

Lake Buffers as Public Recreational Spaces,

Electronic City, Bangalore, India.

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1. Abstract

The city of Bangalore, once known as the Garden City of India and the City of Lakes, has now transformed into the Silicon Valley of India. This transformation has happened over the last few decades and has caused major changes to the City's landscape. One of the important issues the city faces today is the scarcity of water. Researchers owe this issue to the depletion of lakes due to high pollution levels, encroachment and dumping of solid waste in the lakes.

The neighbourhood Electronic City is located in the Southern region of Bangalore Metropolitan Region. The neighbourhood is located within the Koramangala-Challaghatta watershed region and houses about 14 lakes; two of which have disappeared and all the lakes have encroachments in the buffer zones.

The project focusses on transforming the lake buffers into public recreational areas with functional strips of riparian vegetation. To achieve the transformation, analysis of land uses within the neighbourhood and analysis of the percentage of encroached lake area including the buffer are followed by SWOT analysis and recommendations.

The maps generated to analyse the land use in the neighbourhood lay emphasis on the presence of lakes in an industry rich neighbourhood covering about 68% of the area. Also, about a third of the neighbourhood is covered with built structures making most of the area impermeable and reduces the infiltration capacity of storm water.

The recommendations follow up on the analysis and are designed in three zones -

Zone 1 - riparian buffer zone in the 30m buffer zone; which would essentially be the functional part aiding in the first step of filtration of the rainwater entering the waterbody.

Zone 2 - walking/ jogging track; this part of the buffer zone opens up the area for public access. And consists of a permeable paved layer of walking track open to public.

Zone 3 - park with designated areas for food carts and seating; this part of the buffer zone is essentially a public space. this part of the buffer is specifically designed for recreational purpose for all age groups.

The transformation of lake buffer zones into public recreational spaces ensures the area to be free of any buildings that might otherwise be built on this land. Also, bringing in the public into the space would allow increased public involvement in the Bangalore lakes campaign and would ensure better maintenance of the functional parts of the lake.

A recreational space is perceived as a destination and would add value to the place. The addition of food carts and other businesses with designated seating areas would open up the space for more users and bring in additional funding.

The funds allocated by the city agencies such as BBMP and BDA, according to BBMP reports, suffice the rejuvenation of waterbodies and adding fence around for their preservation. This project focusses on procuring funds through Corporate Social Responsibility, and the funds that could possibly be generated through the business within the buffer zone.

2. Introduction

Bangalore Metropolitan Region has been dealing with the issue of contamination, pollution and encroachment of lakes and catchments for more than a decade. Many scientists and researchers working towards the ecological concerns owe this to rapid and unplanned urbanization.

The city of Bangalore has gone through vast growth over the last few decades, in terms of population, and also built infrastructure. To accommodate the increasing population, increasingly high rise residential buildings are being built. These buildings are built on existing lake beds or their immediate buffers leading to low infiltration rates.

Bangalore's lakes were constructed around the sixteenth century to provide the residents of the city with the water supply needs for domestic and agricultural purposes. The lakes were interconnected through an intricate series of channels to ensure the rain water flows down from a lake at a higher altitude to next lake in the series and prevented run-off on the streets.

Presently, most of the lakes have encroachments on the buffers affecting the quality of water, and not serving the purpose of providing water for the resident's needs.

Buffer zones play an important role in maintaining the health of the water in lakes by maintaining the flow, controlling soil erosion, aiding in ground water recharge and also the vegetation enhances recreational values.

This project proposes to develop the buffer zones as recreational spaces. Developing the buffers would ensure the buffer zone to be a no development zone, vegetation would aid in controlling soil erosion and ground water recharge, a walking track, seating area and children's play area would attract users to utilize the space for recreational purposes. Also, developing the space to be an active public space would increase public participation in the conservation and maintenance of the space.

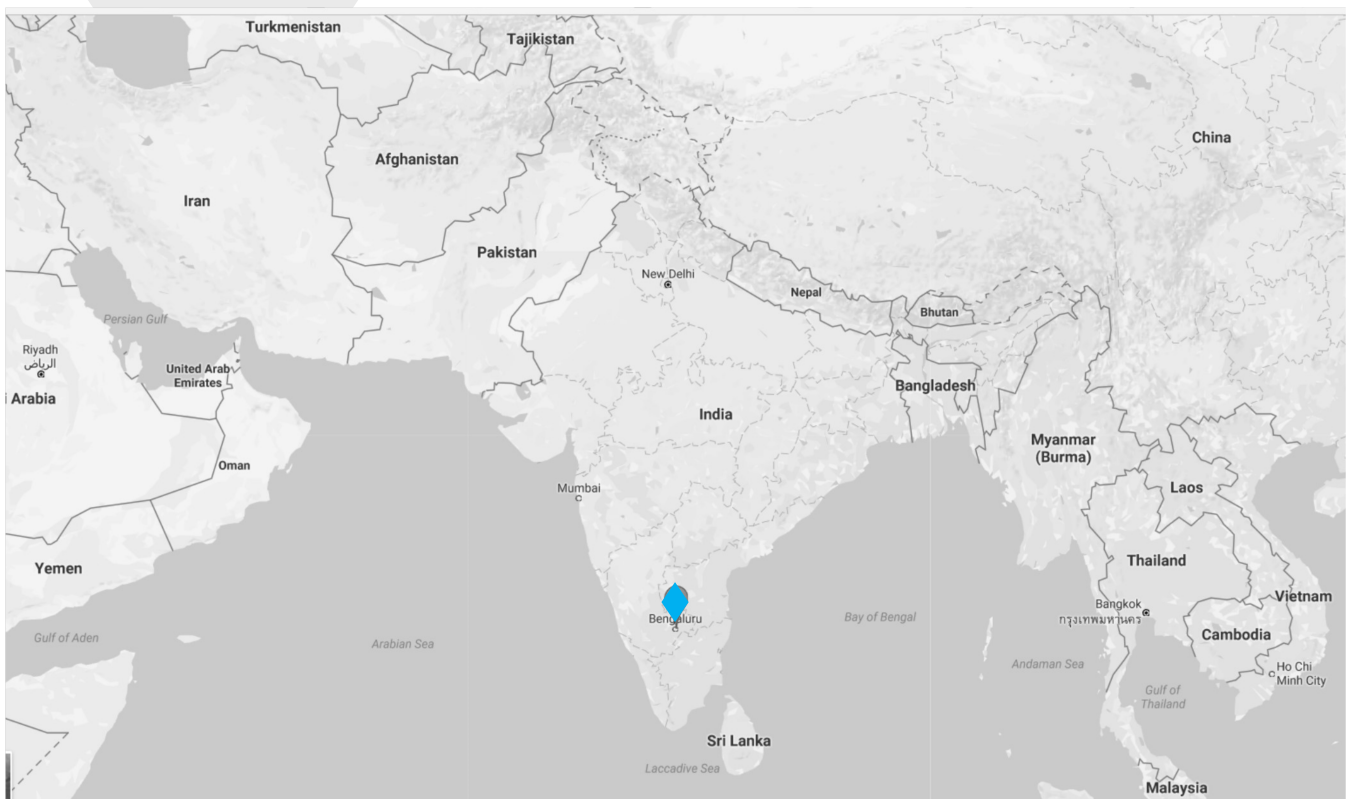
3. Bangalore– Introduction

Silicon Valley of India

South Western
Region of India

Altitude

920 meters/ 3018
ft. Above mean sea
level



Location of Bangalore within the Subcontinent of India.

Figure (1)-

Approx. 90 Rainy
Days a year

Population
9.6 Million

Area
8005 Sq. Kms.



3.1 . About Bangalore

The city of Bangalore is located in the South-Western Region of the Indian Subcontinent. The city is located at an altitude of 920 meters (3018 feet) above the mean seal level ⁽¹⁾; and has distinct wet and dry seasons with about 90 rainy days a year. The region receives about 900 mm of average mean rainfall annually.

The Bangalore metropolitan region covers an area of 8005 sq. kms. and houses a population of about 9.6 million ⁽²⁾. The city houses more than 900 Information Technology Companies and is also known as the “Silicon Valley of India” ⁽¹⁾. Bangalore is the fifth most populous city in India and boasts a growth rate of 38% ⁽³⁾. The rapid growth rate has accounted to many of the problems the city faces like traffic congestion, elevated air and water pollution levels, storm water run-off on the streets, water shortage etc. to name a few ⁽⁴⁾.

Of the existing land area, residential land use covers about 40%, while the industrial land use covers 6.9% and the commercial land use covers just about 2.7%. within the Bangalore urban limits, only 8.4% of the area covers green spaces. About 65% of the urban area is built up ⁽⁵⁾.

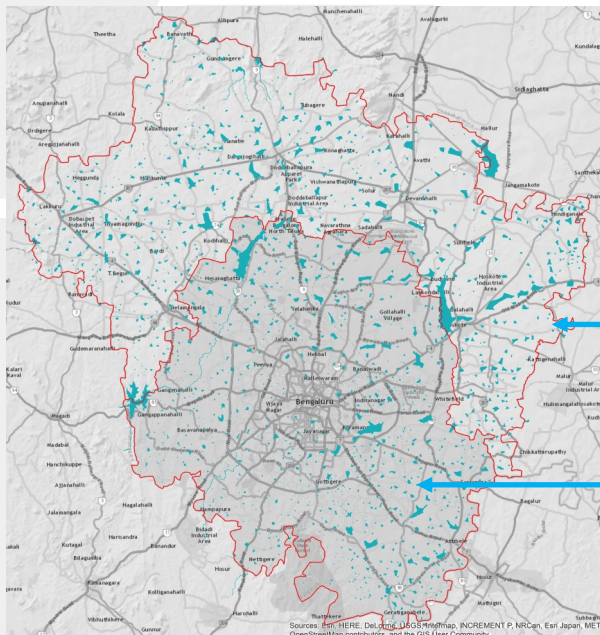


Figure (2)- Bangalore Metropolitan Region with Waterbodies.

Bangalore Rural
Region

Bangalore Urban
Region

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2. www.citypopulation.de/php/india-karnataka.php
3. Ramachandra, T. V.; Pradeep P. Mujumdar. "Urban Floods: Case Study of Bangalore". Indian Institute of Science. Retrieved 14 September 2013.
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3.2. The System of Lakes

210 Lakes in the Metropolitan Region

3 Major watersheds

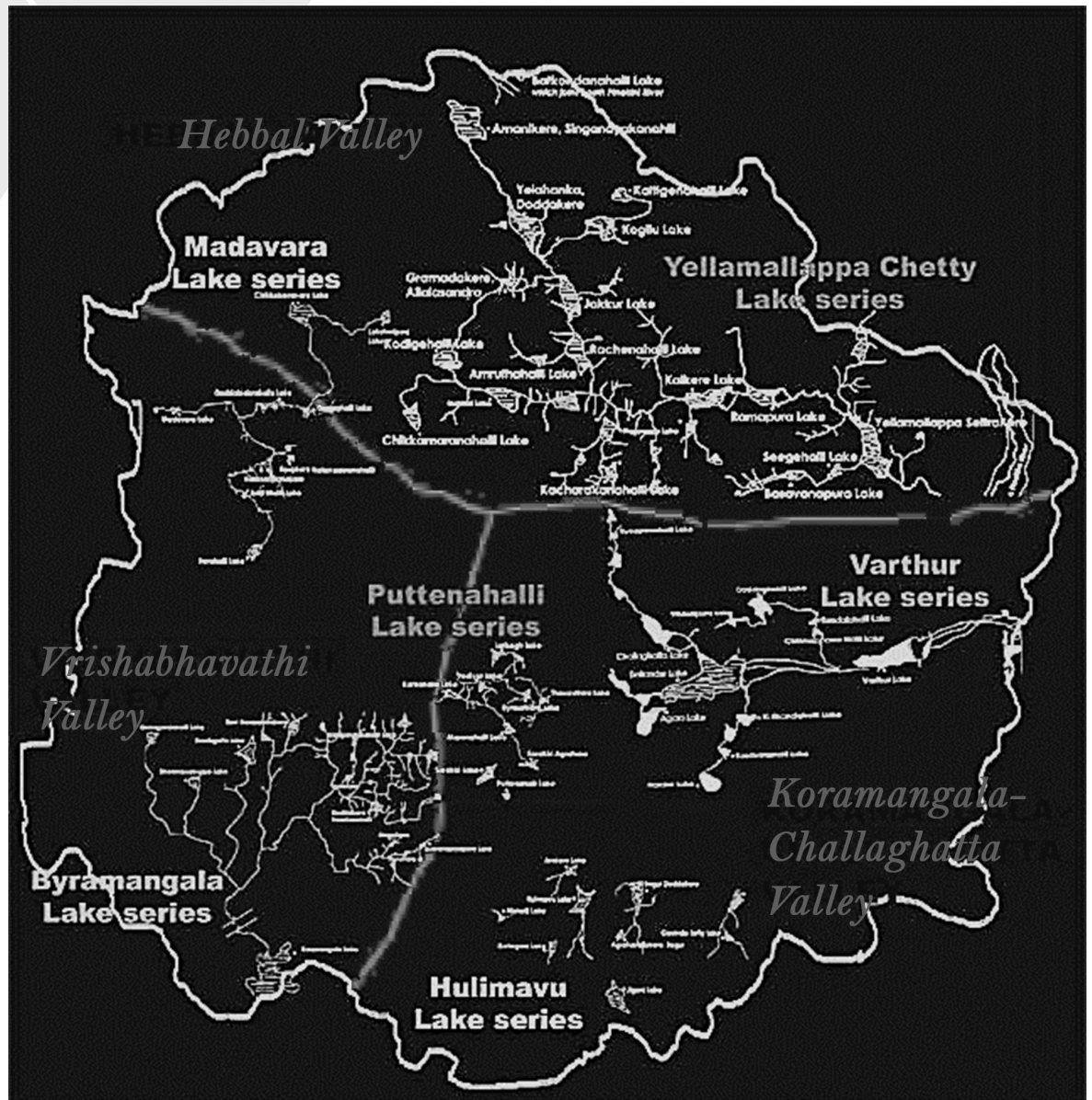


Figure (3) : Bangalore Watersheds and Lake network

48% of the area covered by waterbodies.



3.2. The System of Lakes

The natural terrain of Bangalore slopes from North to South and the city is located over ridges delineating into three major watersheds – Hebbal, Vrishabhavathi and Koramangala & Challaghatta Watersheds. There are about 210 lakes spread across the Bangalore Metropolitan Region. The undulating terrain accommodated the development and preservation of lakes for the capture and storage of rainwater ⁽⁶⁾.

Most of the lakes are manmade and the earliest history of creation of lakes in the city can be traced back to sixteenth century. The founder of Bangalore, Kempegowda, perceived the monsoons as an asset to sustain his kingdom and people ⁽⁷⁾. The lakes were created for the purpose of providing irrigation and domestic water needs such as drinking water, household sanitary water supply etc. The lakes also serve the purpose of ground water recharge and some of the well protected and developed lakes even serve as recreational spaces.

The lakes form a series of hydrological connections and work in series to capture and store rain water. Each lake harvests rainwater from its catchments and surplus water flows downstream spilling into the next lake in the chain ⁽⁸⁾. The lakes and open spaces are the major sources of ground water recharge for the city of Bangalore and only about 4.8% of the land in Bangalore is covered by waterbodies ⁽⁸⁾.

References

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7. Aboud S.Jumbe; Nandini, N; Tandon, Sucharita; Sunitha, N. Bangalore Lakes- Issues and Perspectives on Pollution, Restoration and Management.
8. H.S. Sudhira; T.V. Ramachandra; M.H. Bala Subrahmanya (2007). "City Profile — Bangalore" (PDF). *Cities*. Bangalore: Environmental Information System (Centre of Ecological Sciences), Indian Institute of Science. **24** (5): 382.

3.3. Urbanization and Growth Rate

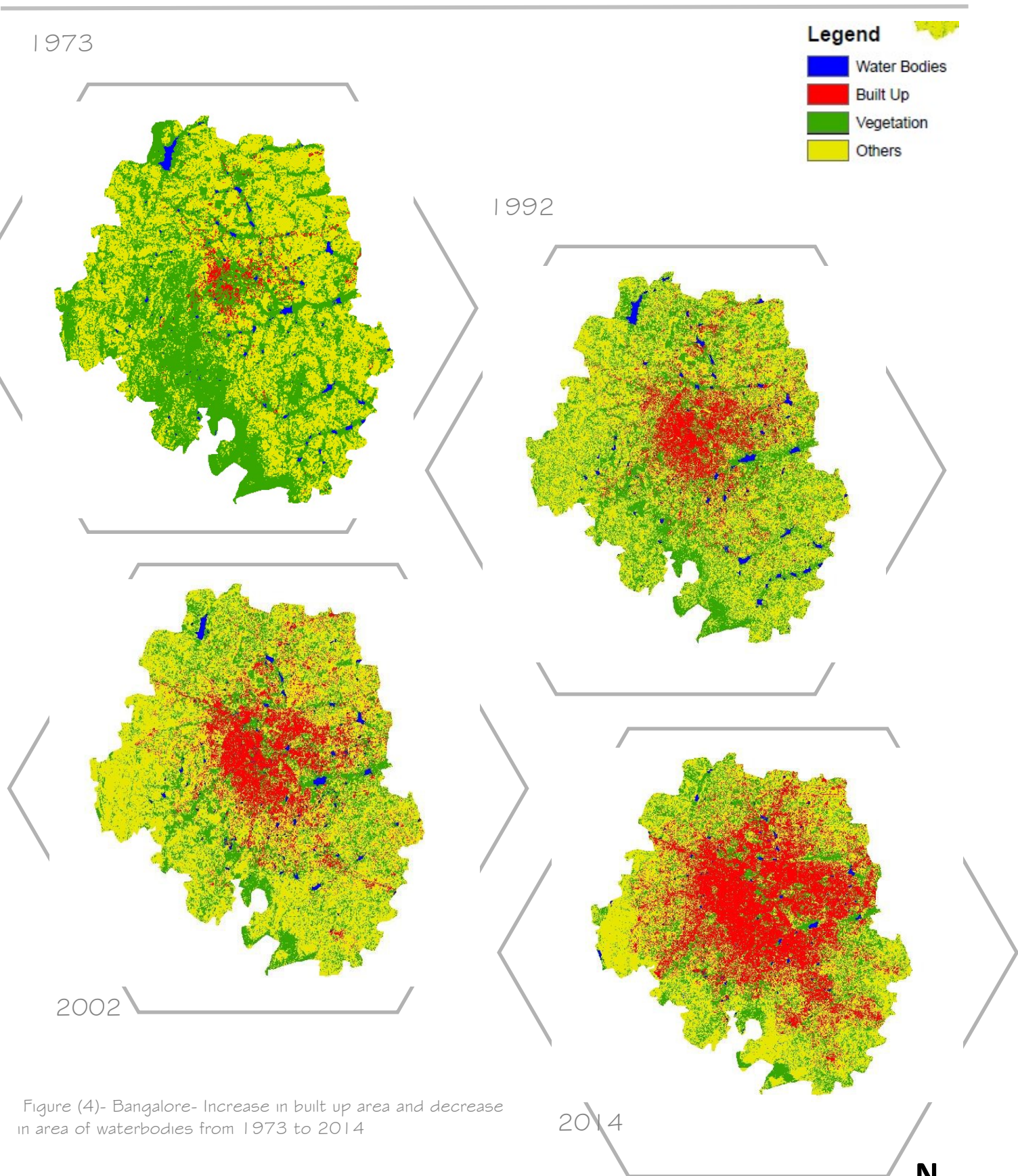


Figure (4)- Bangalore- Increase in built up area and decrease in area of waterbodies from 1973 to 2014

References

9 . Prason Singh; "Trend id Land use Land cover change in Bangalore", The Energy and Resources Institute, Bangalore.

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3.3. Urbanization and Growth Rate

Bangalore Metropolitan Region houses more than 900 Information Technology Companies, about 97 Biotechnology companies, and many small, medium, and large-scale manufacturing industries ⁽¹⁰⁾. The presence of these industries attracts job seekers across the country to the “IT-Hub” resulting in steady increase of population.



Figure (4)

In order to accommodate the burgeoning population, there has been significant increase in the built-up area. Figure 4 shows trends in the increase in the built-up area and the simultaneous decrease in the area and the number of waterbodies and other open spaces from 1973 to 2014.

Most of the buildings are found either in the vicinity of the lakes or are illegally constructed in the catchment area of the lakes. The increase in built up area and the extensive growth accounts for the decrease in green cover, elevated levels of pollution and the depletion of lakes.



Figure (5)

The figures 4 and 5 show residential developments along lake buffers in Bangalore. With very little to no vegetation in the buffer and having the entire space as a built-up area with no permeable area reduces the rate of ground water infiltration rates and eventually reducing ground water table.

The increase in built up area is one of the many reasons for the depletion of lakes. Most lakes are sewage fed, used as dumping grounds for construction debris, solid waste and plastics, informal settlements are found on the lakebeds, illegal construction in the catchment areas and encroachment of lakes for residential and other building types, being a few other reasons.

References

10.

3.4. Current Surface Water and Ground Water Conditions

Figure (6) - % of households with Cauvery water Supply

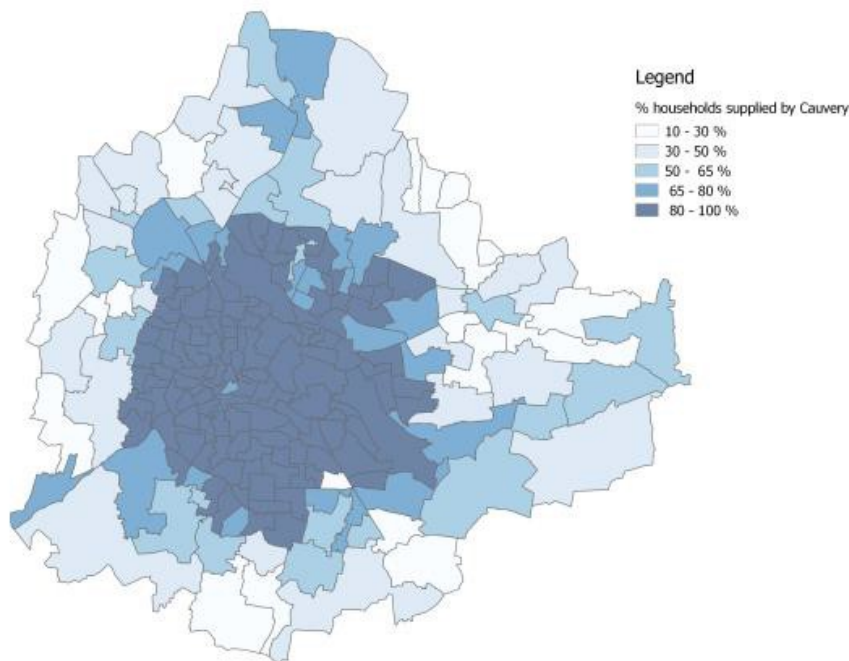
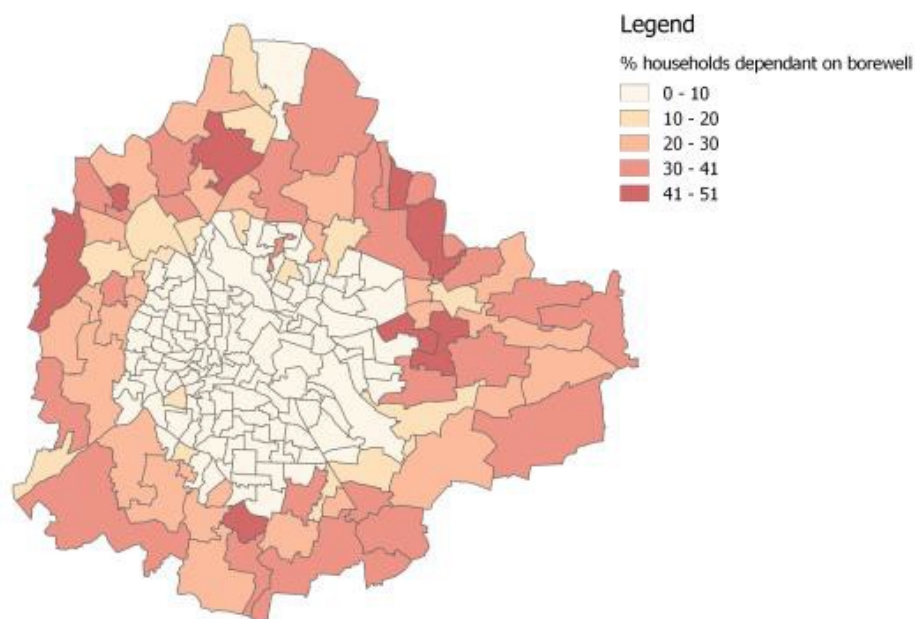


Figure (7) - % of households dependent on borewells.



Bangalore City has two major sources of surface water, i.e., Arkavathy and Cauvery rivers. Cauvery river is located at a distance of 100 kilometres from the city and accounts for about 1,350 MLD of water supply. Figures 6 & 7 ⁽¹¹⁾ show the maps with Cauvery water distribution and households dependent on borewells respectively. About 80%-100% of the households in the central part of the city have Cauvery water supply and the distribution reduces along the periphery; while, in the neighbourhoods within the periphery, most of the houses are entirely dependent on borewells.

References

11. Karnataka State Pollution Control Board : Domestic Water in Bengaluru: From where? To whom?

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4. Current Conditions of Lakes and their Buffer Zones

The Energy and Wetlands Research Group, Center for Ecological Sciences, IISc., Bangalore conducted a study of 105 lakes within the city limits and found that out of the 105 lakes studied, only 4 were in good condition and about 25 lakes were in awful state completely covered with macrophytes, solid waste, plastics, or construction waste etc. with little or no water ⁽¹¹⁾.

98% of the Lakebeds are Encroached

The study also discovered that -

98% of the lakes are encroached ⁽¹²⁾.

90% of the Lakes are Sewage Fed

98% of their These the

the lakes in the metropolitan region have built up spaces in catchments, on the lake beds and along the flood plains. These encroachments result in the loss of interconnectivity among the lakes, alterations in the topography of the catchments; 82% of the lakes showed loss of catchment areas.

90% of the lakes are sewage fed ⁽¹²⁾.

Most lakes have sustained flow of untreated sewage and industrial effluents. The reason for this could be the removal of riparian buffers and unabated construction activities in the buffer zones.

More than half of the lakes showed prominent level of pollution ⁽¹²⁾.

The sources of pollution include both point sources such as nutrients from waste water, toxins from industrial wastes, and storm water run-off; and non-point sources such as fertilizers, toxic pesticides, agriculture run-off etc. Lakes in the Koramangala-Challaghatta valley showed higher levels of pollution as compared to Hebbal and Vrishabhavathi valleys. The lakes show prominent levels of chloride, nitrates, potassium and sodium and high alkaline levels.

The area of focus for this project- the neighbourhood of Electronic City can be found within the Koramangala-Challaghatta Watershed region.

References

12. Ramachandra, T. V.; Pradeep P. Mujumdar. "Urban Floods: Case Study of Bangalore". Indian Institute of Science.

13. Ramachandra, T. V.; Sudarshan P. Bhat; Bharath H. Aithal. "Wetlands: Treasure of Bangalore". Centre for Ecological Studies, IISc., January 2016.

4.1 Categorization based on Existing Conditions

Another study conducted by United Way Bengaluru on the existing conditions analysis of 200 lakes focussing on the state of water, biodiversity and community involvement shows the following findings ⁽¹³⁾-

The findings from the study show that very few lakes have fully fenced boundaries, of the 200 lakes analysed, about 114 of the lakes support a rich ecosystem and about 70 of the lakes have active fishing as well. 64 of the lakes have sewage redirected and as few as 15 of the lakes have sewage treatment plants. Just about 48 of the lakes have water quality within the permissible limits set by the Karnataka State Pollution Control Board.

About 52 of the lakes have active community participation and 40 lakes have partial community participation.

The report also describes an ideal lake in Bangalore would have the following features-

- Storm water inlets with no sewage and garbage inlets and the sewage directed into a sewage treatment plant.
- A zero-energy sewage treatment plant with minimal maintenance, which would allow the treated water to join the lake.
- A well-defined and fenced boundary with vegetated buffers.
- Active community with successful partnerships with the Government and other corporations.
- Connectivity with the rest of the watershed.

References

14. Unite for lakes- Save Bengaluru, United Way Bengaluru, Bangalore. April 2016; pg. 4.

Based on the findings, the lakes studied were categorized into six categories focussing on their overall health. The categories are presented in Table (1)-

| Category | Number of lakes | Description |
|-----------------------------------|------------------------|---|
| Bangalore's best lakes | 33 | Lake physically intact and complete, Sewage diverted and treated, rich biodiversity and has an active community. |
| Almost there | 42 | 1-2 aspects of the above aspects are missing. Steps away from joining the best lake. |
| Average lakes with communities | 16 | Several steps needed become one of the city's best lakes. Lacking in biodiversity or water treatment or some physical as- |
| Average lakes without communities | 25 | Several steps needed become one of the city's best lakes. |
| Lakes with a faint hope of life | 29 | Fencing not complete, significant physical work needed, some lakes are fully dry, low on biodiversity or have sewage water coming in. But having active communities that are trying to change things. |
| Lakes staring at death | 55 | Lakes facing death, and not currently having communities that care. High encroachment, may also have legal dis- |

References

15. Unite for lakes- Save Bengaluru, United Way Bengaluru, Bangalore. April 2016. Pg. 6

4.2. Encroachment Removal and Rejuvenation

The Bangalore Metropolitan region has 183 lakes which are governed by various Government agencies. 55 of the lakes are governed by Bruhat Bengaluru Mahanagara Palike (BBMP-the administrative body responsible for the civic and infrastructural assets of the Greater Bangalore metropolitan area). The 55 lakes cover an area of 2088 acres. An area of 151 acres of that had been encroached; about 83 acres of encroached area has been removed by BBMP⁽¹⁶⁾.

The BBMP has taken up demolition drives to remove encroached lake beds and storm water drains. As of 2016, BBMP had identified 1923 encroachments that had to be removed; of which 200 were already removed.

The demolition drive was carried out without any contingency plan leaving many families homeless. The city government did not promise the citizens any alternate accommodation either.

After removing the encroachment, 39 of the lakes under BBMP were fenced and fencing of 13 lakes was in progress as on 2013; And 3 of the lakes did not have fenced boundaries.

BBMP, after removing the encroachment, carried out the rejuvenation of lakes. rejuvenation consisted of the following steps-

- Adding fenced boundaries
- Diversion of sewage inflow
- Engineered wetland treatment for the flow of storm water
- Setting up of Sewage treatment plants to maintain water balance in lakes
- Desilting of lakes to restore the original holding capacity
- Construction of silt traps and
- Afforestation (adding planted buffer strips).

References

16. Survey and Encroachment Details of 55 lakes as on 30.06.2013, Bangalore, India. <http://bbmp.gov.in/encroachment-details>



Many Non-Governmental Organizations have also stepped up to maintain the rejuvenated lakes by-

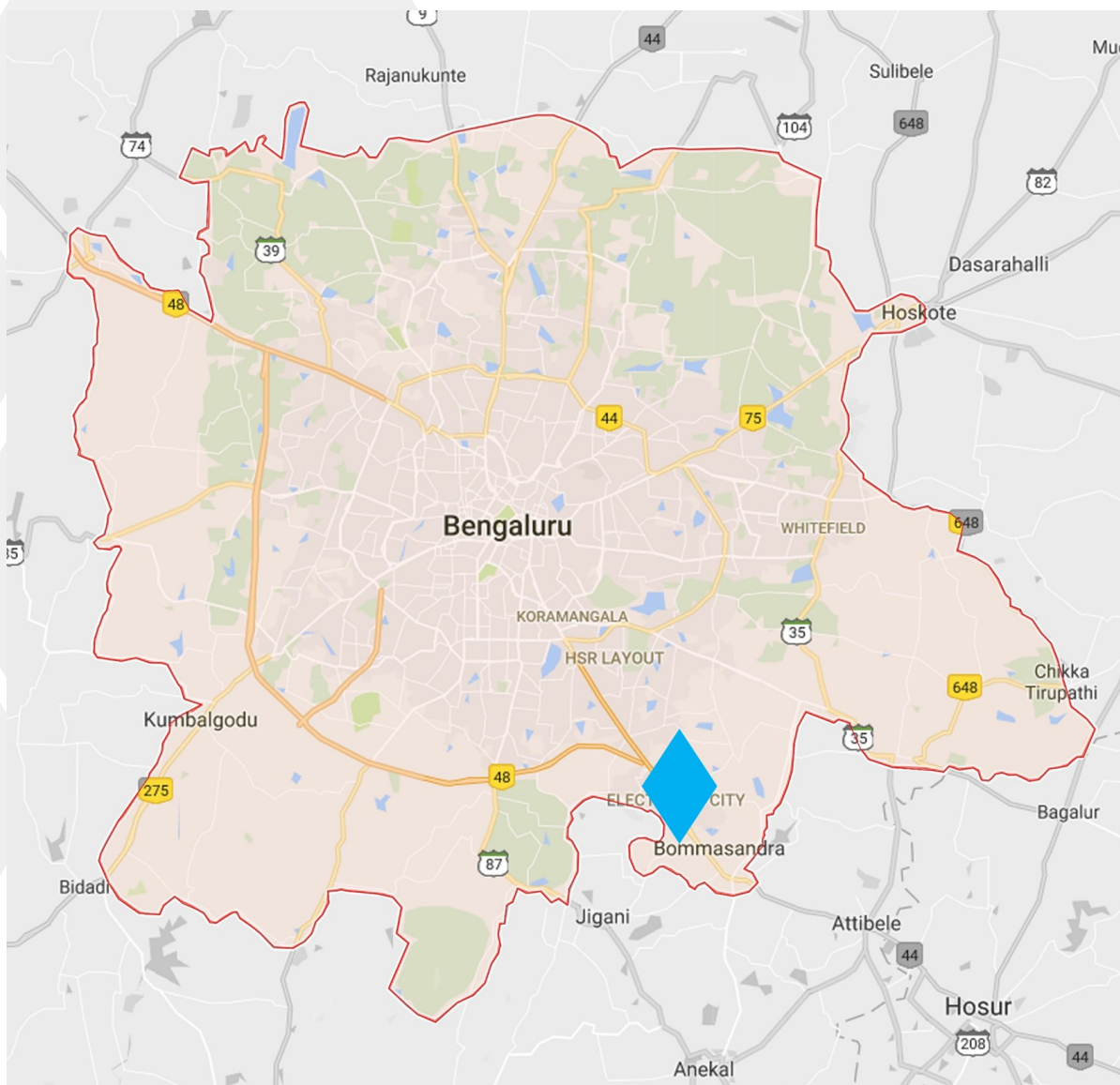
- Maintaining pathways, plants and the garden area
- Installation of signage boards
- Regular removal of solid wastes
- Removal of weeds in the waterbody and sedimentation tank
- Allowing public access at prescribed hours.

5. Electronic City

The project mainly focusses on the lakes in the neighbourhood of Electronic City in Bangalore. The lakes are within the Koramangala-Challaghatta watershed.

The lakes in the area of study show prominent levels of pollution, most of the lakes are abandoned and also are sewage fed. All the lakes considered for the study have high rise developments, and various other buildings in the buffer zones.

About 80% of households in this neighbourhood are dependent on Ground water resources (17).

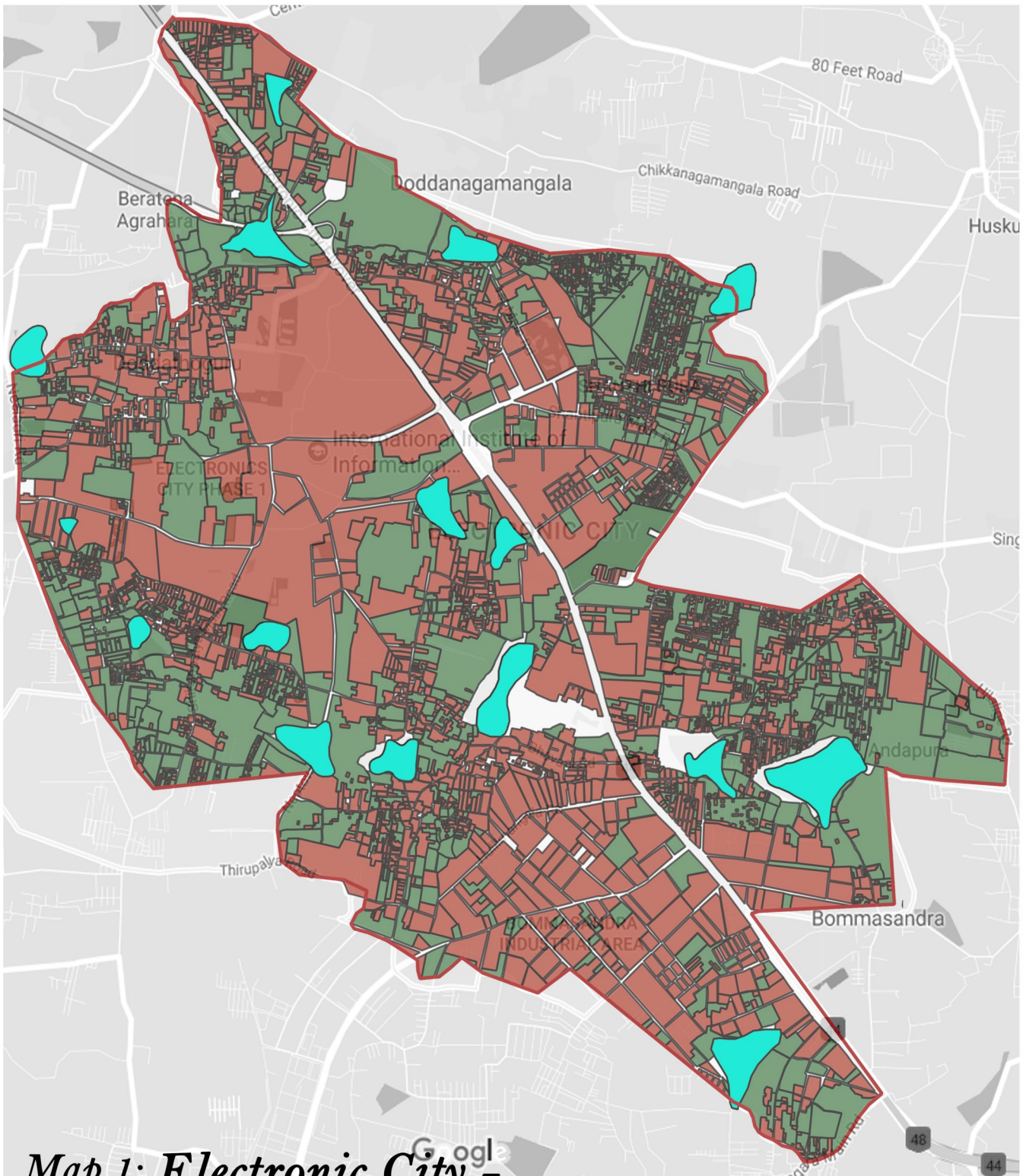


References

Image: Google Maps

17. Karnataka State Pollution Control Board : Domestic Water in Bengaluru: From where? To whom?

5.1. Land Use Analysis



Legend

- Built-up area*
- Unbuilt space*
- Waterbodies*
- Electronic City Boundary*



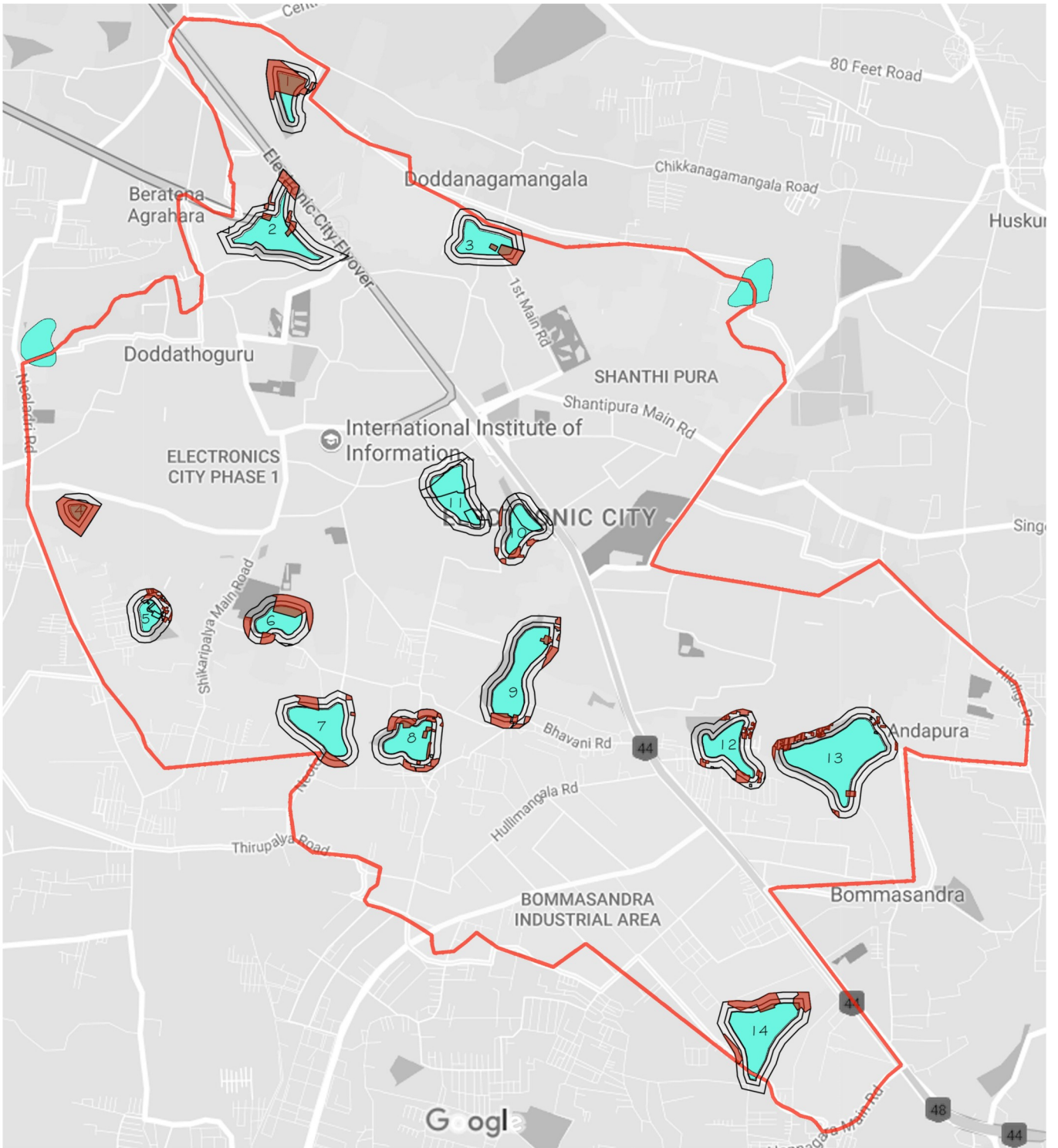
Figure 8: Electronic city- Ratio of Built-up to Unbuilt area.

The lakes this project focusses on are present among a mix of various land uses ranging from small scale residential, high rise residential buildings, commercial spaces, and Information Technology Companies. Table 2 summarizes the area covered by the built up and unbuilt land and the total area encroached within the 75m buffer specified by the National Green Tribunal for the Lakes in Electronic City as shown in Figure 8. From the map and table, it can be inferred that about half of the neighbourhood is covered by concrete structures and a comparable area of land also remains vacant.

53% of the neighbourhood area is built-up whereas 42% remains unbuilt; and about 5% of the entire neighbourhood is covered by waterbodies.

| | |
|--|---------------|
| Total area of Electronic city | 6522.58 Acres |
| Total Built-up area | 3117.35 Acres |
| Total Unbuilt area | 2466.25 Acres |
| Area of water bodies | 260.77 Acres |
| Total encroached area within the 75m buffer of the | 118.99 Acres |

Table 2: Built-Up Vs. Unbuilt land in Electronic City



Map 2: *Electronic City - Encroachment analysis within 75m Buffer Zone*

Legend

- Encroached land within 75m buffer zone*
- Electronic City Boundary*
- Waterbodies*

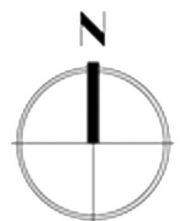


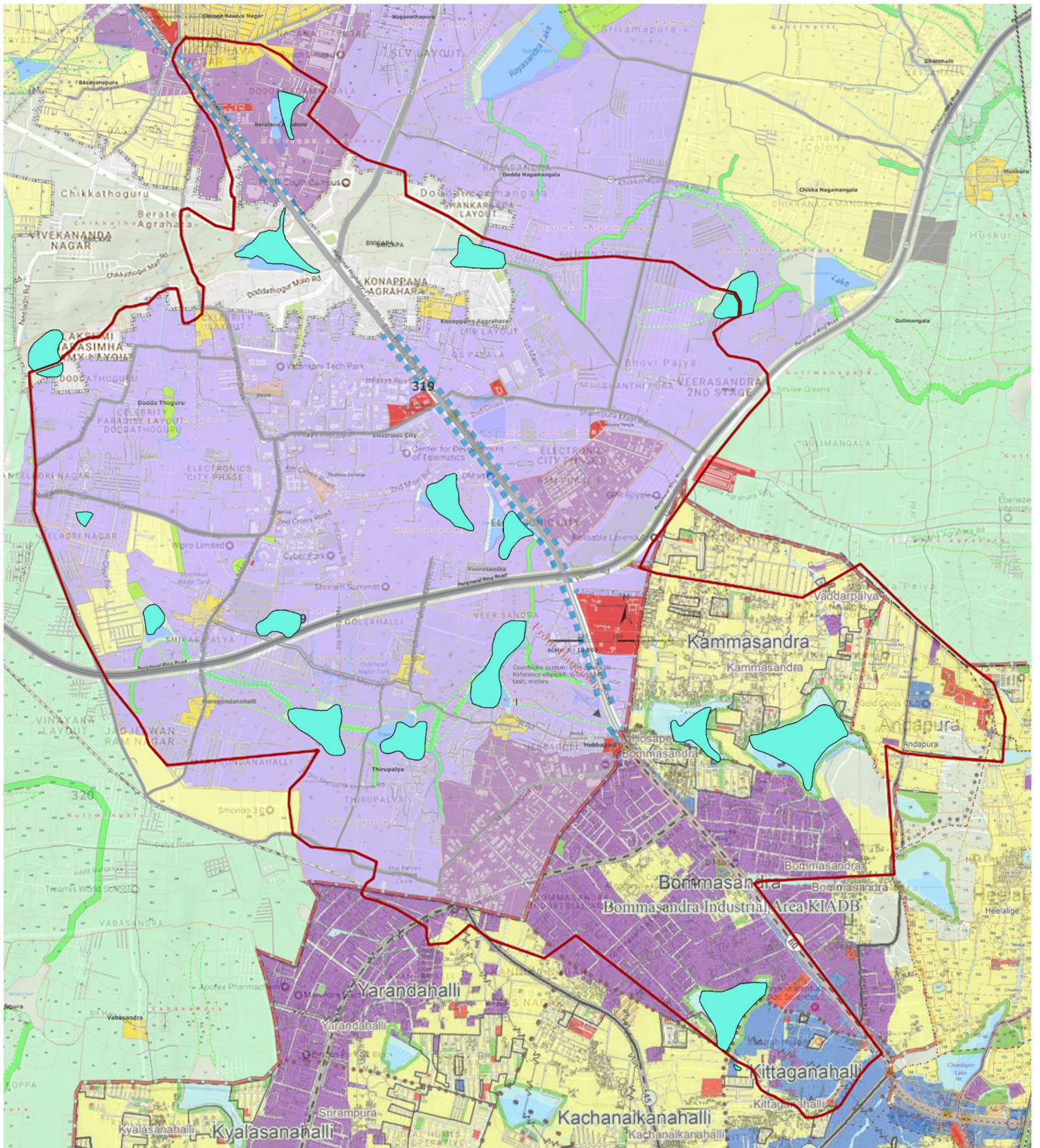
Figure 9: Electronic city- Encroachment within the 75m buffer zone

The Bangalore Development Authority (BDA) Comprehensive Development Plan for the City recommends maintaining a 30-meter buffer around water bodies, while, the National Green Tribunal recommends a 75-meter buffer. An analysis of the areas covered by the lakes and the buffers is presented in Table (3)-

| Lake | Area of waterbody (in acres) | 30m Buffer area (in acres) | 75m Buffer area (in acres) | Encroached area within the 75m. buffer | Land uses around ⁽¹⁷⁾ |
|------|------------------------------|----------------------------|----------------------------|--|-------------------------------------|
| 1 | 8.20 | 7.79 | 22.33 | 12.99 | Industrial, Residential |
| 2 | 22.24 | 15.25 | 42.15 | 5.97 | Uncategorized land |
| 3 | 15.83 | 8.9 | 24.99 | 4.06 | Industrial, uncategorized land |
| 4 | 2.44 | 3.71 | 12.31 | 11.95 | Industrial, Residential (mixed use) |
| 5 | 6.50 | 5.28 | 15.86 | 3.14 | Industrial, Residential |
| 6 | 12.23 | 7.46 | 21.29 | 11.53 | Industrial |
| 7 | 23.20 | 10.70 | 29.48 | 5.60 | Industrial |
| 8 | 16.69 | 9.0 | 25.07 | 8.72 | Industrial |
| 9 | 28.44 | 13.50 | 36.56 | 7.49 | Industrial |
| 10 | 11.01 | 7.84 | 22.26 | 9.99 | Industrial |
| 11 | 18.24 | 9.77 | 26.8 | 17.92 | Industrial |
| 12 | 15.37 | 10.69 | 29.16 | 4.42 | Residential (Main) |
| 13 | 48.66 | 16.10 | 42.94 | 4.87 | Residential (Main), Industrial |
| 14 | 31.64 | 13.32 | 36.61 | 10.34 | Industrial, Residential, Commercial |





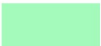

Total encroached area = 118.99 acres

Table 3: Area and buffer zone areas of lakes in Electronic City



**Map 3: Electronic City -
Land Use Map**

Legend

- | | | |
|---|---|--|
|  Industrial |  Waterbodies |  Public/Semi-public areas |
|  Residential |  Green Space |  Electronic City Boundary |

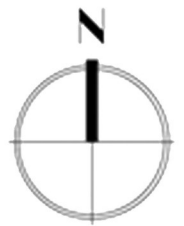


Figure 10: Overlay of Land uses with Lakes- Electronic City

References

17. Land use map courtesy : Bangalore & Anekal Revised Master Pan 2015

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Figure 10 shows the land use distribution in the neighbourhood of Electronic City. The percentage distribution of land uses is as shown in Table 3-

| Land use | Area in Acres | % of area covered |
|-------------------------------|----------------------|--------------------------|
| Residential (Main) | 818.47 | 12.54 |
| Residential (Mixed) | 60.08 | 0.92 |
| Mutation Corridor | 50.26 | 0.77 |
| Industrial | 4480.11 | 68.68 |
| Public and Semi Public | 83.58 | 1.28 |
| Green (Parks and Open Spaces) | 8.78 | 0.13 |
| Traffic and Transportation | 596.38 | 9.14 |
| Commercial | 424.92 | 6.51 |
| Total | 6522.58 | 100 |

Table 4: Land use Analysis of Electronic City (18)

From Table 4, it can be inferred that a major part of the neighbourhood is covered by Industrial land use. From the map, it can also be inferred that most of the lakes considered for the study are also in close proximity to the Industrial areas.

The next land use type to cover the maximum area would be the Residential land use; also, one of the commonly found land use types in close proximity to the lakes. the residential areas consist of residential developments of various scales ranging from high rise to small scale single family homes .

An interesting find from the analysis of land uses within the neighbourhood shows that only 0.13% of land is allocated for parks and other open spaces.

References

5.2. S.W.O.T.

Strengths

- High ratio of commercial/ industrial land use.
- Presence of residential population.
- Low encroachment rates in the southern part of the neighbourhood..
- Temporary working population in the neighbourhoods.

Weakness

- Encroachment of lakes for informal settlements.
- High ratio of built up spaces as compared to open spaces.
- Traffic issues due to the presence of IT companies.
- Limited funding through BBMP/BDA-enough to carry out rejuvenation and fencing.
- High levels of air and water pollution.

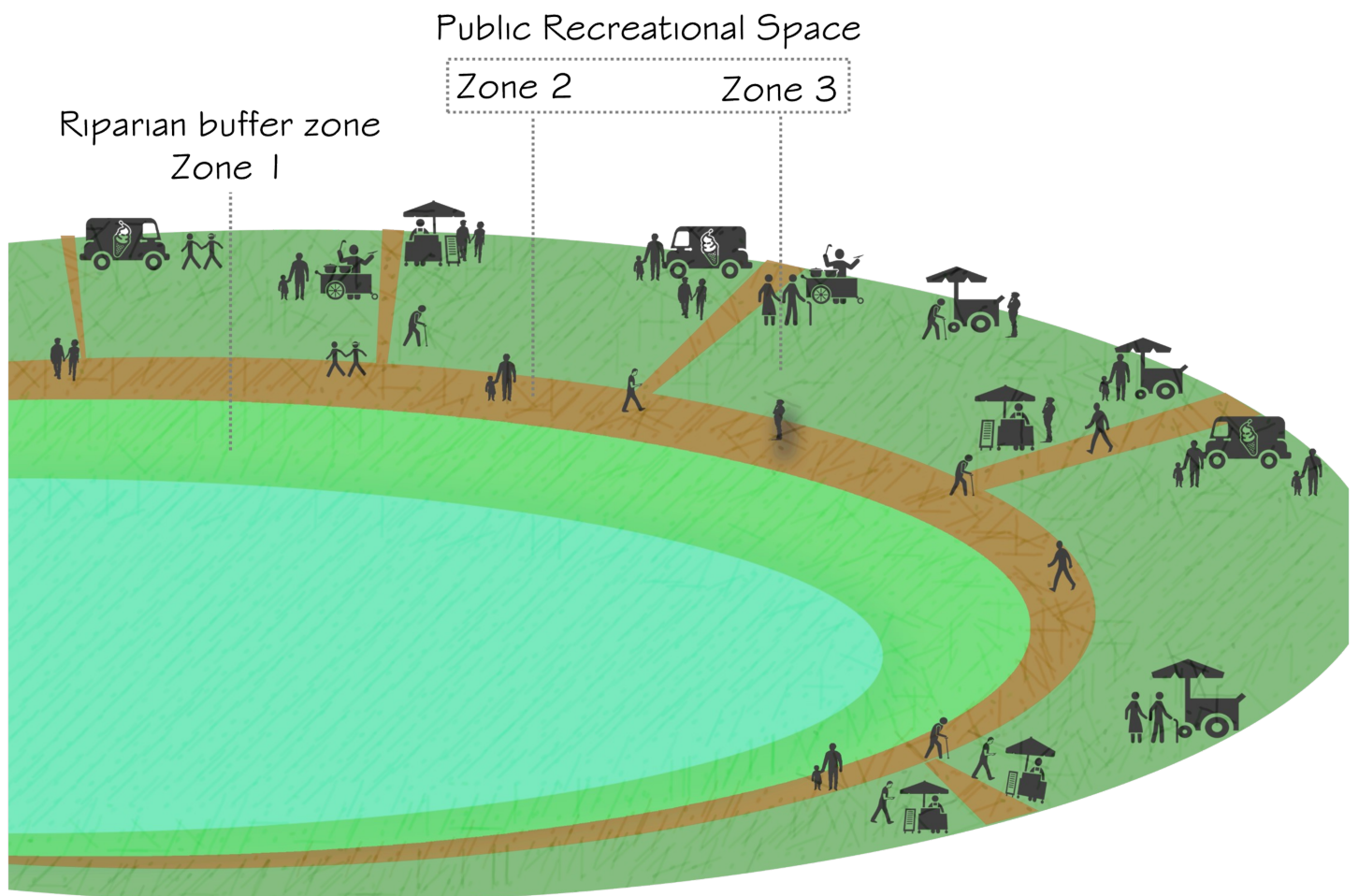
Opportunities

- Less ratio of parks and open spaces.
- Funding available through CSR from the IT companies.
- Well- connected road network .
- BDA and NGT regulations for lake buffers.
- Temporary population and the young population provides opportunities to bring in new business.

Threats

- opposition against the removal of informal settlements.
- Petitions filed by residents against the removal of buildings on the buffer zone.
- Non adherence to buffer zone laws.

6. Lake Buffers as Public Recreational Spaces



6.1. Why are Buffer Zones Important?

Well maintained Buffer Zones



Slow run-off



Filtration of pollutants



Preserve Bio-diversity



Maintain the health of waterbodies

Lake buffers play a significant role in maintaining stream flow, mitigation of floods, and ground water recharge and most importantly they maintain the health of water bodies. The plants present along the buffers help in controlling non-point pollution and improve water quality by purifying toxic substances and pollutants from run-off water ⁽¹⁹⁾.

In Bangalore, as mentioned in the current conditions of lakes chapter, 98% of the lakes are encroached and have buildings in the area ⁽²⁰⁾. All the 14 lakes considered for analysis in the Electronic City region have encroachments with a total of 118.99 acres of encroachment within the 75m. buffer zone.

These encroachments render the buffer zones impermeable and reduce the infiltration capacity, leading to storm water run off on the streets. In order to ensure the infiltration of storm water and prevent polluted water from entering the main water body, it is essential to maintain a riparian buffer zone around all lakes.

The riparian buffer zone would aid in slowing run off, reducing erosion, and supports bio diversity in the lake eco system. This zone mainly consists of grass, shrubs, trees and other vegetation. These plants help in maintaining the health of waterbodies by purifying toxic substances and pollutants from run-off water ⁽²¹⁾.

Transforming the buffer zone into public recreational space provides further opportunities for public involvement, additional funds through local businesses and also ensures better maintenance of the lake ecosystem as discussed in the further chapters.

References

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21. *ibid* 19 pg7

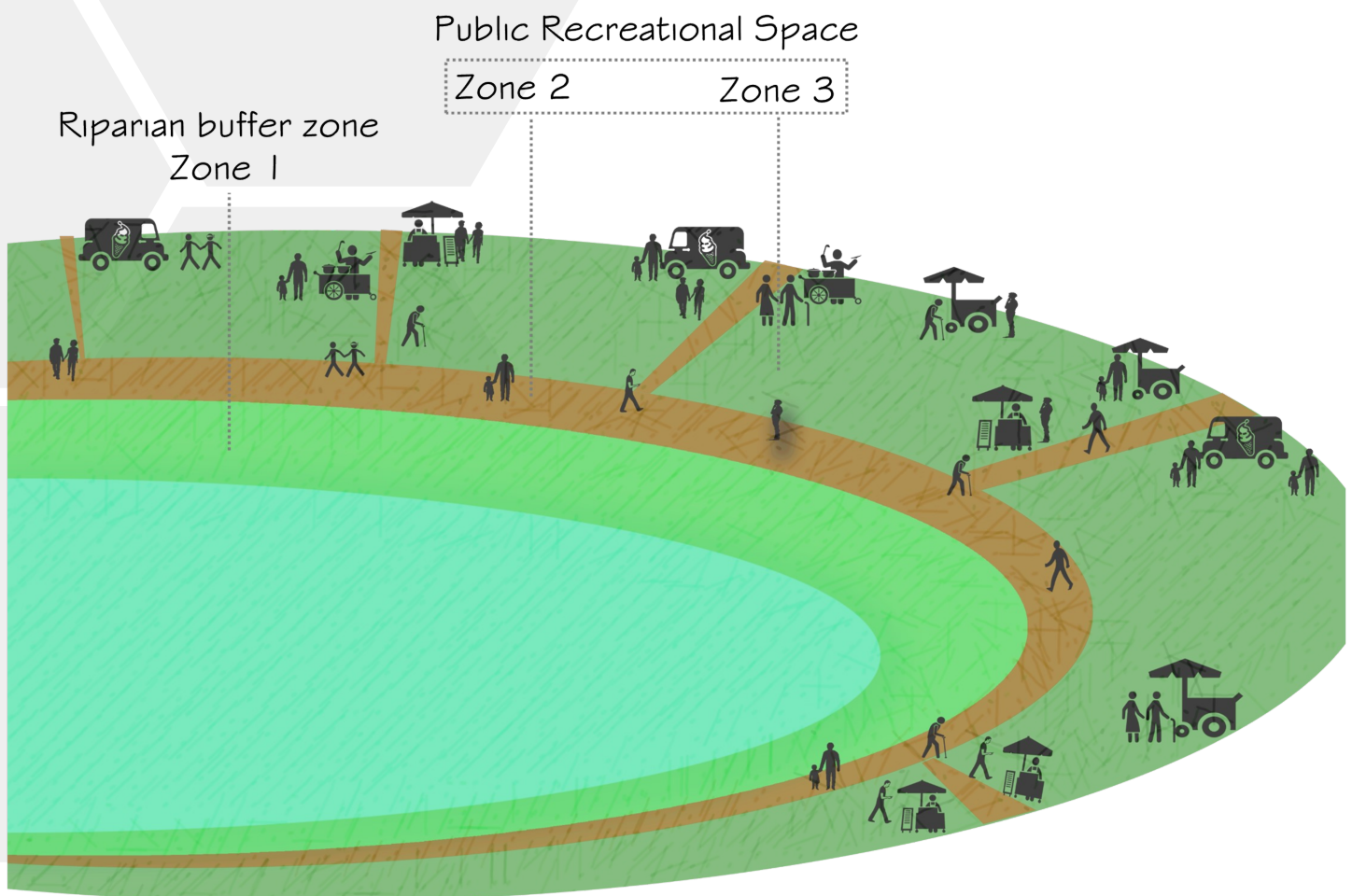
6.2. Recommendations

The recommendations for the lakes of the IT neighbourhood of Electronic City are structured keeping in mind the community and the health of the lakes. The lake buffer area is divided into three zones-

Zone 1 – Riparian buffer zone.

Zone 2- walking track.

Zone 3 – park with recreational activities.

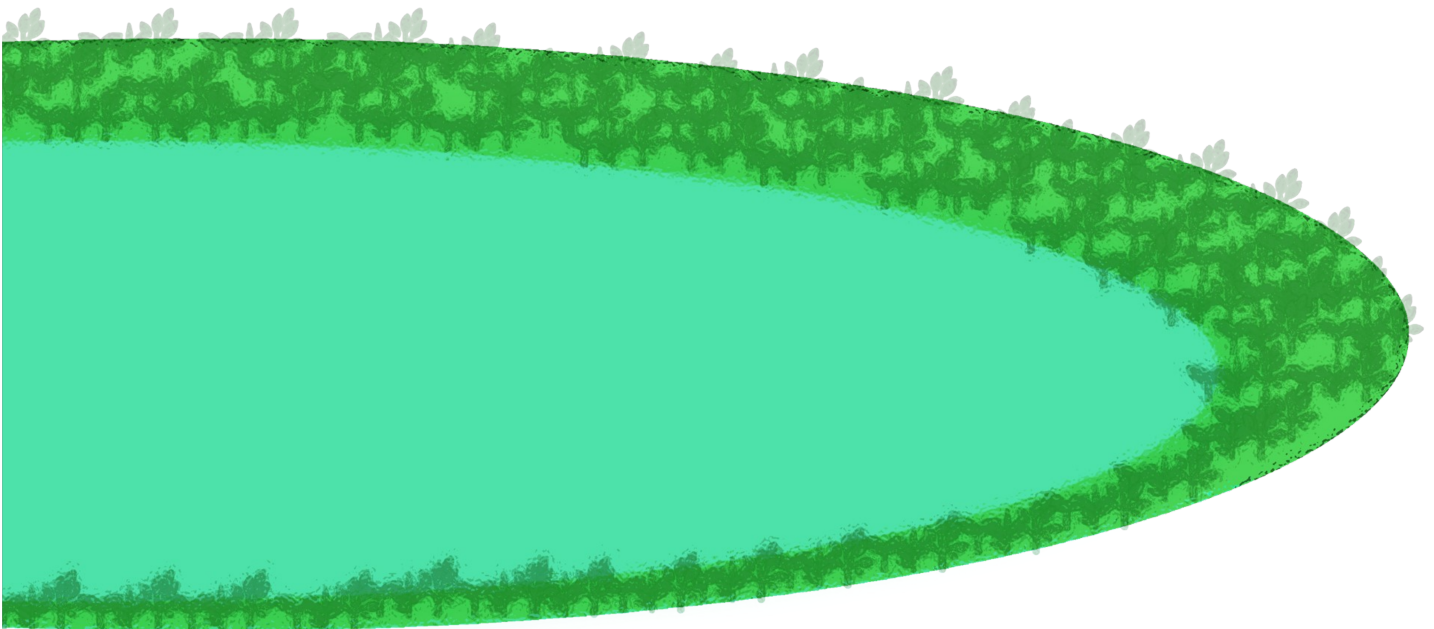


Riparian vegetation- constructed wetlands with local macrophytes and algae.

The vegetative zone has two main parts, Macrophytes and Algae. The wastewater entering the Sewage treatment plant passes through the vegetative layer for the next level of filtration. This zone between the water body and the land is significant transition zone and aids in the recharge of ground water aquifers and stabilization of shores ⁽²²⁾. This zone is integral in slowing run-off, supporting bio-diversity, and reducing erosion.

The native macrophytes and algae help in the treatment of waste water due to their ability to filter out nutrients and heavy metals. Macrophytes act as a filter and aid in the removal of suspended matter; the Algal pond treats waste water by natural oxidative processes. Treatment of waste water through this system helps the treatment system in the complete removal of nutrients and bacteria.

Most of the lakes in the neighbourhood show prominent level of pollution, have sewage directed into the lakes, construction debris is dumped in lakes, among many other issues. Construction of an active wetland site with macrophytes and algal pond in addition to sewage treatment plant would help in purifying the water and provide drinking water to the residents; specially since a large amount of the neighbourhood is dependent on ground water resources (borewells).

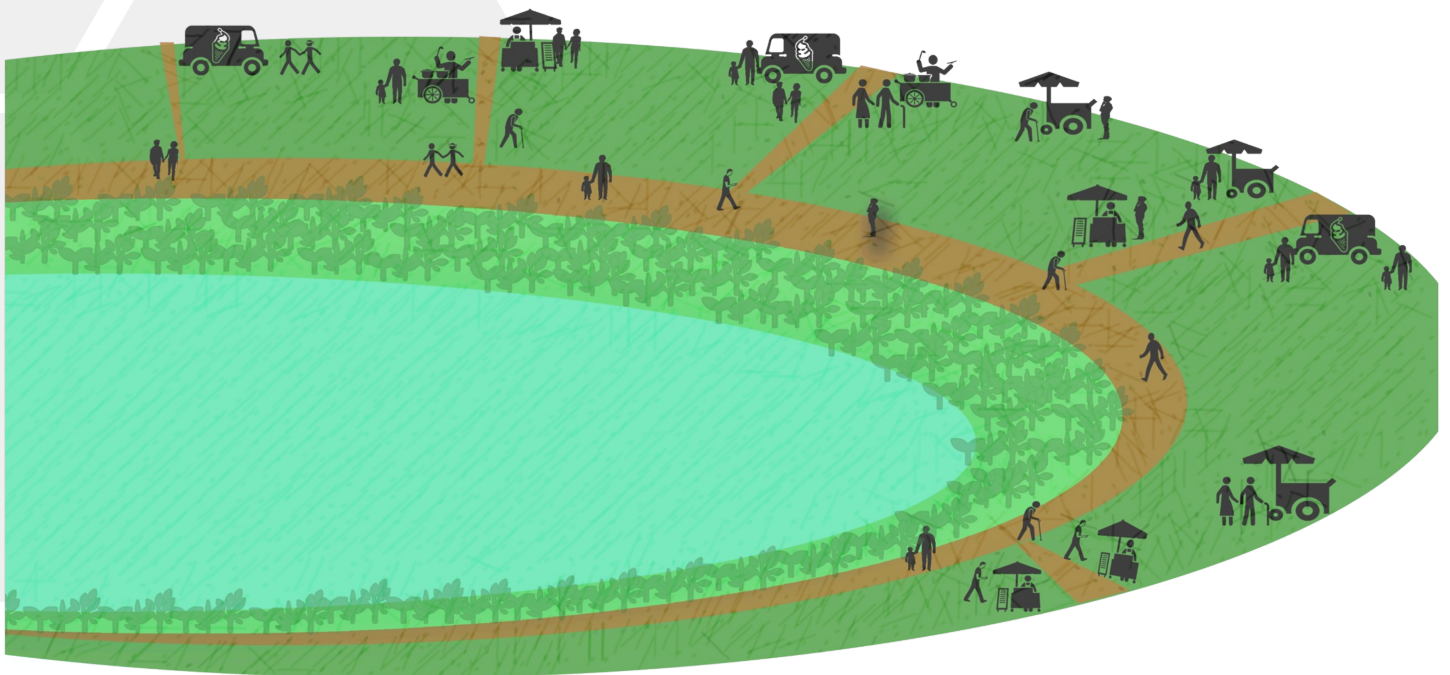


Developing the lake zones as public recreational spaces.

Land use analysis of the neighbourhood indicates that a large part of the neighbourhood is covered by built up spaces as compared to open spaces. Most of the spaces around the lakes, that are meant to be maintained as buffer zones are covered by buildings; this space would otherwise aid in maintaining the health of the lake.

The national green tribunal specifies the maintenance of a 75m around all lakes and the Bangalore Development Authority specifies the maintenance of a 30m buffer; both of these regulations have been violated around many of the lakes.

According to studies, an approximate width of 30m would be required as a functional space with riparian vegetation around the lakes; adding an extra 45m would provide the opportunity to develop the added buffer zone as a recreational space. Involving the public in the activities of the space would inculcate a sense of ownership among the residents of the neighbourhood.



Recommendations for the recreation space include-

i. Walking track

Lakes that once served as sources of water, have now evolved to be spaces of recreational values in addition to providing domestic water. Many well developed and preserved lakes such as Sankey and Ulsoor lake serve as places of recreation and support activities such as boating etc. Most of the spaces such as parks are mostly used for fitness activities such as walking and running during specific times of the day.

Introducing a walking track in the buffer zone of the lake would bring in significant number of residents to the lake and encourage recreational activities while also enhance stakeholder engagement.

Land use analysis of the neighbourhood shows the ratio of built up spaces to open spaces; and the location of many industrial spaces in proximity to the lakes and residential buildings in the designated buffer zones. BBMP is running demolition drives to remove all the buildings encroaching the lake buffer zones and lake beds and has been successful (chapter 5.2). Developing the buffer zone as a public recreational space would ensure the maintenance of the lake and add to the recreational value of the neighbourhood.

ii. Space for food carts with seating

Many lakes, parks and other outdoor recreational spaces have food carts and other eateries along the nearby streets; obstructing the traffic flow on the streets. Having designated areas for food carts within the buffer zone of the lakes would relieve the high traffic neighbourhood from the traffic woes and also generate funds for the maintenance of the lakes. As most of the population in the neighbourhood consists of the employees working in the IT companies, the area with food carts and outdoor seating would be highly utilized.

Many NGO's on the city could also utilize the space to carry out their social development activities like collecting donations, running education drives etc.

iii. Educational center

After BBMP recovers the encroached areas, the lakes are handed over to Non-Governmental Organizations for their maintenance and development. Having an educational center or encouraging awareness activities in the vicinity of the lakes and educating them about the importance of lakes for the city of Bangalore would encourage the residents and the temporary population to care for the lakes and stay involved in the lakes campaign.

iv. Children's activity center and play area.

The need for a recreational space in the neighbourhood also calls for the addition of a designated children's activity and play area. This addition would also provide an opportunity to involve and educate the children and teens in the area in the lakes campaign. Organizing regular tours of the space would keep the children and their families involved in the lakes campaign.

6.3. How is the Recreational area Beneficial?

The case study of integrated wetlands ecosystem model for Jakkur lake shows the importance of macrophyte buffers, algae in the filtration of water before entering the sewage treatment plant.

The above-mentioned recommendations for the lake buffer zones would benefit the lakes and the neighbourhood in the following ways



Improved public access = better maintenance

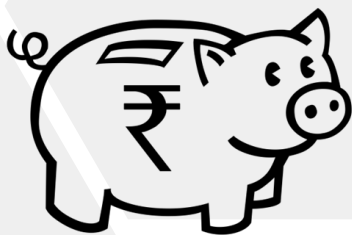
Improved public access = increased public involvement and better maintenance of lake

Having a second zone of buffer with seating area, green space and walking tracks offers more access to the public and the users perceive the area as a destination rather than just another water body.

Bringing in more users into the space would give

the users a sense of ownership towards the area, and would eventually add value to the waterbody and its buffer zone.

Organizing various activities for people of different age groups to create awareness about the importance of waterbodies to the neighbourhood and the city. Public perception of the lake as a destination for recreation would ensure better maintenance of the lake and its buffer region.



Additional funds through business

Additional funds generated through local food business

Having designated areas for local food, and other stores within the buffer zone brings in public and also generates funds for the NGO's for the maintenance and operation of the waterbodies in addition to BBMP and other Government funds. Having the business owners to contribute a small portion of their income towards the maintenance and operation costs either in terms of taxes or rent would ensure the flow of funds throughout the year.

An advantage of the recreational space in the neighbourhood of electronic city is the presence of industrial zone, mainly the information technology industries, both small scale and large scale. This zone of the neighbourhood brings in a relatively high number of working population from other parts of the city; who would add to the list of users of the recreational



Increased awareness

Awareness among the residents = increased stakeholder

engagement

The weather conditions of Bangalore make the city a perfect place to host outdoor activities throughout the year. Organizing activities such as quiz, debates, etc for different age groups would bring in more people and funds eventually.

Organizing tours for school children of the lake regularly would also aid in the perception of the lake area as a destination and would also educate the children about the history and importance of lakes to the city and the importance of maintaining healthy and functional buffers around the lakes.

6.4. Funding

The city corporation, BBMP has been running demolition drives to free the lakebeds of encroachment; after removing the encroachment, the lakes are rejuvenated and fenced and the lakes are taken over by non-governmental organizations for further maintenance and operation.

To implement the recommendations, the lake activist groups and NGO's would require more funding. Here are some of the funding streams that the NGO's can tap into other than the BBMP funding -


Corporate social responsibility funding (CSR)

In India, the spectrum of CSR includes various initiatives such as, human rights, safety at work, consumer protection, climate protection and environmental care and sustainable management of natural resources ⁽²⁵⁾.

Many companies have taken up initiatives mainly focussing on poverty alleviation, environmental protection, and sustainable development ⁽²⁶⁾.

One of the crucial issues Bangalore faces is water pollution and scarcity of water; which is a major environmental and social concern the City needs to address immediately. The lakes are one of the major sources of water for the city, these lakes also help maintaining the micro-climate. Electronic City, houses about 200 IT companies and is the largest industrial Technology hub of Bangalore ⁽²⁷⁾; most of which are subsidiaries of foreign companies which earn relatively high revenues annually. A regional approach to the CSR strategy would aid in bringing in donations towards the lakes campaign in Bangalore. This would also create many temporary employment opportunities by involving the local workforce in the planting and maintenance activities that are a part of the lake rejuvenation process, and investing in local food businesses that would thrive within the lake recreational space would provide encouragement to local businesses.

Bringing in the CSR donations of Bangalore for the rejuvenation and development of lakes would be highly beneficial to both the local residents and the city.

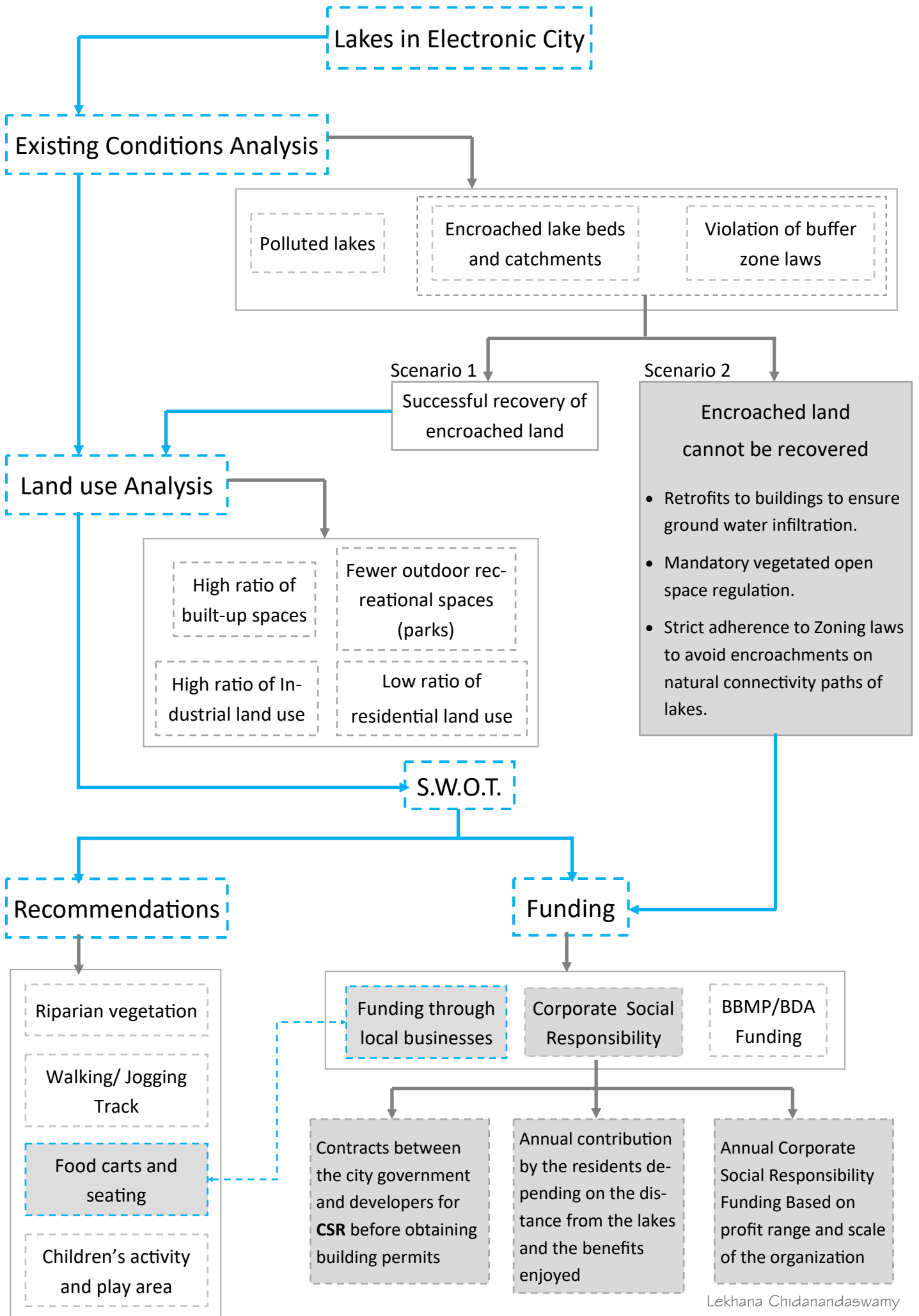


Funding generated by bringing in local businesses and residents

The local businesses in the lake recreational region also would contribute towards the maintenance of the lakes and the buffer zones associated with them. Their contribution would be in the form of renting a certain square foot space in the buffer area, or annual net profit contribution depending on the type of business.

Most of the existing and upcoming high rise residential developments in the neighbourhood are implemented by the local real estate companies. These companies should be mandated to contribute towards the lakes campaign depending on the proximity as the people living in these areas would enjoy the most benefits as compared to the residents in a distant neighbourhood.

6.4. Process Diagram



7. Conclusion

Bangalore city has been through many changes especially in terms of growth. The city has evolved to be one of the largest Metropolitan regions of India. The immense growth rate has impacted the city's landscape in both positive and negative ways. One of the striking issues being water scarcity.

The lakes that previously played an important role in providing domestic water needs, have now been polluted to an extent to catch fire.

One of the reasons for the deterioration of the waterbodies is the lack of active public involvement . Transforming the lakes into public recreational spaces brings in more users and would eventually ensure better maintenance of the lake regions.

Corporate Social Responsibility in India follows a wide spectrum of environmental and social issues. Including the lakes campaign in the social and environmental issues would greatly benefit the city of Bangalore.

Transformation of lake buffers into public spaces benefits the city in many ways if the encroached land is recovered with strong contingency plan by the City Authorities (BBMP). This transformation would benefit the city in many ways including protection of city's water resources, maintenance of buffer zones, and also creates job opportunities.

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Abbreviations

1. BDA – Bangalore Development Authority
2. BBMP – Bruhat Bengaluru Mahanagara Palike
3. NGT – National Green Tribunal
4. CSR – Corporate Social Responsibility.
5. IISc.- Indian Institute of Science.