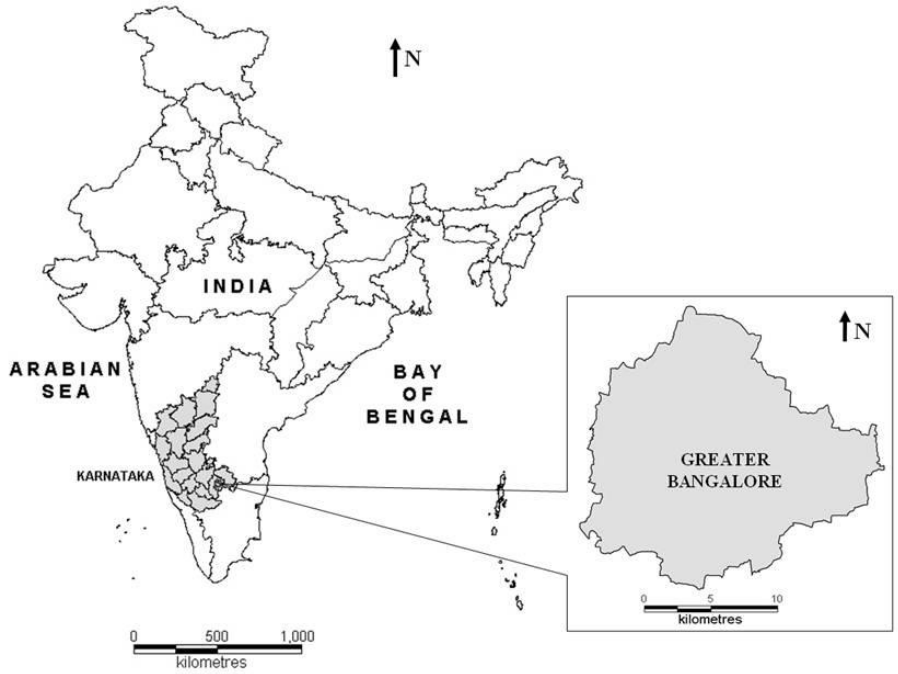

Figure 1.1: Study area –Bangalore

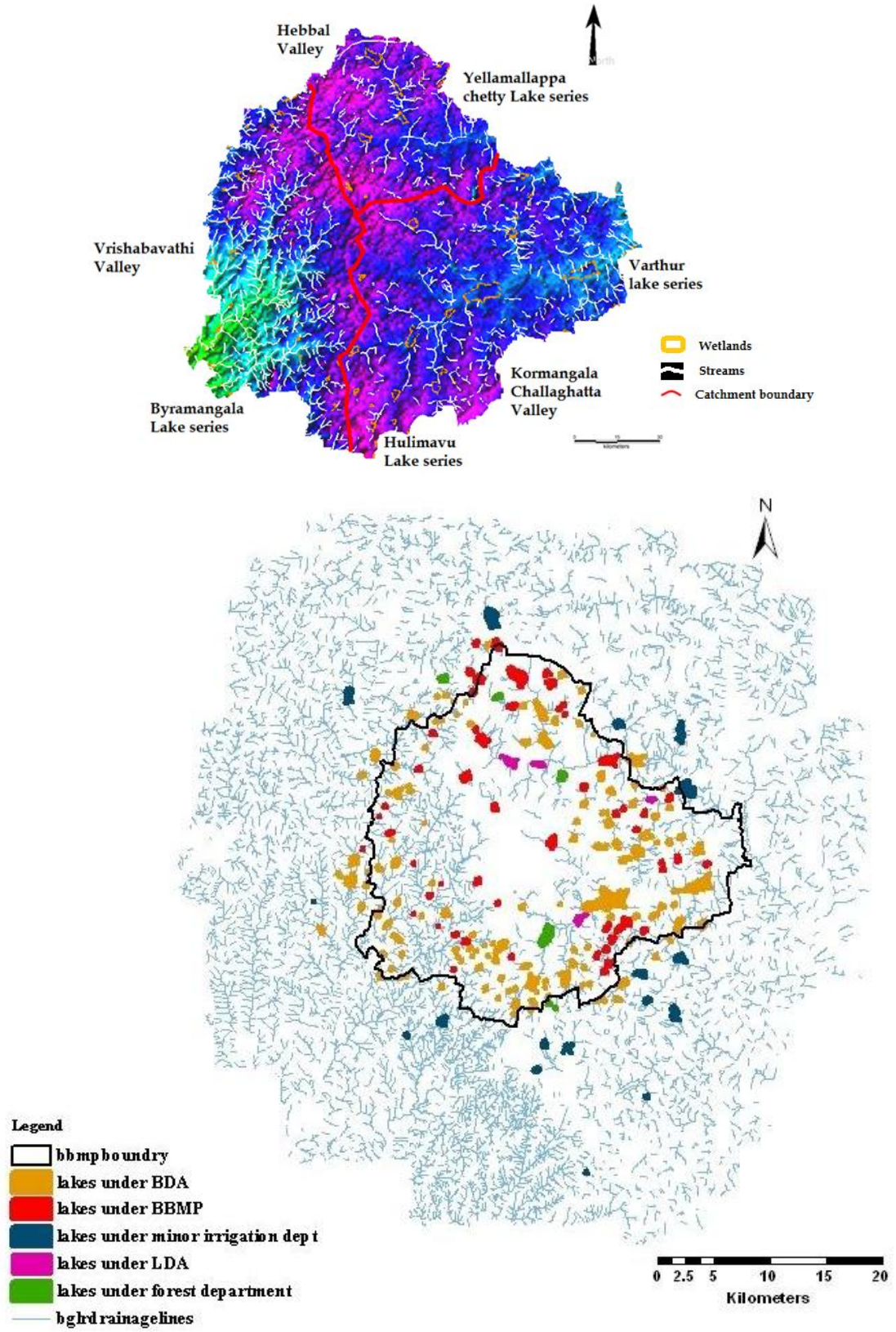

Figure 1.2: Watersheds (drainage with water bodies) of Bangalore

Land use analyses were carried out using supervised pattern classifier - Gaussian maximum likelihood classifier (GMLC) for Landsat and IRS data, and Bayesian Classifier (MODIS data). The method involved (Ramachandra *et al*., 2012): i) generation of False Colour Composite (FCC) of remote sensing data (bands – green, red and NIR). This helped in locating heterogeneous patches in the landscape ii) selection of training polygons (these correspond to heterogeneous patches in FCC) covering 15% of the study area and uniformly distributed over the entire study area, iii) loading these training polygons co-ordinates into pre-calibrated GPS, vi) collection of the corresponding attribute data (land use types) for these polygons from the field. GPS helped in locating respective training polygons in the field, iv) supplementing this information with Google Earth (latest as well as archived data), v) 60% of the training data has been used for classification, while the balance is used for validation or accuracy assessment.

Land use analysis carried out using GRASS - Geographic Resources Analysis Support System (http://wgbis.ces.iisc.ernet.in/ grass) for the period 1973 to 2013 and details are in table 1.1 and urban dynamics is illustrated in Figure 1.3. There has been a 925% increase in built up area from 1973 to 2013 leading to a sharp decline of 79% area in water bodies in Bangalore mostly attributing to intense urbanisation process. Analyses of the temporal data reveals an increase in urban built up area of 342.83% (during 1973 to 1992), 129.56% (during 1992 to 1999), 106.7% (1999 to 2002), 114.51% (2002 to 2006) and 126.19% (2006 to 2010). 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 64% (2002 to 2013). Disappearance of water bodies or sharp decline in the number of water bodies in Bangalore is mainly due to intense urbanisation and urban sprawl. Many lakes (54%) were encroached for illegal buildings. Field survey of all lakes (in 2007) shows that nearly 66% of lakes are sewage fed, 14% surrounded by slums and 72% showed loss of catchment area. In addition, lake catchments were used as dumping yards for either municipal solid waste or building debris (Ramachandra, 2009a). 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.

Table 1.1: Land use changes in Bengaluru during 1973 to 2013

Class →	**Urban**		**Vegetation**		**Water**		**Others**	
Year ↓	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**
1973	5448	7.97	46639	68.27	2324	3.40	13903	20.35
1992	18650	27.30	31579	46.22	1790	2.60	16303	23.86
1999	24163	35.37	31272	45.77	1542	2.26	11346	16.61
2002	25782	37.75	26453	38.72	1263	1.84	14825	21.69
2006	29535	43.23	19696	28.83	1073	1.57	18017	26.37
2010	37266	54.42	16031	23.41	617	0.90	14565	21.27
2013	50440	73.72	10050	14.69	445.95	0.65	7485	10.94

Urbanisation in Greater Bangalore

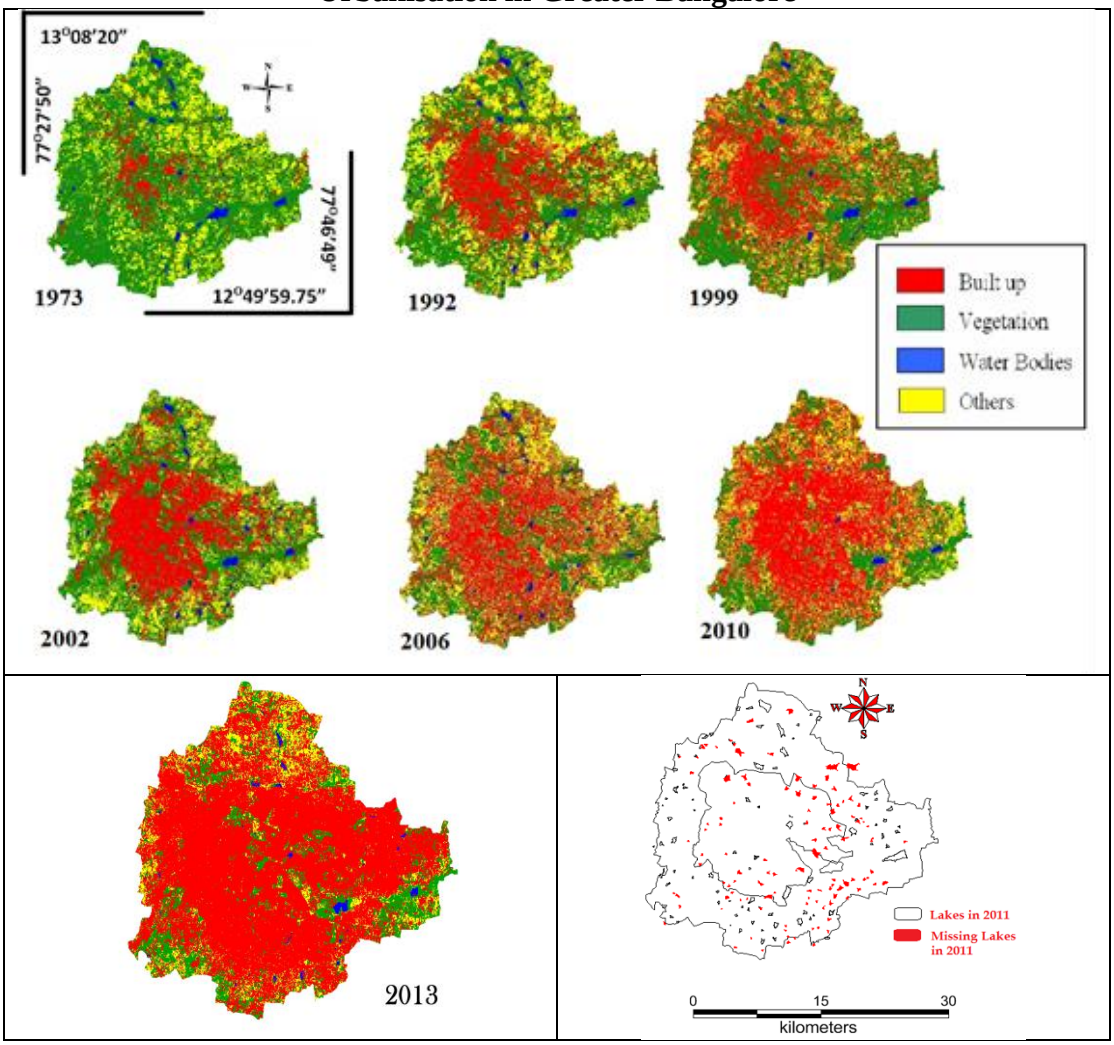

Figure 1.3: Land use dynamics since 1973

Increase in Built-up (concrete / paved surface): 925%

Loss of vegetation: 78%

Loss of water bodies: 79%

SOLUTION: GOOD GOVERNANCE

"DECONGEST AND DECONTAMINATE BANGALORE"

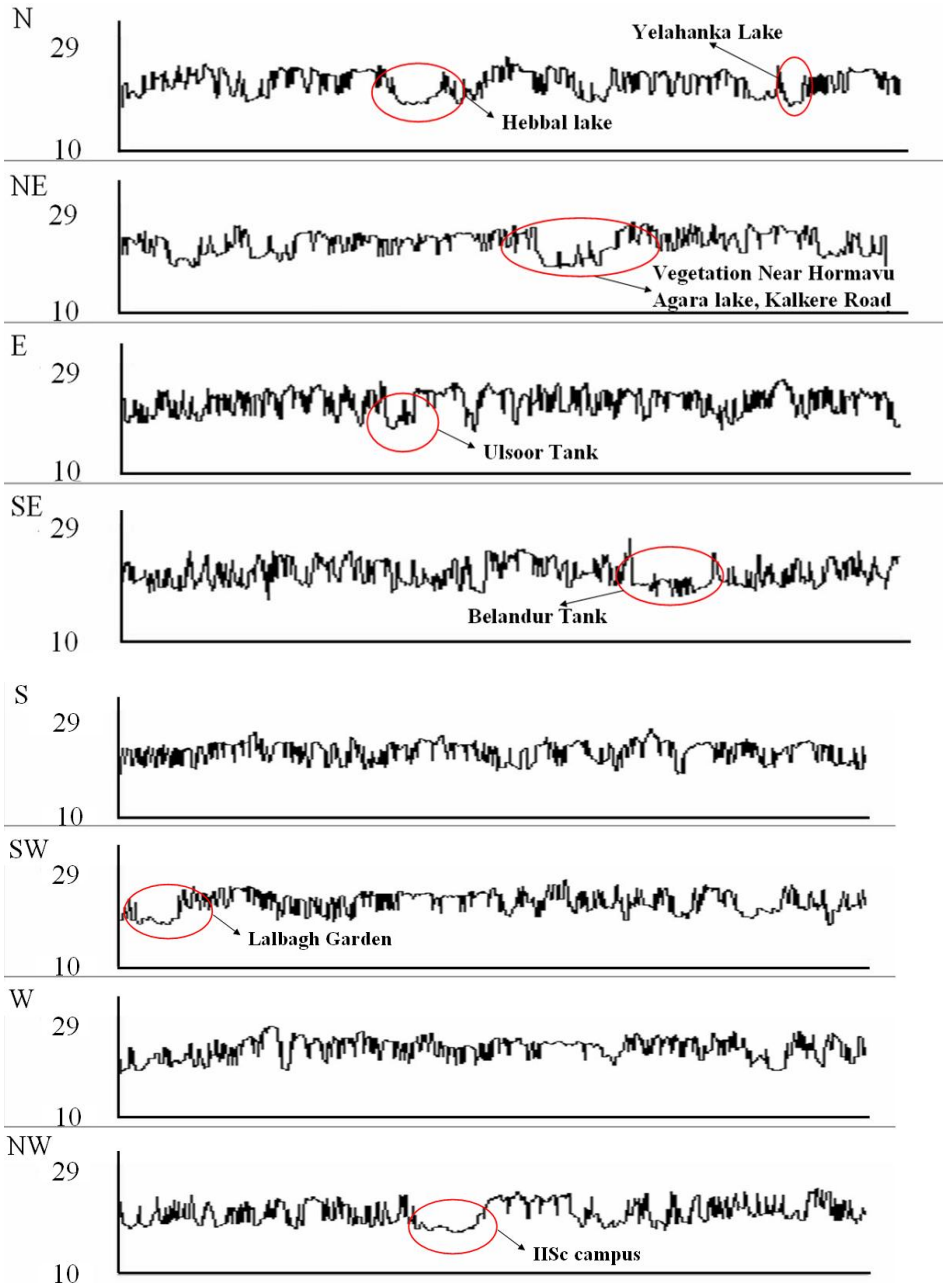

Figure 1.4: Temperature profile in various directions. X axis – Movement along the transacts from the city centre, Y-axis - Temperature (°C)

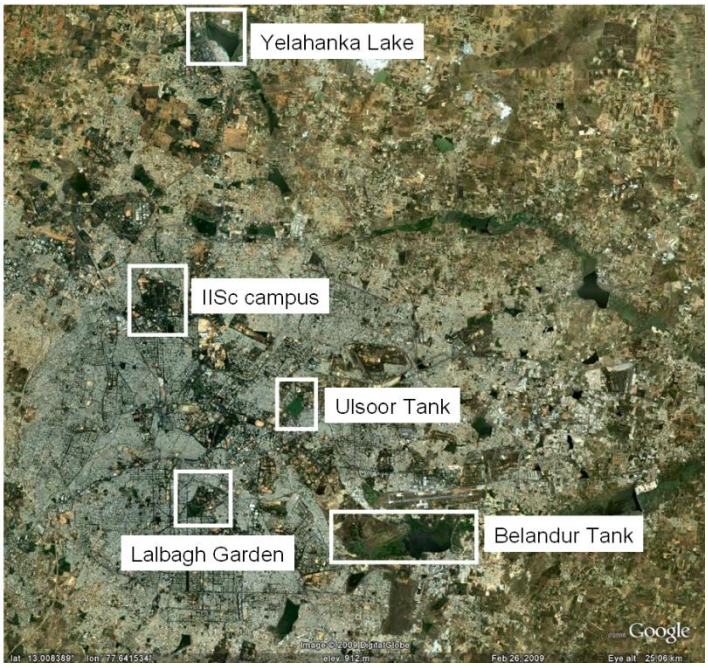

Figure 1.5: Google Earth image showing the low temperature areas [Source: http://earth.google.com/]

The temperature profile plot fell below the mean when a vegetation patch or water body was encountered on the transact beginning from the centre of the city and moving outwards eight directions along the transact as in figure 1.4 It is evident that major natural green area and water bodies act as microclimate moderators responsible for lower temperature (marked with circle in Figure 1.5). The spatial location of these green areas and water bodies are marked in figure 1.5.

Conclusion

Urbanisation and the consequent loss of lakes has led to decrease in catchment yield, water storage capacity, wetland area, number of migratory birds, flora and fauna diversity and ground water table. Temporal land use analysis reveal that there has been a 925% increase in built up area from 1973 to 2013 leading to a sharp decline of 79% area in water bodies in Bangalore mostly attributing to intense urbanisation process. The increase in urban built up area ranges from 342.83% (during 1973 to 1992), 129.56% (during 1992 to 1999), 106.7% (1999 to 2002), 114.51% (2002 to 2006) to 126.19% (2006 to 2010). The gradient analysis showed that Bangalore grew radially from 1973 to 2010 indicating that the urbanization is intensifying from the city centre and has reached the periphery of the Bangalore. The temperature profile analysis by overlaying the LST on the land use reveal of higher temperatures in urban area while vegetation and water bodies aided in moderating temperature at local levels (evident from at least 2 to 2.5 °C lower temperature compared to urban pockets).

Frequent flooding in the city is a consequence of the drastic increase in impervious area (of 925% in 4 decades) and loss of wetlands (and interconnectivity of wetlands) with the high-density urban developments. The uncoordinated pattern of urban growth is attributed to a lack of good governance and decentralized administration, which was evident from the lack of coordination among many Para-state agencies. This has led to unsustainable use of the land and other resources. 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.

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8.0 WETLANDS FOR BANGALOREANS' SURVIVAL IN 21ST CENTURY

Executive Summary:

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 ºC 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.

THREATS FACED BY WETLANDS IN BANGALORE

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).

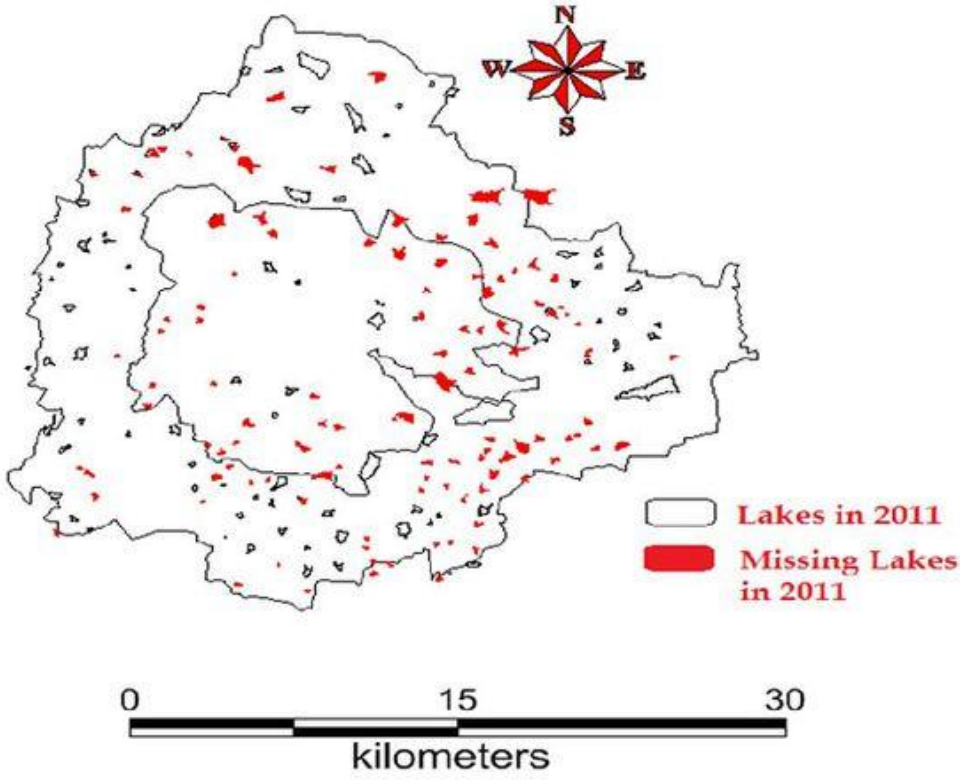


Figure 1: Lakes encroached by land mafia

Disappearance of water bodies or sharp decline in the number of water bodies in Bangalore is mainly due to intense urbanisation and urban sprawl. Many lakes (54%) were encroached for illegal buildings. Field survey of all lakes (in 2007) shows that nearly 66% of lakes are sewage fed, 14% surrounded by slums and 72% showed loss of catchment area. Also, lake catchments were used as dumping yards for either municipal solid waste or building debris (Ramachandra, 2009a; 2012a). 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. 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).

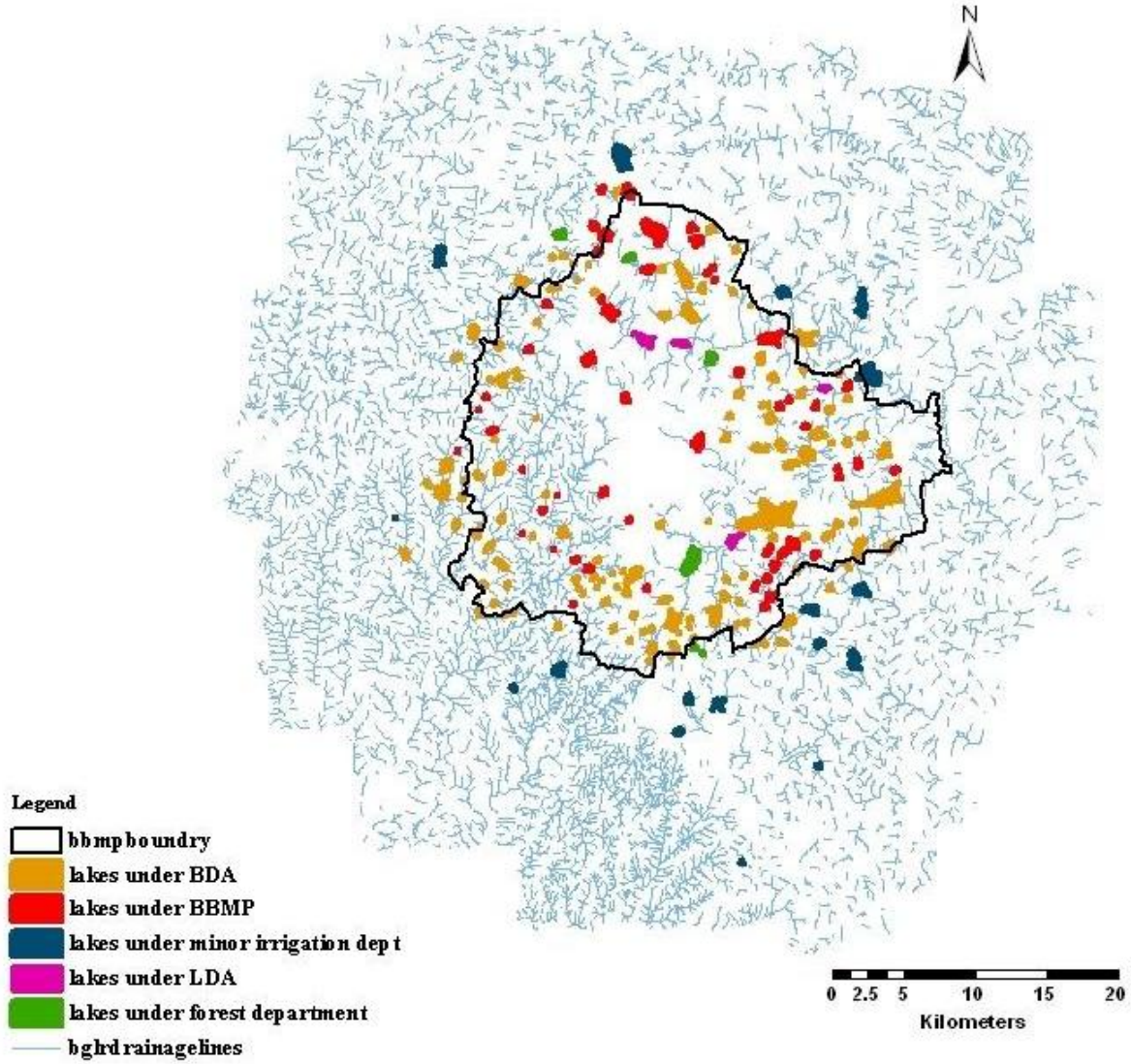


Figure 2: Spatial spread of lakes and custodians (too many – BBMP, BDA, LDA…. But too less effort to protect these lakes)

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'lore North	Yelahanka	Agrahara -33	**15-34**
2	Allalasandra kere	B'lore North	Yalahanka	Allalsandra -15	**41-23**
3	Ambalipura Kelagina kere	B'lore East	Varthur	Ambalipura-40 & 41	3-0, 4-09 T-**7-09**
4	Amblipura Melinakere	B'lore East	Varthur	Ambalipura-36	**12-16**
5	Attur kere	B'lore 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'lore North	Yalahanka	Avalahalli -10 & Singanayakanahalli 64	11-01 2-10 **T-13-11**
7	Bhimmana katte	B'lore South	Kengeri	Halagevaderahalli-138	1-23
8	Bayappanapalya Kunte (Munniyappana katte)	B'lore South	Uttarahalli	Vajarahalli -36	2-31
9	Challakere Lake	B'lore East	K.R. Puram	Challakere - 85	38-05
10	Chinnapanhalli kere	B'lore East	K.R. Puram	Chinnapanahalli 15 & 17	11-33 11-10
11	Chokkanahalli lake	B'lore North	Yelahanka	Chokkanahalli Sy-2	8-02
12	Dasarahalli kere (Chokkasandra)	B'lore North	Yeshwanthapura	Dasarahalli - 24 Chokkasandra - 5	3-29 24-04 **T-27-33**
13	Deepanjali kere	B'lore South	Kengeri	Devatige Ramanahalli-32	**7-22**
14	Devsandra kere	B'lore East	K.R. Puram	Devasandra 31	**16-08**
15	Doddabommasandra	B'lore 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	Kasavanhalli	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	Yeshwanthapura	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	Yeshwanthapura	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'lore South	Uttarahalli	Allahalli -30 Gollahalli-3	15-35 5-30 **T-21-25**
3	Amruthalli kere	B'lore North	Yelahanka	Amruthalli-115	**24-36**
4	Annappahalli/ Yelachenahalli Lake	B'lore South	Uttarahalli	Yelachenahalli-06, Govinayakanahalli-14	4-39 1-33 **T-6-32**
5	Arakere	B'lore South	Beguru	Arakere-34	**37-21**

6	Avalahalli	B'lore North	Yelahanaka	Avalahalli-10 Shiganayakanahalli-64	11-01 2-10 **T-13-11**
7	B.Narayanapura	B'lore East	K.R. Puram	B.Narayanapura-109	15-06
8	Baiyappanahalli kere	B'lore East	K.R. Puram	Baiyappanahalli-61	8-09
9	Basapura Lake-2	B'lore South	Beguru	Basapura-66	10-29
10	Basavanapura Lake	B'lore South	Beguru	Basavanapura-14	**7-34**
11	Begur Lake	Bl'lore South	Begur	Begur-94	**137-24**
12	Bellahalli	B'lore North	Yelahanka	Bellahalli-68	**18-32**
13	Bellandur	B'lore 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'lore South	Begur	Beratena Agrahara (Chowdeshwari)-18	**11-18**
15	Bhattralli kere	B'lore East	Bidarahalli	Bhattralli-2	**18-10**
16	Bheemanakuppe	B'lore South	Kengeri	Bheemanakuppe-180	75-15
17	Bhoganalli kere	B'lore East	Varthur	Bhoganalli-21	12-24
18	Byrasandra	B'lore South	Utharahalli	Byrasandra-56	15-11
19	Byrasandra kere (Chikkepet) (Melinakere)	B'lore East	K.R. Puram	Byrasandra-109	14-19
20	Chennasandra-2	B'lore East	K.R. Puram	Banasawadi-211	47-38
21	Chikka Banavara	B'lore 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'lore East	Varthur	Chikka Bellandur-9 Mullur -63	67-14 8-07 **T-75-21**
23	Chikkabasavanapura kere	B'lore East	K.R. Puram	Basavanapura-14	14-07
24	Chikkabasthi	B'lore South	Kengeri	Ramasandra-6	7-06
25	Chikkabettahalli	B'lore North	Yelahanka	Chikkabettahalli-52	1-32
26	Chick begur Lake	B'lore South	Begur	Begur-168, Singanadra-86	32-19 9-37 **T-42-16**
27	Chikkammanahalli Lake	B'lore South	Begur	Kammanahalli -22 Vamadevanahalli-	5-19
28	Chikkegowdana palya Lake	B'lore South	Kengeri	Hemmagepura-92	

29	Chunchanaghatta	B'lore South	Utharahalli	Chunchanaghatta-70, 70/2, 70/3	20-31 1-0 1-0 **T-22-31**
30	Chowdeshwari Layout Lake	B'lore South	Begur		
31	Devarakere Lake	B'lore South	Uttarahalli	Bikasipura-9	7-15
32	Doddabidarakallu	B'lore North	Yeshwanthpur	Doddabidarakallu-125 Nagasandra -06	23-21 16-36 **T-40-17**
33	Doddakallasandra	B'lore South	Uttarahalli	Doddakallasandra-27	**21-16**
34	Doddanakundi	B'lore 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'lore South	Kengeri	Valagerehalli-43, 43/P1	23-35 1-0 **T-24-35**
36	Gangasetty kere (Diesel shed kere (Gangadhariahnakere) (Dyavasandrakunte kere)	B'lore East	K.R. Puram	KR Pura-58 Devasandra-46	18-32 2-35 **T-21-27**
37	Gandhinagara Lake	B'lore North			
38	Garudachar Palya Kere -1 (Achanakere)	B'lore East	K.R. Puram	Mahadevapura-31	**5-36**
39	Garudachar Palya Kere -2 (Goshala) Yekkalagatta kere	B'lore East	K.R. Puram	Mahadevapura-86	**5-14**
40	Garvebhavi Palya	B'lore South	Begur	Hongasandra -41	**18-04**
41	Gattigere palya Lake	B'lore South	Kengeri	Somapura-27/53	0-37
42	Gottigere Lake	B'lore South	Uttarahalli	Gottigere-71	**37-13**
43	Gowdana Palya Lake	B'lore South	Uttarahalli	Kadirenahalli-33	**9-30**
44	Gubbalala	B'lore South	Uttarahalli	Gubbalala-25 Vajarahalli-	**8-10**
45	Gunjur Kere (Carmelarm)	B'lore East	Varthur	Gunjur-95	**9-17**
46	Gunjur Mouji kere	B'lore East	Varthur	Gunjur-301, Kachamaranhalli-74	59-13 4-26 **T- 63-39**
47	Gunjur Palya kere	B'lore East	Varthur	Gunjur-83	**36-27**
48	Haralakunte Lake (Somasandrakere)	B'lore South	Begur	Haralakunte-51	**16-29**
49	Hoodi kere (GIDDANA KERE)	B'lore East	K.R. Puram	Hoodi-138	**28-31**
50	Hoodi kere -1	B'lore East	K.R. Puram	Hoodi-79	**15-10**
51	Horamavu Agara	B'lore East	K.R. Puram	Horamavu Agra-77	**51-34**
52	Horamavu kere	B'lore East	K.R. Puram	Horamavu-83	**37-14**
53	Hosakerehalli	B'lore South	Uttarahalli	Hosakerehalli-15	**59-26**

54	Hosakere	B'lore South			
55	Hulimavu	B'lore South	Beguru	Hulimavu-42 Kammanahalli -110	124-25 5-32 **130-17**
56	Ibbalur Lake	B'lore South	Beguru	Ibbalur-36	18-06
57	Jakkur & Sampigehalli	B'lore 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'lore 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'lore East	Bidarahalli	Varanasi-47	**8-24**
60	Junnsandra kere	B'lore East	Varthur	Junnasandra-32	**24-33**
61	Kadirenapalya kere	B'lore East	KR Puram	Binnamangala-99	
62	K R Puram (BEML) Bendiganahalli kere	B'lore East	K.R. Puram	Benniganahalli-47 & 55	18-24, 27-14 **T- 45-39**
63	Kaggadasanapura	B'lore 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'lore South	Begur	Kalena Agrahara-43	**7-30**
65	Kalkere Rampura kere	Anekal Taluk (B'lore 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'lore South	Uttarahalli	Vasanthpura-21	**1-33**
67	Kannenahalli	B'lore North (Bng South)	Kengeri Yeshwanthpur		
68	Kelagina kere / Byrasandra	B'lore East	K.R. Puram	Byrasandra-112	**12-21**
69	Kembatha halli	B'lore South	Uttarahalli	Kembathahalli-3 Kathnuru-32/3	5-16 1-33 **T-7-20**
70	Kenchanapura	B'lore South	Kengeri	Kenchanapura-10	**17-20**
71	Kengeri Lake	B'lore South	Kengeri	Kengeri-15, Valagerehalli-85	27-03 5-13 **T-32-16**

72	Kommaghatta	B'lore South	Kengeri	Komaghatta-03 Ramasandra-46	9-04 28-01 **T-37-05**
73	Konankunte	B'lore South	Uttarahalli	Konanakunte - 2	**09-18**
74	Konasandra	Anekal Taluk	Jigani	Dyavasandra-9 Bommandahalli-18 Konasandra-17	21-13 7-39 3-20 **T-32-32**
75	Konnappana agrahara	B'lore South	Begur	Naganathpura (South)81	**5-17**
76	Kothnur	B'lore South	Utharahalli	Kothnur-54	**18-09**
77	Lakshmipura lake	B'lore North	Yeshwanthpur	Lakshmipura-25	**10-06**
78	Lingadheeranahalli	B'lore South	Kengeri	Lingadheeranahalli-13	**5-22**
79	Madavara	B'lore 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'lore East	K.R. Puram	Mahadevapura-187	**13-11**
81	Mallasandra Gudde lake	B'lore North	Dasanapura	Mallasandra-49, Mallasandra-50	11-28 5-23 **T-17-11**
82	Mallathahalli	B'lore North	Yeshwanthpur	Mallathahalli-101 Giddadakonenahalli-6	50-38 20-08 **T-71-06**
83	Manganahalli	B'lore North	Yeshwanthpur	Manganahalli - 43	**6-22**
84	Medi Agrahara	B'lore North	Yelahanka	Medi Agrahara-33	**13-15**
85	Meenakshi Kere	B'lore South	Begur	Kammanahalli (Meenakshi)-38	**18-37**
86	Mesthripalya Lake	B'lore South	Begur	Jakkasandra- 30	11-21
87	Nagarabhavi	B'lore North (Bng South)	Yeshwanthpur	Nagarabhavi-17	**17-39**
88	Nagareshwara-Nagenahalli Lake	B'lore East	K.R. Puram	Nagareshwara-Nagenahalli -10	11-08
89	Nellagaderanahalli	B'lore North	Yeshwanthpur	Nallagaderanahalli - 62	19-22
90	Nalluralli tank	B'lore East	K.R. Puram	Nalluralli-4 Pantandur Agrahara-85	20-34 27-05 **T-47-39**

91	Narasappanahalli	B'lore 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'lore South	Begur	Begur-344	**6-07**
93	Panathur kere -38	B'lore East	Varthur	Panathur - 38	**27-17**
94	Panathur kere -48	B'lore East	Varthur	Panathur - 48	**6-30**
95	Pattandur Agrahara	B'lore East	K.R. Puram	Pattandur Agrahara-124	**16-35**
96	Pattandur Agrahara	B'lore East	K.R. Puram	Pattandur Agrahara-54	12-37
97	Pattanagere Kenchenhalli	B'lore South		Kenchenahalli-33 Pattanagere-43	3-39 0-31 **T-4-30**
98	Rachenahalli	B'lore North B'lore 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'lore South B'lore North	Kengeri Yeshwanthpur	Ramasandra-159 Kenchanpura-36/* Kenchenapura - 36/¥ÉÊQ Kannahalli-37 (Bng north-Yeshwanthpura)	66-20 56-05 5-0 12-29 **T-140-14**
100	Sadaramangala kere	B'lore East	K.R. Puram	Sadaramangala-61, Kodigehalli-8	51-04 1-17 **T-52-21**
101	Shivanahalli	B'lore North	Yelahanka	shivanahalli-48 Allalasandra-38, 48	14-30 3-22 0-27 **T-18-39**
102	Siddapura kere	B'lore East	Varthur	Siddapura -18	**27-38**
103	Singapura Kere	B'lore North	Yelahanka	Singapura-102	**66-18**
104	Singasandra	B'lore South	Beguru	Singasandra -99, 100	10-14 0-34 **T-11-08**
105	Sitaram Palya	B'lore East	K R Puram	Sonnenahalli (Seetharmapalya)-33	**23-37**
106	Sompura	B'lore South	Kengeri	Sompura - 11	17-38

107	Srigandadakaval (near Rajivgandhi nagar)	B'lore North	Yeshwanthpur	Srigandakavalu-15	**6-33**
108	Srinivasapura Kere	B'lore North	Yelahanaka	Srinivasapura-2	**3-14**
109	Subbarayanakere	B'lore South	Uttarahalli	Gottigere-12	**5-10**
110	Subedeharanakere	B'lore South	Begur	Begur-48	**6-05**
111	Subramanyapura Lake	B'lore South	Uttarahalli	Uttarahalli-64	**18-06**
112	Sulekere (Soolikere)	B'lore South	Kengeri	Maragondanahalli Krishnasagara	
113	Swarnakunte gudda kere	B'lore South	Begur	Chandrashekarpura-1	**09-05**
114	Talaghattapura (Gowdarakere)	B'lore South	Uttarahalli	Talaghattapura -73	**19-16**
115	Ullal	B'lore North	Yeshwanthpur	Ullal-93	**24-12**
116	Vaderahalli	B'lore North	Yelahanka	Vaderahalli-32	**9-34**
117	Varahasandra Lake	B'lore South	Kengeri	Hemigepura-4, Varahasandra-24	4-11 13-09 **T-17-20**
118	Varthur	B'lore East	Varthur	Varthur-319	**445-14**
119	Vasanthapura (Janardhanakere)	B'lore South	Utharahalli	Vasanthpura-28	**7-10**
120	Venkateshpura	B'lore North	Yelahanka	Ventateshpura-12 Sampigehalli-37	6-35 11-29 **T-18-24**
121	Vibhuthipura kere	B'lore East	Varthur	Vibhuthipura-175	**45-18**
122	Vishwa nidam lake	B'lore North	Yeshwanthpur	Herohalli-50	**4-30**
123	Yellenhalli Lake (Elenahalli)	B'lore 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'lore South	Kengeri	Agara-11 Venkojiraokhane-11	5-39 136-30 **T-142-29**
2	Hebbal Lake	B'lore North	Kasaba	Hebbla-38 Kodigehalli-37	92-26 99-33 **T-192-19**
3	Nagavara Lake	B'lore North	Kasaba	Nagawara-58 Vishwanatanagenahalli - 12,13	56-17 12-35 6-01 **T-75-13**
4	Vengaiahnakere	B'lore 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'lore North	Kasaba	Hennur - 53 Nagawara - 13	58-30 14-11 **T-73-01**
2	J.B.Kaval Tank (Bangalore Range)	B'lore North	Yelahanka	Jyarakabande Kavalu-P1-36	44-21 2-04
3	Madiwala (K.R.Puram Range)	B'lore South	Begur	Madivala- 7 Kodichikkanahalli-23 Belekannahalli-64 Rupena Agrahara-11	166-39 80-09 21-35 6-10 T-275-13
4	Mylsandra (Kaggalipura Range) Gumaiahanakere (Mylasandra 1) Mylasandra 2	B'lore South	Kengeri	Mylasandra-37 Kasaba Kengeri-58 Mylasandra - 27 Kasaba Kengeri-66	6-24 6-02 **T-12-26** 10-14 5-28 **T-16-02**
5	Puttenahalli (Yelahanka Range)	B'lore 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.

9.0 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, rajjakaluves (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;
- **Decontaminate:** Restriction of the entry of untreated sewage and industrial effluents into lakes; De-silt (to remove contaminants in sediments due to sustained inflow of pollutants - untreated sewage, and industrial effluents)
- To make land grabbing cognizable non-bailable offence;
- **Decontaminate:** 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;
- **Decontaminate:** Implementation of 'polluter pays' principle as per water act 1974;
- Plant native species of macrophytes in open spaces of lake catchment area;
- **Decontaminate:** 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	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. Eviction of encroachment: Need to be evicted as per Karnataka Public Premises (eviction of unauthorised occupants) 1974 and the Karnataka Land Revenue Act, 1964
Buildings in the buffer zone of lakes	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) • 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	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.
Construction activities in the valley zone (SEZ by Karnataka Industrial Areas Development Board (KIADB)) **in the**	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

valley zone	and these regions are 'NO DEVELOPMENT ZONES' as per CDP 2005, 2015
Alterations in topography	Flooding of regions would lead to loss of property and human life and, spread of diseases.
Increase in deforestation in catchment area	Removing vegetation in the catchment area increases soil erosion and which in turn increases siltation and decreases transpiration
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
Implementation of sanitation facilities	• 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	Environment Impact Assessment (EIA) Notification, 2009. **Wetlands (Conservation and Management) rules 2010, Government of India; Regulatory wetland framework, 2008** **Regulated activity** • 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 **Prohibited activity** 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	High Court of Karnataka (WP No. 817/2008) had passed an order which include: • 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	**National Environment Policy, 2006** The principal objectives of NEP includes : • 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	**National Water Policy, 2002** Water is a scarce and precious national resource and requires conservation 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 of pollution.
Discharge of untreated sewage into lakes	**The Environment (Protection) Act, 1986** • 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 • 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	**Water (Prevention and Control of Pollution) Act, 1974** • It is based on the **"**Polluter pays**"** principle. The Pollution Control Boards performs the following functions : • 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 modifiy 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	The depletion of ground water and drying up off 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

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 waterbodies and public awareness will help in developing appropriate conservation and management strategies (Ramachandra, 2005).

Ecological and Environmental Implications:

- Land use change: 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 FatehpurSikhri and fading out of AdilShahi'sBijapur, 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.

10.0 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.
   - 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.

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.
- 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 strengthening their catchment area and allowing sloping shorelines for fulfilling their ecological function.
- 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 microphytes management need to be developed. Research should go beyond the removal of nuisance microphytes 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 inter-disciplinary 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 advices 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 acts 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:

- 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.
- 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	Prohibits hunting of wild animals, their young ones as well as their eggs Prohibits the picking, uprooting, destroying, damaging, possessing of any plant in a protected area Can declare any area with high ecological significance as a national park, sanctuary or a closed area.
2	The Biological Diversity Act, 2002	Prior approval needed from National Biodiversity Authority for collection of biological materials occurring in India as well as for its commercial utilization. Panchayath to document biodiversity and maintain biodiversity registers
3	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 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	It is based on the "Polluter pays" principle. The Pollution Control Boards performs the following functions : • 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	Prohibited Activities • Conversion of wetland to non-wetland use • Reclamation of wetlands • Solid waste dumping and discharge of untreated effluents. Regulated activities • 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	The principal objectives of NEP includes : • 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	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.
9	National Water Policy, 2002	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 of pollution.
10	KARNATAKA LAKE CONSERVATION AND DEVELOPMENT AUTHORITY ACT, 2014, **KARNATAKA ACT NO. 10 OF 2015** **RMP 2015 (BDA)**	Conservation of lakes and wetlands 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. NEEDS PROTECTION – possible only with the implementation of norms without any dilutions and violations.

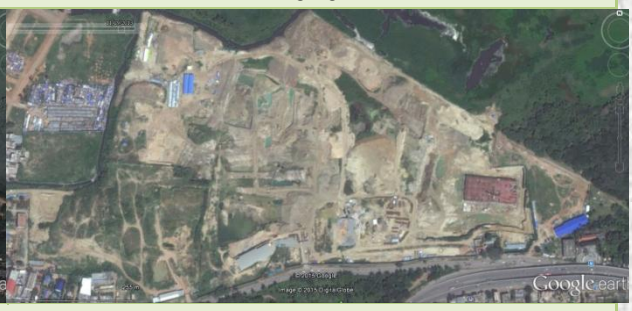
2000

2005

2007

2010

2012



2013

2015 [LANDSCAPE DYNAMICS during 2000 – 2015**]**

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