INVESTIGATING THE RELATIONSHIP BETWEEN URBAN LAKES AND LAKE COMMUNITIES: A CASE OF BENGALURU, INDIA

Kirti Parvati[1] Dr. Ajai Chandran C. K[2]

1. Ph.D. Scholar at Christ University, Bengaluru, Karnataka, India

2. Professor at Christ University, Bengaluru, Karnataka, India.

Abstract

This Paper examines the Relationship between Urban Lakes and Lake communities in the context of Bengaluru. In various parts of the world, a rapid urbanization process is taking place that generates numerous impacts on societies and the environment. In this process, the worst hit sectors are the urban commons, and the urban lakes are the most critical commons affected by Urbanization. Urban lakes are fragile and highly productive ecosystems, an essential source of fresh water. They perform various functions and play multiple roles in society. We cannot imagine our planet without these waterbodies in future generations. The lakes and lake communities are both inseparable entities. The community interface is an essential aspect of a lake ecosystem. The anthropogenic activities, i.e., the human interventions with nature, are increasing daily, causing ecological imbalance. For lakes to be used sustainably, people and the environment must live in harmony (CPHEEO). It is the responsibility of the surrounding lake communities to take care of the lake ecosystem and utilize the ecosystem services in the right manner. The study deals with understanding the bonding between lakes and the surrounding lake communities. The intention is to identify how local lake communities perceive the lake ecosystem as a whole and the repercussions of Urbanization on both lake ecosystems and surrounding lake communities, also assessing the potential for future developments that have evolved historically and transformed rigorously. The Paper aims to formulate self-sustainable lake and lake communities and strategies for the holistic development of lake communities.

Keywords: ***Urban lakes, Urbanization, Lake Communities, Anthropogenic activities, Ecosystem, Self-sustainable***

I Introduction

"Cities are not just brick and mortar; they represent societies' dreams, aspirations, and hopes."

UN-Habitat (2008)

Urban water bodies like lakes are tightly woven into the fabric of a city, and social and cultural considerations play a crucial role in managing water resources in urban environments (UNEP,2000).

For instance, two crucial cultural aspects impacting water resource management in cities and urban lakes are urban architecture and resident lifestyle (Marsalek et al., 2006). In addition to their aesthetic, historical, and cultural significance, urban lakes are valued for a variety of reasons, including their utility as a drinking water reservoir, for groundwater recharge, transportation, recreation, and environmental value (UNEP, 1994; Snehal & Unnati, 2012).

Due to deteriorating water quality, many urban lakes in Asia are thought to be losing their original purpose for which they were built, frequently as a supply of drinking and irrigation water (Nagendra & Ostrom, 2014; Kora et al., 2017). Polluted water bodies eventually lose their appeal to current and prospective users, hindering attempts to protect and improve them (Unnikrishnan et al., 2016). Natural resources near urban areas are seriously threatened by the rapid Urbanization that is taking place in many regions of the world, including India. The land became more and more in demand. This was addressed by growth in peri-urban areas and encroaching on urban neighborhood's green spaces. Green places, parks, open areas, and water bodies were among them. Urban lakes and ponds in and around urban areas were the hardest affected by this process. All of this led to the majority of urban lakes disappearing. The disappearance of lakes has threatened agricultural activity, the livelihoods of fishermen, the environment, and recreational pursuits. It has also resulted in the loss of irrigated lands and drinking water sources. Water hyacinths, aquatic plants, and encroachments have made the existing lakes unusable as drinking water supplies.

These no longer can absorb floodwater, giving rise to the new occurrence of "Urban Floods." Urban flooding is wreaking havoc in cities due to the absence of natural drainage processes. Bengaluru is no exception to these trends and, compared to many other cities throughout the nation, is significantly worse. The city has no perennial river, so it must survive on the lakes. The urban lakes are surrounded by lake settlements or urban local communities, which are communities of people who live near the lake and depend on the lake ecosystem for their livelihood. These settlements often include small businesses, such as restaurants, marinas, and boat rental services. They may also include residential areas, parks, and other amenities.

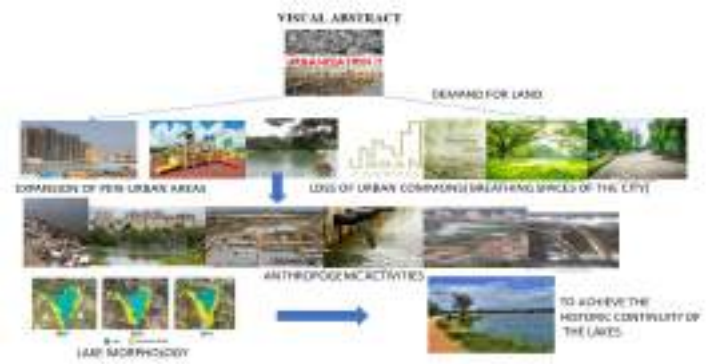

Fig 1 Visual Abstract depicting the urban ecosystem

The above visual abstract depicts the impact of Urbanization on urban land and urban commons like parks, open spaces, and waterbodies, and the worst-hit sectors of lake ecosystems.

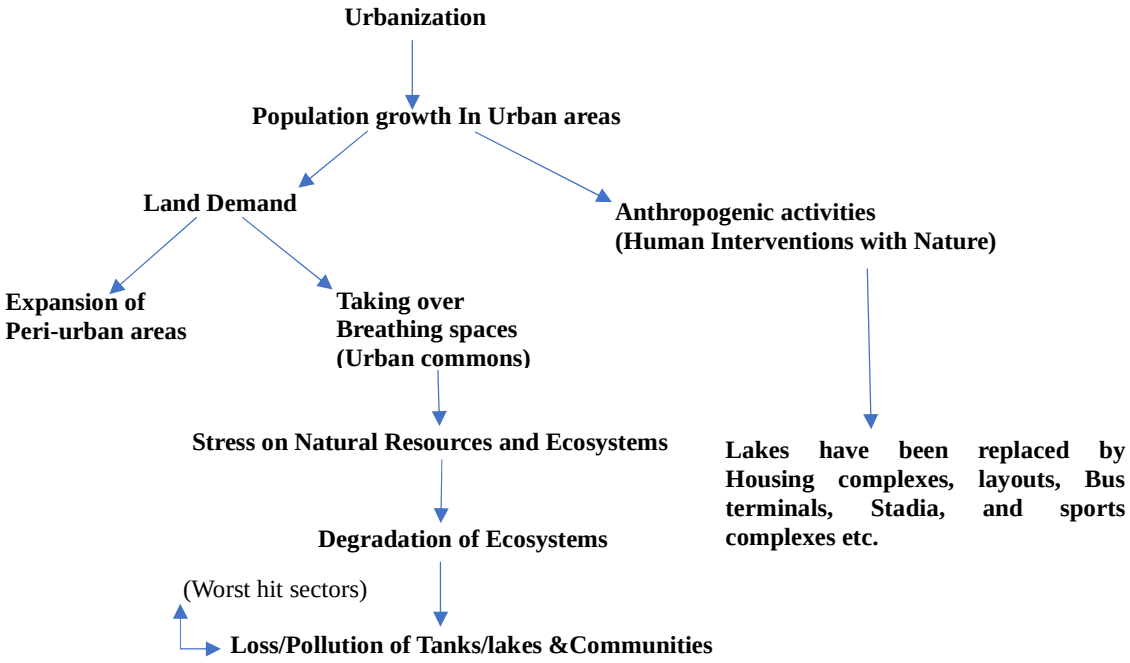

Fig 2 The Dynamics of Urbanization and its impact on the ecosystem
Source: Researcher's own schematic sketch, Ref: Social and Economic Change Monographs (ISEC, Bengaluru 2009)

1.1 History of Water and Early Settlements

The early settlements grew near the river valleys, as fresh water and fertile land were available. Human settlements became more significant with trade, commerce, and manufacturing development. The settlement flourished, and civilizations developed near river valleys. A river gives the inhabitants

a reliable source of fresh water for drinking and agriculture. Additional benefits include fishing, fertile soil, ease of transportation, and favourable climatic conditions that helped their crops to grow. So, living near the rivers made it convenient for people to perform day-to-day activities for survival. The first great civilizations formed on the banks of rivers were the Ancient Egyptians, who were based on the Nile, and the Mesopotamians in the Fertile Crescent on the Tigris/Euphrates rivers—the Ancient Chinese on the Yellow River, and Ancient India on the Indus. As time went on, waterways began to serve more purposes. Rivers, lakes, and seas began to be used for transportation. People built boats and started exploring the area around them. People began to build homes where they could be close to food and supplies. Larger towns and cities began to spring up along trade routes.

The relationship between water and settlements has existed since ancient civilizations. Even today, this relationship exists between water and the surrounding settlements or communities. Intense Urbanization and overcrowding in the city have negatively impacted the waterbodies and the surrounding communities.

1.2 History of Lakes

Water is essential for human survival and the growth of cities (Nature in the City by Harini Nagendra). As early as 300 B.C., the communities of Karnataka were knowledgeable about tank construction methods and understood the significance of tank maintenance (Vatsala Iyengar, 2004). For a variety of uses, they constructed several tanks and lakes.

Historically, Indians have explored the scientific aspects of rain and water harvesting through lakes, tanks, and ponds. Further significance of construction tanks and lakes is highlighted as "a person who constructs a lake or a tank attains 100 million times more and goes directly to heaven in a fine chariot". Furthermore, since cattle and other animals drink water from the tank, the person who builds a tank is absolved of any sin. Gifting water through the construction of a reliable water source was considered worthy and more critical than having 1,000 children.

During the time of the Western Gangas, the Cholas, and the Hoysalas, lakes were constructed in an effort to save water. A network of natural drainage networks has historically connected these lakes,

and most agrarian villages have gathered around them. According to the Karnataka Lake Conservation and Development Authority Act, 2014, "Lake" refers to any inland water feature that is listed in revenue records as Sarkari Kere, Kharab Kere, Kunte, Katte, or by any other name, regardless of whether it contains water or not.

Lake consists of the main feeder inlet, additional inlets, bunds, weirs, sluices, draught channels, outpu ts, and primary drainage canals in the outlying catchment areas (Raja Kaluve).

Any region needs lakes to conserve water, recharge the groundwater table, and channel water flow to avoid flooding and water logging.

When Sri Kempe Gowda founded Bengaluru 475 years ago, it had a well-developed natural drainage system.

Bangalore used to be known as the "City of 1000 Lakes," a collection of lakes connected by a network of canals (Rajakaluves) that followed the land's natural slope and allowed runoff from one lake to flow through trash weirs into the next, preventing flooding. Through the colonial era and into more recent times, this method could be kept up for a very long time. This has significantly contributed to the city's development of its own microclimate and significant groundwater recharge. Bengaluru was associated with many names like" City of Lakes,"" Kalyana Nagara" (City of Kalyanis), "Pensioners Paradise," "Green City," and "Garden City," etc.

1.3 Relationship between Urban Lakes and Lake Communities

A lake can be defined as "A large area of water surrounded by land." Bangalore was once a city of 1,000 tanks. (Book: Deccan Traverses, Anuradha Mathur, and Dilip da Kunha) The lakes and lake communities are both inseparable entities. Both depend on each other historically, philosophically, Culturally, spatially, socially, ecologically, Economically, and spiritually for their livelihoods and day-to-day lives. The community interface is an essential aspect of a lake ecosystem. The lake is a living organism that sustains the local community, and both will have a sense of belonging. The lake

ecosystem will provide ecosystem services for the surrounding communities, and the communities need to maintain them to have holistic development of both lakes and lake communities.

These urban lakes have an evolving relationship with the city, they are associated with and hold their importance in terms of providing a sense of collective identity, community, and belonging to communities living in close proximity to the lake.

Rapid Urbanization has negatively impacted this relationship between lake and lake communities, which is also a root cause of the ecological imbalance. Bengaluru is no exception to these developments and is even worse than many other cities in the country. Compared to other cities in the state, more tanks and lakes were built in and around Bengaluru. In terms of Urbanization, both Karnataka and the city of Bengaluru have experienced relatively faster growth in India. According to the 2001 census, the state stood fourth in Urbanization. Similarly, the Bangalore Metropolitan Area also has experienced faster growth and Urbanization in terms of area expansion and population.

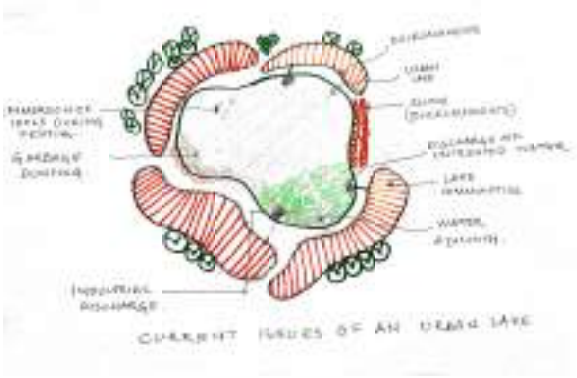

Fig 3 A typical lake ecosystem and its surrounding Lake communities
Source: researcher's own schematic sketch

1.4 Ecosystem Services

The commodities and services that ecosystems offer to humans are referred to as ecosystem services or eco-system services. Any advantageous benefit that people receive from wildlife or the ecosystems is referred to as an ecosystem service. The advantages may be slight or substantial, direct or indirect.

Four basic categories can be used to classify ecosystem services: provisioning, which includes the production of food and water; regulating, which includes the prevention and treatment of disease;

supporting, which includes the maintenance of nutrient cycles and the production of oxygen; and cultu ral, which includes spiritual and recreational advantages.

The term "ecosystem services" first appeared in the 1970s and has grown in popularity over the years. The notion that natural systems promote human welfare, on the other hand, is far older.

According to the United Nations Millennium Ecosystem Assessment (2005), which evaluated the effe cts of ecosystem change, people have rendered Earth's ecosystems incapable of sustaining social welf are.

So, a lake ecosystem is a natural ecosystem that provides ecosystem services beneficial to society. The surrounding lake communities are benefitted to the maximum extent by the lake ecosystem services. Hence, there will be a harmonious relationship between the Lake and the Lake Community. Both will have a sense of belonging and are an inseparable entity. It is the responsibility of the Lake communities to maintain the Lake ecosystem without any damage or harm, and they should always try to maximize the services provided by the Lake ecosystem. This way, Lakes and Lake communities can develop a good rapport or bonding. All the members of the Lake communities should be involved in the developmental activities and upliftment of the lake ecosystem to maximize the services and utilization of the services by the community. This way, the system will develop dependency on each other, and hence, we can formulate self-sustainable communities.

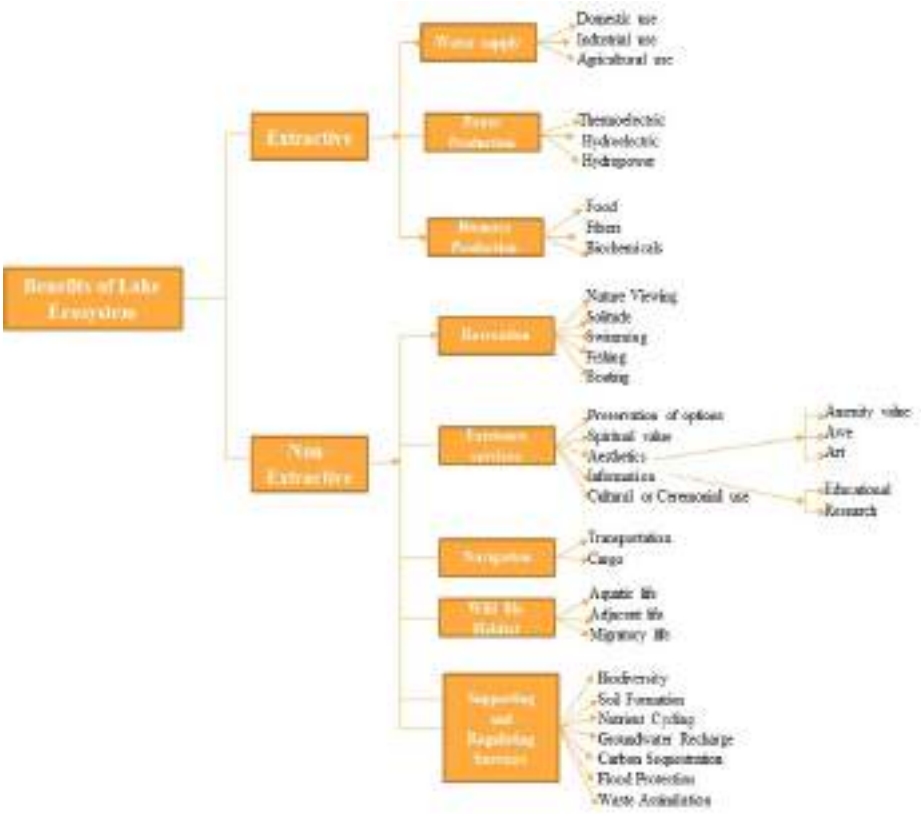

Fig 4 Ecosystem Services in Lakes
Source: Environmental Protection Agency, U.S

1.5 Status of Lakes in Bengaluru

As mentioned before, Bengaluru was associated with many names, including City of Lakes, Garden City, Green City, Pensioner's Paradise, etc. Unfortunately, now it has become a Garbage City due to various reasons. Bengaluru has no perennial rivers; hence, it depends on the local water bodies or urban lakes. It has three Valley systems: Hebbal, Vrishabhavathi, and Kormangala-challaghatta valleys. Each valley has several lake series, consisting of 6-10 lakes that were interconnected once by a robust system of channels called Rajakaluves. Now, due to intense Urbanization, this interconnection is lost. Till 1960, there were 262 lakes, out of which 81 are remaining, in which 34 are said to be live lakes. As per the surveys, by 2050, there will be a massive water shortage in Bengaluru. Bengaluru's naturally undulating landscape, which includes hills and valleys, is ideal for the growth of lake systems.Along the natural gradient, water often flows from north to southeast as well as north to southwest.Due to encroachments, pollution, and fast Urbanization, lakes and tanks in Bengaluru's urb an and periurban districts haveseen notable changes over the past three to four decades, seriously har

ming the lake ecosystem.A thorough assessment of the water bodies in the Bengaluru Metropolitan Ar ea (BMA) was conducted by EMPRI (Environmental Management & Policy Research Institute), coup led with biochemical analyses for 14 important water quality indicators.

The study found that 303 water bodies have solid waste dumps, 261 lakes are polluted according to w ater quality tests, 89 lakes are dried out, and 101 lakes are abandoned due to increased Urbanization (EMPRI, 2017).

Year	Map/Image	Bengaluru City		Greater Bengaluru	
		No. of water bodies	Area (Ha)	No. of water bodies	Area (Ha)
SOI 1973	Map	58	406	207	2342
1973	Image	51	321	159	2003
1992	Image	38	207	147	1582
2002	Image	25	135	107	1083
2007	Image	17	87	93	918

Table 1: Status of water bodies in Bengaluru city limits and Greater Bengaluru (Source; Ramachandra & Uttam,2008)

Fig5.Three major valleys of the BBMP area
Source:ENVIS

Morphology of Bengaluru Lake

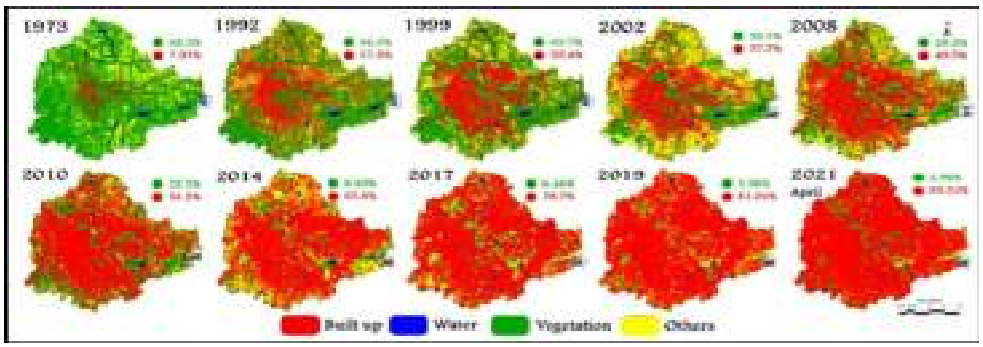

Fig6 Urbanization- Land use changes over five decades
Source: Dr.T.V Ramachandra, IISC, Bangalore

Inference: Most of the waterbodies and vegetation have disappeared and been replaced by built-up space from 1973 to 2021

Fig7 Distribution of lakes within and surrounding Bangalore.
Source: eBook, Urbanization, Biodiversity, and Ecosystem Services: Challenges and Opportunities

Inference: From the above map, we can observe the lack of lakes in the city center, indicating their encroachment and conversion to other land use

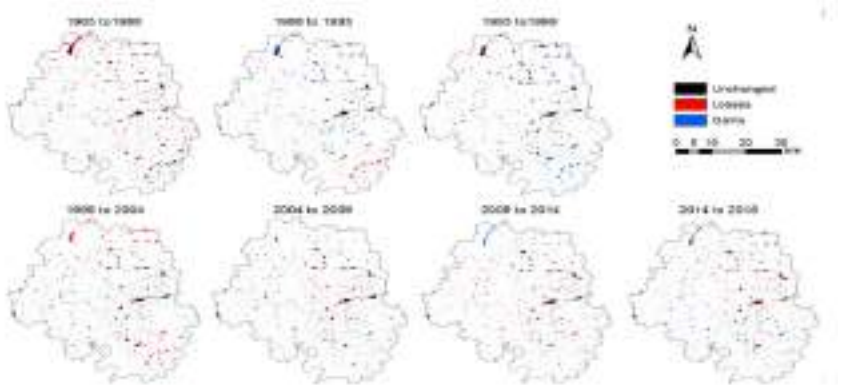

Fig8 Map of losses, gains, and unchanged areas of open water bodies for the different observation periods between 1965 and 2018 in the Bengaluru Urban district, S-India.
Source: Remote sensing MDPI-2020

Inference: In the above map**,** from 1965 to 2018, we can observe more loss in the waterbodies than gains and unchanged water bodies.

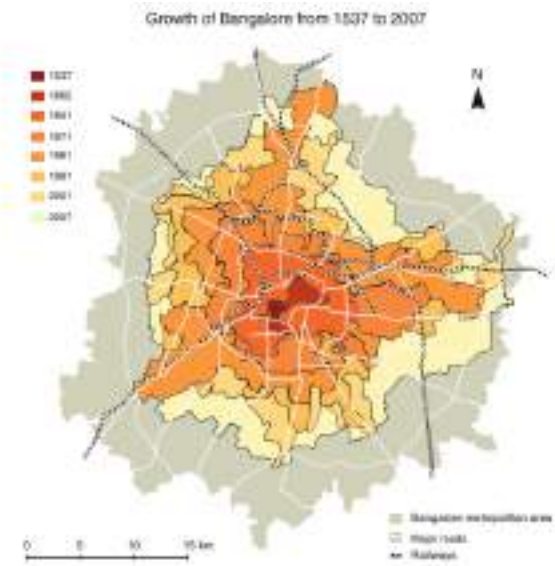

Fig9 Spatial growth of Bangalore from 1537 (red) to 2007 (light yellow) Source: data from Census of India.

Inference: Bengaluru has expanded drastically from 1537 to 2007 (470 yrs.)

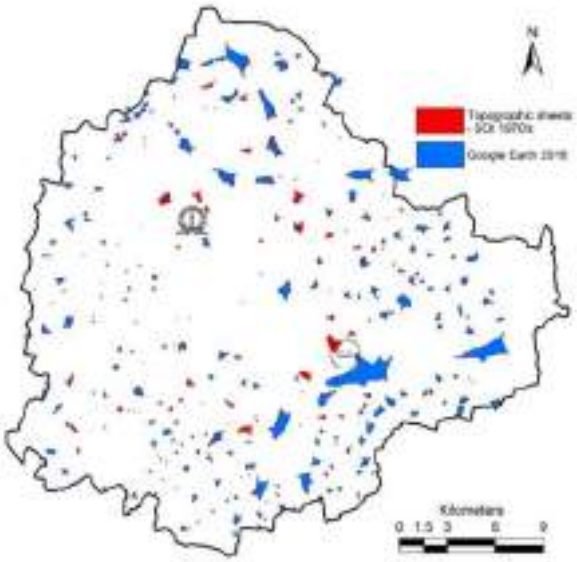

Fig10 Status of Lakes in Bengaluru
Source: ENVIS technical report, IISC 2016 (Red color indicates lost lakes between 1970s 2016)

Inference: We can see that many lakes have lost their lives during the last 46 years

	1970	2016
No.of Lakes in Bengaluru	285	194
The spatial extent of Bengaluru	161 sq.km	741 sq.km
The spatial extent of the Lake cover of Bengaluru	3180 Hectares	2792 Hectares

Table 2: Reduction in water bodies
Source: ENVIS technical report,2016 IISC

Inference: During the last four decades, there has been a **79%** reduction in water bodies. During 1800, the storage capacity of Bengaluru was **35 TMC.** The current capacity of lakes is about **5 TMC,** and due to siltation, the current storage capacity of lakes is just **1.2 TMC.**i.e nearly 387 hectares of waterbodies were lost apart from a reduction in **the storage capacity** by **60%.**

II. Literature Review

An extensive literature review was done to understand and establish the relationship between urban lakes and Lake communities. The literature review reveals that there needs to be more studies and analysis on spatial aspects and the morphological analysis of lakes and lake communities. There is a need for proper interpretation of Lakes and dependent Lake communities and for making the neighborhood lake communities self-sustainable.

Case studies:

Criteria for selection: The ecosystems that involve the society or the local communities to address the societal changes.

1.Kaikondrahalli Lake

Pic 1: Children painting leaves and stones at the Kere Habba (lake festival) of 2015.Pic 2: A group of local residents surveying the lake and identifying locations of water inlet channels blocked by construction.
Source: Restoration of the Kaikondrahalli Lake in Bangalore: Forging a new urban commons by H.Nagendra

Kaikondrahalli Lake is located in the southeast part of Bengaluru and has been managed by MAPSAS (Mahadevapura Parisara Samrakshane Mattu Abhivrudhi Samiti), a resident welfare association through an MoU with BBMP (Bruhat Bengaluru Mahanagara Palike)The lake is having a water spread area of 48 acres. The lake development plan was produced collaboratively with BBMP and the participation of the local communities. The lake facilities include a walkway, children's play area, Gazebo, etc. The lake ecosystem supports the livelihoods of fishermen. The surrounding lake community people were the key contributors to the lake revival, along with the BBMP. The involvement of the local community has been a significant aspect of the maintenance of the lake. An annual lake festival (Kere Habba) is celebrated yearly to create awareness of the significance of lakes and raise funds. During this festival, thousands of visitors participate in various activities, such as Bird walk, Kere run, Puppet show, Storytelling, Photography, etc. Various competitions will be held for children.

2. Jala Poshan: Nurturing the Jakkur Lake

This is a Citizen Participation program initiated by the Satya Foundation to Nurture Jakkur Lake. Jalasevikas are an integral part of Jakkur Lake. All of them are from the local community that has

witnessed the shift of the identity of the lake and has been one of the pillar stones for the conservation efforts. They have contributed to the nurturing of the lake for the past eight years. The lake community volunteers are the backbone of the lake premises to maintain the lake ecosystem and maximize the ecosystem services.

Pic 1 Pictures showing the Jakkur Lake, Jalasevikas, and community volunteers, Source: Jalaposhan Facebook page

III. Development potentials of Lake and Lake Communities

The potential for the development of lakes and lake communities takes priority today. The lakes of Bengaluru are in very bad shape and are deteriorating daily for various reasons. It is the need of the hour to Revive, Protect, Conserve, and Develop the existing and disused lakes in the city. The lake ecosystem and ecosystem services highly impact our communities and vice versa. The lakes and Lake communities are inseparable entities. Both are highly dependent on each other in their daily life. If the

lake communities utilize the ecosystem services effectively by consistently maintaining the ecosystem by all the stakeholders, there will be a harmonious ecosystem development.

The Millennium Ecosystem Assessment (2003) defined ecosystem services as the advantages individuals derive from ecosystems. These services frequently improve human well-being and are essential to life. As a result, they are frequently seen as free and form a part of the global commons. An ecosystem services perspective is a clear recognition of the worth of nature and the fact that this worth can be quantified and used to inform environmental management choices.

Every lake has the potential to offer numerous ecosystem services at once, but the actual output of each will vary depending on the basin's physical features and the quantity, quality, and timing of water flow. The benefits and services provided by the ecosystem will be impacted as manmade effects grow. Managers who want to retain multiple ecosystem services benefits while ensuring overall lake health is maintained may face considerable difficulties. Lake ecosystems have a climatological impact on the local microclimate. In addition, they help to lower the surface radiation and temperature. They also control humidity, preserve soil moisture, and cool the atmosphere. They are used for various recreational purposes, such as parks, gardens, boating, bird-watching clubs, water sports, etc. There are religious structures along the lake margins; tanks are employed for immersion during festivals and other events.

Socially and economically, the lakes can be used to provide jobs through a variety of pursuits, includi ng fishing, farming, recreation, and street vending along lakefronts. The lakes can be utilized in nearby parks and gardens for horticultural and botanical activities, the biological study of ecosystems and their flora and fauna, water supply, sewage treatment, and related activities.

With the above opportunities and services of the lake ecosystem, the surrounding lake communities will benefit in all aspects of the lake ecosystem, and there will be multitudes of potential for the development of lakes and lake communities. The community can be involved in all the activities of the lake ecosystem. It can have ownership of the ecosystem, giving rise to a sense of belonging with the system, hence creating a self-sustainable lake ecosystem- lake communities.

IV Conclusion

Urban lakes and lake settlements or communities are closely related. Lakes provide a source of water for the settlement, and the settlement provides a source of food and other resources for the lake. The presence of a lake can also attracts people to the area, leading to the development of a settlement or a community. In addition, the presence of a settlement or a lake community can help protect the lake from pollution and other environmental threats. Finally, a lake can provide recreational opportunities for the people living in the community.

With significant land-use changes in the recent past resulting in the loss of water bodies, primarily, the prevalence of water bodies and availability of water will be a crucial factor for the city's growth. Anthropogenic actions and Encroachments are the root cause of the degradation of lakes and ecological imbalance. We need to control them with strict guidelines and strategies. There is potential to develop lakes and lake communities, which foster the city's growth.

The lake communities that will benefit from ecosystem services should follow the give-and-take policy. Then, only there will be a harmonious development of the lake and lake community. The lake community should try to maximize the efficiency of the ecosystem services through proper maintenance and utilize the services in the right and equitable manner. This would result in sustainable lake communities. The communities will become socially responsible, economically viable, and ecologically sensitive. This self-sustainable lake community model would become a prototype for other lakes in Bengaluru.

It is necessary to save the lakes for future generations and work on re-interlinking or the cascading of the urban lakes to bring back the legacy of smooth water flow from one lake to another with the Natural gradient system that existed in the 19th century.

V Bibliography

[1]“Bring Back the Lakes Revival of Bengaluru Lakes,” Karnataka Lake Conservation & Development Authority (KLCDA), Bengaluru, Jun. 2016.

[2]P.THIPPAIAH, “VANISHING LAKES :A STUDY OF BENGALURU CITY,” SOCIAL AND ECONOMIC CHANGE MONOGRAPHS, BANGALORE, 2009.

[3]Centre for Lake Conservation (CLC), Environmental Management and Policy Research Institute (EMPRI), "Final Report on Inventorisation of Water Bodies in Bengaluru Metropolitan Area (BMA) Volume-II: Lake Database and Atlas (Part-4: Bengaluru South Taluk)," KKarnataka Lake Conservation and Development Authority (KLCDA) , Mar. 2018.

[4]Centre for Lake Conservation (CLC), Environmental Management and Policy Research Institute (EMPRI), "Inventorization of water bodies in Bengaluru Metropolitan Area," Karnataka Lake Conservation and Development Authority (KLCDA), VOL 1, Mar. 2018.

[5]H. Nagendra and E. Ostrom, "Applying the social-ecological system framework to the diagnosis of urban lake commons in Bangalore, India," *Ecology and Society*, vol. 19, no. 2, 2014, doi: https://doi.org/10.5751/es-06582-190267.

[6]E. Cohen-Shacham, G. Walters, C. Janzen, and S. Maginnis, Eds., *Nature-based solutions to address global societal challenges*. IUCN International Union for Conservation of Nature, 2016. doi: https://doi.org/10.2305/iucn.ch.2016.13.en.

[7]F. S. Saidoddin, A. Suseelan, and A. Krishna, "Evolution of Bangalore city's water tank system," *Ecology and the Environment*, Dec. 2011, doi: https://doi.org/10.2495/rav110351.

[8]K. M. Sujauddin, "Socio-Economic Impact of Grabbing Water Bodies: A Sociological Study," *EAS Journal of Humanities and Cultural Studies*, vol. 2, no. 5, pp. 241–247, Oct. 2020, doi: https://doi.org/10.36349/easjhcs.2020.v02i05.001.

[9]A. Sen and H. Nagendra, "The differentiated impacts of urbanisation on lake communities in Bengaluru, India," *International Journal of Urban Sustainable Development*, pp. 1–15, May 2020, doi: https://doi.org/10.1080/19463138.2020.1770260.

[10]J. Wu, J. Luo, and L. Tang, "Coupling Relationship between Urban Expansion and Lake Change—A Case Study of Wuhan," *Water*, vol. 11, no. 6, p. 1215, Jun. 2019, doi: https://doi.org/10.3390/w11061215.

[11]R. Gopinath, A. Cu, and M. Me, "Time-Line Based Aerial Analysis for Impact of Rampant Urbanization on Lakes of Bengaluru (India)," *Civil and Environmental Engineering Reports*, vol. 32, no. 1, pp. 1–18, Mar. 2022, doi: https://doi.org/10.2478/ceer-2022-0001.

[12]B. Lekshmi *et al.*, "Science & Technology Agenda for Blue-Green Spaces Inspired by Citizen

Science: Case for Rejuvenation of Powai Lake," *Sustainability*, vol. 13, no. 18, p. 10061, Sep. 2021, doi: https://doi.org/10.3390/su131810061.

[13]P. A. Saragi, T. E. Budhi Soesilo, and C. A. Abidin, "Review on community-based strategies for improving the quality of lake waters (Case study: Urban Lake Rawa Besar, Depok, West Java, Indonesia)," *IOP Conference Series: Materials Science and Engineering*, vol. 725, no. 1, p. 012029, Jan. 2020, doi: https://doi.org/10.1088/1757-899x/725/1/012029.

[14]P. A. Saragi, T. E. Budhi Soesilo, and C. A. Abidin, "Review on community-based strategies for improving the quality of lake waters (Case study: Urban Lake Rawa Besar, Depok, West Java, Indonesia)," *IOP Conference Series: Materials Science and Engineering*, vol. 725, no. 1, p. 012029, Jan. 2020, doi: https://doi.org/10.1088/1757-899x/725/1/012029.

[15]M. Marufuzzaman, "Exploring the Impact of Urban Growth on Surface Waterbody Area Loss in Khulna City using GIS Techniques," *Trends in Civil Engineering and its Architecture*, vol. 3, no. 3, May 2019, doi: https://doi.org/10.32474/tceia.2019.03.000165.

[16]H. A. Muniraja, "Impact of vanished and encroached lakes: A case study of Bangalore metropolitan region," *Geo Eye*, vol. 7, no. 1, pp. 1–5, Jun. 2018, doi: https://doi.org/10.53989/bu.ge.v7i1.1.

[17]H. Santhanam and R. Majumdar, "Quantification of green-blue ratios, impervious surface area and pace of urbanisation for sustainable management of urban lake – land zones in India -a case study from Bengaluru city," *Journal of Urban Management*, Mar. 2022, doi: https://doi.org/10.1016/j.jum.2022.03.001.

[18]W. Smit, "Urbanization in the Global South," *Oxford Research Encyclopedia of Global Public Health*, Apr. 2021, doi: https://doi.org/10.1093/acrefore/9780190632366.013.251.

[19]M. Knibbe and K. Horstman, "Overcoming the tragedy of urban commons. Collective practices for a healthy city ecology in disadvantaged neighborhoods," *Health & Place*, vol. 75, p. 102777, May 2022, doi: https://doi.org/10.1016/j.healthplace.2022.102777.

[20]"Energy, Ecology & Environment Research @ IISc," *Ernet.in*, 2023. http://ces.iisc.ernet.in/energy (accessed Sep. 12, 2023).

[21]S. Mundoli, B. Manjunath, and H. Nagendra, "Effects of urbanisation on the use of lakes as

commons in the peri-urban interface of Bengaluru, India," *International Journal of Urban Sustainable Development*, vol. 7, no. 1, pp. 89–108, Nov. 2014, doi: https://doi.org/10.1080/19463138.2014.982124.

[22]Sukhdev, Pavan *et al.*, "Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities A Global Assessment."

[23]P. Thippaiah, "'Vanishing Lakes"A study of Bengaluru City' ," *Social and economic change Monograph*, 2009.

[24]A. Murphy, J. P. Enqvist, and M. Tengö, "Place-making to transform urban social–ecological systems: insights from the stewardship of urban lakes in Bangalore, India," *Sustainability Science*, vol. 14, no. 3, pp. 607–623, Feb. 2019, doi: https://doi.org/10.1007/s11625-019-00664-1.

[25]M. Baindur, "Bangalore Lake story: reflections on the spirit of a place," *Journal of Cultural Geography*, vol. 31, no. 1, pp. 32–56, Jan. 2014, doi: https://doi.org/10.1080/08873631.2013.873296.

[26]A. Sharifi and A. Murayama, "The Potential of 'CASBEE for Urban Development' for Delivering Sustainable Communities: A Case Study from the 'Koshigaya Lake Town' Planning Experience Climate Change and Environmental Sustainability (CCES) conference View project Smart Cities and Climate-Resilient Urban Planning View project," 2014.

[27]"Urbanisation and emerging economies: Issues and potential solutions for water and food security," *Science of The Total Environment*, vol. 732, p. 139057, Aug. 2020, doi: https://doi.org/10.1016/j.scitotenv.2020.139057.

[28]C. Ravishankar, S. Nautiyal, and M. Seshaiah, "Social Acceptance for Reclaimed Water Use: A Case Study in Bengaluru," *Recycling*, vol. 3, no. 1, p. 4, Jan. 2018, doi: https://doi.org/10.3390/recycling3010004.

[29]Ningrum, Tia, Oktavia, Maharani, and Taufik, Mirna, "Development Of Lake Shuji Tourism Potential On Socio-Economic Community In Lembak Village," vol. 3, no. 2. Oct. 2021.

[30]D. K. Teressa, "Development of community based ecotourism in Wenchi Crater Lake, Ethiopia: Challenges and prospects," *Journal of Hospitality Management and Tourism*, vol. 6, no. 4, pp. 39–46, Jun. 2015, doi: https://doi.org/10.5897/jhmt2014.0133.

[31]T. Plieninger, P. Thapa, D. Bhaskar, H. Nagendra, M. Torralba, and B. M. Zoderer,

"Disentangling ecosystem services perceptions from blue infrastructure around a rapidly expanding megacity," *Landscape and Urban Planning*, vol. 222, p. 104399, Jun. 2022, doi: https://doi.org/10.1016/j.landurbplan.2022.104399.

[32]N. Auddy, A. K. Rai, A. Shrimali, K. K. Pobi, S. Dutta, and S. Nayek, "Assessing influence of anthropogenic and environmental factors on surface water quality for sustainable management of urban lakes: A case study from Udaipur, India," *Water Practice and Technology*, Jul. 2022, doi: https://doi.org/10.2166/wpt.2022.078.

[33]Anuradha Mathur and Dilip Da Cunha, *Deccan traverses : the making of Bangalore's terrain*. New Delhi: Rupa & Co, 2006.

[34]Harini Nagendra, *Nature in the city : Bengaluru in the past, present, and future*. New Delhi, India: Oxford University Press, 2019.

[35]"ENVIS TECHNICAL REPORT," IISC,Bengaluru, 2016.

[36]"REMOTE SENSING ," MDPI, 2020.

[37]"Physico-chemical and bacteriological screening of Hussain Sagar lake: An urban wetland," *Water Science*, vol. 31, no. 1, pp. 24–33, Apr. 2017, doi: https://doi.org/10.1016/j.wsj.2017.03.003.

[38]C. Henny and A. A. Meutia, "Urban Lakes in Megacity Jakarta: Risk and Management Plan for Future Sustainability," *Procedia Environmental Sciences*, vol. 20, pp. 737–746, 2014, doi: https://doi.org/10.1016/j.proenv.2014.03.088.

[39]Z Xiaojuan and D Wei, "14. Integration of the urban water environment space on Chinese traditional water culture," *SPRINGER*, 2021. Arabian Journal of Geosciences

[40]16. Snehal P and Unnati P, "Challenges faced and solutions towards conservation of ecology of urban lakes," 2012. International Journal of Scientific & Engineering Research

[41]"Contested urban commons: mapping the transition of a lake to a sports stadium in Bangalore," *International Journal of the Commons*, vol. 10, no. 1, pp. 265–293, Feb. 2016, doi: https://doi.org/10.18352/ijc.616.

[42]Unep International Environmental Technology Centre, *Planning and management of lakes and reservoirs : an integrated approach to eutrophication*. Osaka, Japan: Unep International Environmental Technology Centre, 2000.