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Working Paper No. 10

Research Area: Development

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and Harini Nagendra**

March 2018

Azim Premji University

Seema Mundoli, Manjunatha B. and Harini Nagendra (2018).
Lakes of Bengaluru: The Once Living, But Now Endangered Peri-Urban Commons
Azim Premji University (Working Paper No. 10).

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Lakes of Bengaluru: The Once Living, But Now Endangered Peri-Urban Commons

Seema Mundoli, Manjunatha B. and Harini Nagendra



Abstract: *Cities of the Global South are expanding both spatially and demographically. While urbanization may contribute to economic growth and employment generation, the impacts of urbanization on sustainability of cities is manifold. One area that is witnessing rapid land use change as a result of urbanization is the peri-urban interface of cities in India. This is especially true in the case of natural spaces that are also common pool resources. In this working paper, we examine the transformation of lakes in the peri-urban interface of Bengaluru city in the south Indian state of Karnataka. Based on GPS observations and interviews, we found that lakes in our study area varied in status and use: ranging from those in a good condition that served multiple uses to those converted to other forms of land use, resulting in loss of all services. We also accessed archival information to underscore the role that one of the lakes in the study area played in serving as a source of water during a time of scarcity. Using the example of lakes in Bengaluru, this paper presents the threats faced by commons in the peri-urban interface of rapidly expanding cities in the Global South. These threats are not restricted to changes to land use alone, but also concern their transformation into recreational sites at the cost of users who depend on them for livelihood and subsistence. We argue for management of the lakes in the peri-urban interface not only as ecosystems that supports ecological and economic uses, but as commons that are a reflection of the diversity and heterogeneity that cities such as Bengaluru represent.*

Keywords: *Commons, Peri-urban interface, Urbanization, Bengaluru*

Lakes of Bengaluru: The Once Living, But Now Endangered Peri-Urban Commons

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Introduction

Common pool resources (henceforth ‘commons’) have been studied extensively in the context of villages in India. The contributions made by rural commons to employment generation, income augmentation and creation of assets, especially in arid regions of the country, have been researched, as have the dynamics of the decline of these commons (Jodha 1990, Menon and Vadivelu 2006). However, cities too have commons though of a different type. In the urban context, the fuzzy and dynamic nature of natural spaces — given their rapid transformations to public, private and toll goods — makes it challenging to categorize them as commons (Helfrich 2012). Urban residents are often even unaware that the green spaces they live next to in cities are commons (Kip 2015). But, in the context of India, an increasing body of research shows how natural spaces, especially water bodies such as rivers, lakes and wetlands, are accessed as commons by urban residents even in the metropolitan cities (Baviskar 2011, Gidwani and Baviskar 2011, Parthasarathy 2011, Narain and Vij 2016).

In many cities in India, the evolution of the city itself cannot often be separated from the ecology of the region, especially the water bodies around which the cities have developed. Thus, the river Yamuna that flows through New Delhi (Baviskar 2011, Sharan 2015), the wetlands to the east of Kolkata (Mukherjee 2015) and the many interconnected man-made lakes of Bengaluru (Nagendra 2016) have all been a part of the historical landscape of these cities. Their significance lies in the manifold economic, social and cultural interactions that residents have developed with these water bodies over generations. These human-nature interactions have resulted in the lakes and rivers being accessed as commons that support livelihood and subsistence use, especially of urban poor. Thus, the ghats of the Sabarmati river are used by dhobis for washing clothes (Mathur 2012) and the banks of the Yamuna as sites for growing food (Baviskar 2011). The wetlands of Kolkata situated in the peri-urban interface (henceforth PUI) of the city support agriculture and fisheries that feed the city population (Mukherjee 2015). Bhopal and Bengaluru are both known as the “city of lakes”. The

Upper Lake of Bhopal supplies potable water to residents while the Lower Lake is used for irrigation (Bajpaiz et al. 2008). Historically, lakes in Bengaluru have been a source of water, sites for foraging food, fodder and fuelwood (Mundoli et al. 2015, Unnikrishnan and Nagendra 2015). The benefits of these lakes and rivers however go beyond supporting individual livelihoods or serving the needs of a household. In a broader context, they provide multiple ecological benefits to the city such as recharging groundwater, preventing flooding, purifying sewage water, and serving as habitats for biodiversity of different kinds (Mundoli et al. 2017). Kolkata for example does not have a separate sewage treatment plant, and the wetlands act as “natural kidneys” that purify the effluents released daily by the city (Mukherjee 2015: 135). The devastating impact of the floods of Chennai in 2015 could have been mitigated had the wetlands that acted as natural buffers been retained and not built over (Shekhar and Thomas 2015). While it is true that wetlands can have negative impacts on human health, proper restoration, maintenance and management can help minimize risks (Dale and Connelly 2016). Also, lakes, rivers and ponds in cities are water bodies revered as sacred, and are sites for ritual offerings and prayers (Samant 2004, Mathur 2012, Nagendra 2016). In spite of their socio-cultural significance and the multiple benefits that cities derive from these water bodies, lakes and rivers across cities in the country are under severe threat of degradation.

India is a rapidly urbanizing country and projections indicate that its cities will experience both a spatial and a demographic growth. Population projections indicate that by 2050 more than half the population in the country will reside in cities (United Nations 2014). Spatially, urbanization in India has been one of the important drivers of land use and land cover change, especially in the period post the 1950s (Tien et al. 2014). The spatial growth as a result of urbanization has resulted in cities sprawling into the rural hinterland creating the PUI. In this PUI, rural and urban land uses exist alongside each other but these sites are also where the most rapid transformation of land use are taking place (Allen 2003, Friedmann 2016). The PUI of cities are marked by an increase in built-up area to support industry (Zhou et al. 2010, IIHS 2011, Pandey and Seto 2014) and a reduction of green and open spaces (Nagendra et al. 2012). An increasing concern for the future is also the loss of arable land around the cities (Pandey and Seto 2014) as well as the disappearance and degradation of commons such as lakes (Narain and Vij 2016).

In this paper, we present findings from our research on the land use changes to lakes and their surroundings in the PUI of Bengaluru. Specifically, the objective of the research was to examine the land use and land cover change to commons, in the PUI of a rapidly expanding city, and to highlight the concerns and challenges that emerge as these commons are lost or converted to public and private resources. The PUI itself has been referred to by Friedmann (2016: 164) as a “restless landscape” that is little understood. Our research presented in this working paper is an attempt to contribute to the understanding of the dynamics of urban commons in the PUI of cities in the Global South.

Study Area and Methods

The city of Bengaluru (earlier known as Bangalore) has grown considerably, both demographically and spatially, since its formation in 1537 AD. The foundation of this historical city was laid by Kempe Gowda I, a *palegar* or local chieftain of the Vijayanagara dynasty. Kempe Gowda marked the boundaries of the city, and within these boundaries constructed a tiny mud fort and a township with well laid out streets, markets and temples (Hasan 1970, Annaswamy 2003). Since its inception, the city has witnessed a turbulent history. Many battles were fought in and around this small fort and town: the Marathas, the Mughals, the Wodeyars, Hyder Ali, Tipu Sultan, and the British have all played a part in defining the city's landscape (Hasan 1970, Annaswamy 2003, Nagendra 2016). At the time of the country's independence, the city spread over an area of 69 sq. km. and in 1951 had a population of 0.7 million (Sudhira 2008). Since then the growth of the city has been exponential: as per the Census 2011, the population of Bengaluru was 9.5 million and the area in 2007 was 741 sq. km. (Sudhira et al. 2007). Remnants of the fort and township still exist in the core of the city, but the city has sprawled extensively into the peripheries with a dense network of residential layouts, business and industrial units, hospitals, hotels and malls. The liberalization in the 1990s that saw the establishment of information technology hubs (IT) and associated infrastructure (Shaw and Satish 2007) has also contributed to the city's growth. The expansion into the peri-urban has been marked by a loss of green and open spaces (Nagendra et al. 2012) that are also urban commons. The rapid land use change in PUIs come with associated problems of governance, poverty and ecological degradation (Dupont 2007, Mallik 2009, Kundu 2011) — all of which pose challenges for environmental sustainability of the city and the well-being of urban residents.

Our research examines the transformations to peri-urban commons such as lakes, ponds, wooded groves, cemeteries, grazing lands and other commons (rock, fallow land, water channels, submerged land near waterbodies) in the PUI of Bengaluru city. We chose Bengaluru East taluk as the study area as we had previous experience in working in the same region (Figure 1). First, we defined two sub-watersheds in this area using ArcGIS, a geographic information system software used for working with maps and geographic information. Settlements in these two sub-watersheds were then listed using maps sourced from revenue offices, and 46 sites were identified. Two sites from Bengaluru North taluk also came under the sub-watersheds and were included in our study area. We filed an application under the Right to Information (RTI) Act 2005 to get the complete list of commons in the two taluks, and 392 commons were identified from this RTI document. The RTI document being in Kannada had to be first translated into English.

This process of developing the study plan, preparing the maps, filing the RTI and receiving the response, translation of the RTI document from Kannada to English and listing the study sites commenced in July 2014. Field visits were then conducted to each of the 392 commons between February 2015 and May 2017. During these field visits, we recorded the GPS points of the commons, noted the status of commons, and documented the land use in the immediate vicinity of the

commons. We located the commons in each of the sites using site maps procured from the revenue offices that had the survey numbers and boundaries marked. Wherever we had difficulty in finding the commons, we approached local residents and officials in the revenue and panchayat offices for clarifications. The GPS points recorded were then plotted on Google Earth, and we checked each of the points against the site maps to see if the data collected was accurate. The Karnataka government's online system of land management, Bhoomi, had uploaded kml (keyhole markup language) files for many sites in the municipal boundary or the Bruhat Bengaluru Mahanagara Palike (BBMP) area. Wherever the kml files were available for our sites, we checked the GPS points recorded in the field for each of the commons against survey numbers marked on the kml files using Google Earth. In the case of errors, the sites were re-visited, fresh points were noted and mapped on Google Earth to recheck. While some points were easy to locate using the site maps and conversations with locals, in many cases, especially in the more urbanized parts, we experienced much difficulty in locating the commons. Here the demography and land use had changed considerably, and the commons did not exist in their earlier state and current residents had no memory of their existence. Thus, for some points we had to make repeated visits — as often as three to four times — to locate the commons. In some instances, where we could not approach the commons because they had been fenced or because there was no approach path, we took the GPS points at the closest accessible point from the commons.

Though the main focus of this research was to document the land use changes to the commons, we also conducted interviews and recorded short oral histories in some of the sites to document the social and cultural importance of commons to local residents and the changes to the commons over time. As part of the research, we also focused on the historical dependence on urban commons, and used archival research as a method to understand this. We used archival data from state archives in Bengaluru, Mysore and Chennai, material from the National Archives in New Delhi and records in the India Office of the British Library located in London. In addition, libraries of institutions within and outside Bengaluru were also a source of archival data, as were online archival catalogues. A wide range of material including administrative correspondence, government reports, maps, travelogues and gazettes were accessed.

In this working paper, we present the findings of changes in land use with regard to one type of commons — lakes — from the study sites. We accessed archival data specifically for one of the lakes in the study area, the Yelemallappachetty lake (henceforth Y Chetty lake) for which we found considerable information. In addition, we drew on broader narratives for the Bengaluru region from our work.

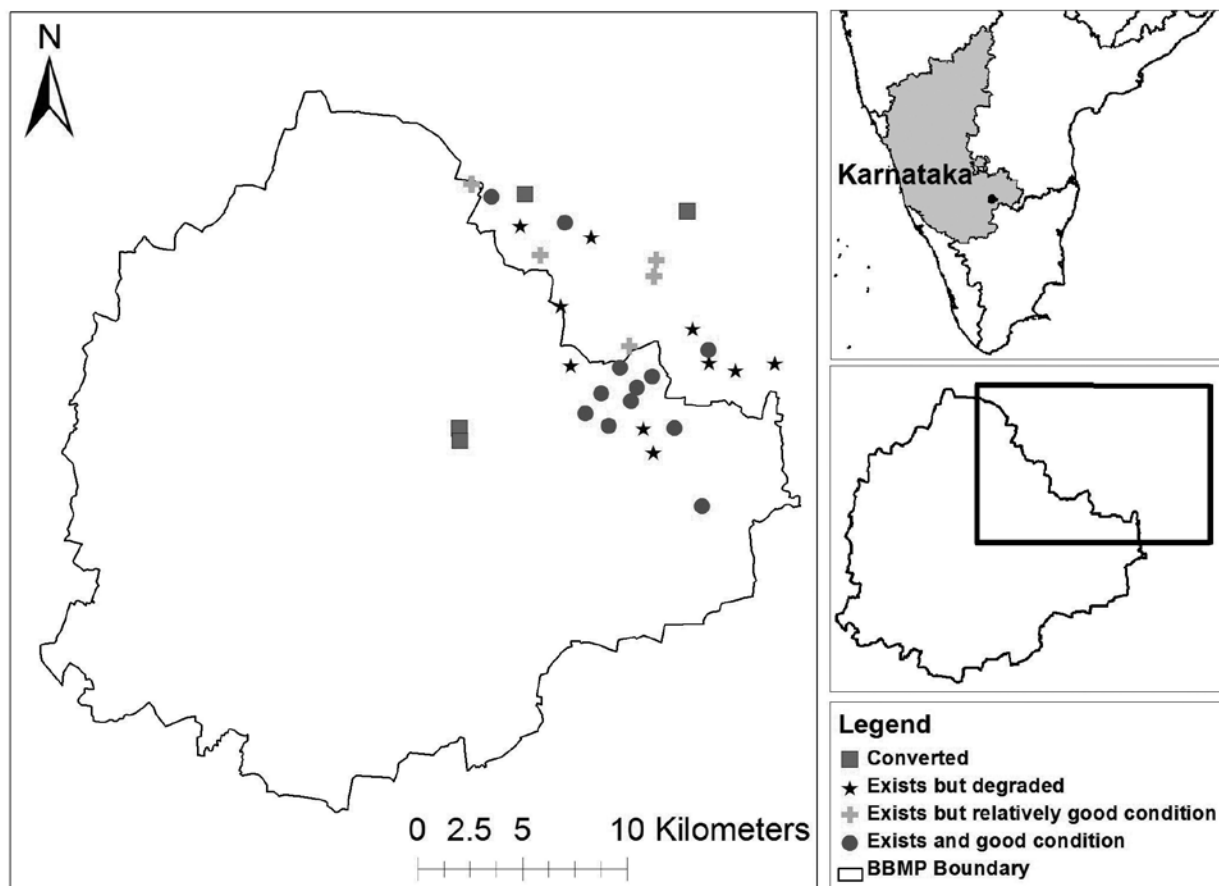
Findings

In this section, we present different aspects of the lake system in peri-urban Bengaluru both past and present. In the first part, we elaborate the current status of the lakes in the study area. We also note the dependence on the lakes as a source of livelihood and subsistence, as well as recreation, based on brief interviews with locals, and observations made during field visits. In the second part, we use archival data to highlight the importance of one these lakes seen as a supplemental water source during a period of scarcity faced by Bengaluru in the early 1900s.

Status of lakes: From the lost to the living lakes

In the study area, there were 31 lakes at 30 sites covering 35 survey numbers. Of these, two lakes in two sites were not mentioned in the RTI document, but we have included them in this paper. Twenty one sites have one lake each within their boundaries. Three sites have two lakes each, and one of the largest lakes covers two survey points in one site and one of another site in the study area. Similarly, another lake is shared between two sites. In the case of two sites, one site has two lakes, of which one lake is shared between two sites (Table 1). While one lake fell within the Bangalore North Taluk, the rest came under the administrative boundary of the Bengaluru East Taluk. The lakes were situated both in the gram panchayats (GP) and within the BBMP municipality boundary; 20 survey numbers came under the GP while 15 came under the BBMP (Figure 1).

Figure 1: Map of study area and status of lakes



The status of the lakes in the area under study varied greatly (Figure 1).

Four lakes (covering four survey numbers and three sites) are completely lost as they have been converted to other forms of land use. Two of these lost lakes were located in a single site situated within the municipal boundary (BBMP) that has seen considerable urbanization in the recent decades. In the site where these lakes once stood, we found congested residential layouts interspersed with roads, shops, and religious institutions. The other two lakes were located in the jurisdiction of GPs. One of them has been converted over decades to make way for facilities such as a school and veterinary unit in addition to houses; the other is enclosed within the property belonging to the defense authorities.

Eight lakes (covering eight survey numbers in seven sites) were in a degraded state. There were signs of extreme pollution such as frothing in one of the lakes. Large heaps of garbage and construction debris were found dumped in the lake and surroundings. Sewage was also found flowing into a couple of these degraded lakes. Invasive water hyacinth covered the water's surface in several of the lakes, while weeds clogged the water's edge. In most of these lakes, the drier parts of the bed and surroundings were being used for open defecation by migrant workers and urban poor who had set up settlements in lands next to these water bodies. Many of these were construction laborers, who had not been provided any facilities for sanitation or water by the contractors. In one of the lakes, we noted considerable encroachment, as people had built hutments on the lake bed. We also noticed land being prepared for cultivation in the wetland adjacent to one of these lakes. Some cattle were also found grazing on the lake bund of this lake.

We recorded five lakes (extending across seven survey numbers and six sites) in a relatively good condition. While there was not much water even after the rains in the lake, our observations indicated that the surroundings were not used as sites for dumping garbage as extensively as in the case of degraded lakes, nor were there any signs of encroachment. The lakes were sites for grazing livestock and collecting fodder, and the pools of water were accessed for washing and watering the animals. In one of the lakes, we observed women collecting a variety of leafy vegetable locally termed *onagane soppu* (*Alternanthera sessilis*) a high nutritional value produce and part of the local diet. Washing clothes and bathing were also observed in some of these lakes, though to a very limited extent. Only one of these five lakes falls within the BBMP boundary.

Twelve lakes (covering 14 survey numbers and 12 sites) were in good condition. We found that they held considerable water after the rains, and had fewer signs of pollution when compared to the other lakes. We observed garbage and construction debris dumped in the lake and surroundings, but this was much less compared to any of the other lakes. Similarly, water hyacinth growth was visible, but not to the extent observed in the degraded lakes. Traditionally, the lakes supported cultivation in the wetland, but today both paddy and finger millet (*Eleusine coracana*) cultivation has been discontinued in majority of the lakes. Some cultivation of millets and fodder grass was

observed in the surroundings of one lake during our research. In nine of these lakes, tenders for fishing had been given. Traditionally fishing in these inland lakes was done by the locals, who revealed that the fish was a source of protein in their diet. Under the current system, lakes are leased out for fishing for a specified period of time to the highest bidder. These fishers introduce fingerlings of specific species, which have replaced indigenous varieties. The fish is then sold in markets and to eateries across the city. In one of these lakes we also witnessed local youth catching fish using lines even though the lake was leased out. Three of these lakes had also been “developed” — with fencing and neatly paved footpaths that were accessed by local residents for walking. One of the lakes had been leased to a private entity and is now an amusement park (Fantasy Lagoon Park) with eateries, boating, play-areas for children, and benches for adults to relax. With the exception of the privatized lake and the lakes enclosed with fencing, we observed grazing, fodder collection, collection of leafy vegetables, or washing of clothes and vehicles. Fuelwood collection was also seen along the bund and around the lake land.

Two lakes coming under GPs were not mentioned in the RTI. One of these lakes has a fence running almost through the centre of the lake. Locals interviewed said that a court ruling had given the lake land to a private entity. We noticed that in a small patch on the lake bed maize and chilli was being cultivated by, according to an interviewee, a landless person. Water was also being pumped into adjacent fields in the wetland where cucumbers and beans were being grown. The other lake, according to the locals, had not held water for decades. At present, the lake boundary exists, and we observed small pools of water within its boundary. On one of the visits, we noticed women collecting grass with which to make brooms from the land around the lake. Locals said that initially it had been encroached, but speculated that the land would be allocated for housing.

All the lakes in the study area fall within a spectrum of varying urban to rural features in the PUI of Bengaluru city. In the more rural parts, some very typical features of this PUI are visible. The land use around lakes includes a mix of rural and urban processes. Thus, in some sites, cultivation of millets, fodder grass, flowers, and vegetables were found to exist in close proximity with small business enterprises such as block-making, plywood factories and brick-making units. Residential layouts have been marked for development around the lakes, and high-rise apartments too are rapidly being constructed. The degradations associated with the PUI were also clearly visible. The lake and lands in the surrounding area were the sites for dumping the waste such as garbage and construction debris generated in the city. Two of the lakes, one in a GP and the other in the BBMP, were separated by a rocky hillock that had been extensively quarried. While the quarrying has been stopped, the quarry is being converted into a landfill, with the waste from the city being dumped into the pits. In sites located in the more urban part of the PUI, the rural features were mainly absent, and the land use was marked by extensively built-up areas. However, some activities such as grazing cattle and washing clothes using lake water were visible.

Table 1: Lakes in study sites: Status and dependence

No. of Lakes	No. of Sites	Status of Lakes	Type of Use	Dependence on Lake
4	3	Converted	To houses for disadvantaged groups, roads, small traders, government offices, enclosed for defence establishment	NA
8	7	Degraded	Extreme pollution, dumping of garbage and construction debris, sewage inflow, invasive water hyacinth growth, open defecation, encroachment	Some cultivation in wetland Grazing to some extent
5	6	Relatively good	Not much water in the lakes Some dumping of garbage	Grazing and fodder collection in lake land Water from some existing pools for washing and watering livestock. Foraging for food, water for household use Fuelwood collection
12	12	Good	Lesser signs of pollution Some garbage and construction debris Water hyacinth growth	Fishing via tenders Recreational use Grazing and fodder collection Washing of clothes and vehicles Collection of leafy vegetables Fuelwood collection
2	2	Lakes not included in RTI: Degraded	Mainly dry with small pools of water One partially given to private entity Other lake marked for conversion	Cultivation on lake bed Collection of grass from around lake
T=31	T=30			

Bengaluru's Endless Struggle For Water: Lessons Never Learnt

In this section, we use archival data to describe the driving forces that led to changes to the Y Chetty lake, one of the larger lakes that falls within our study area, starting from a period of water scarcity in the 1890s. This narrative helps us to understand the larger forces of change that led to the decay of the once vibrant and functional lake network of Bengaluru in the late 19th century, which shaped the outcomes we see today across the PUI of the city.

The Y Chetty lake today covers an area of approximately 110 ha (LDA 2017), and is bifurcated by the National Highway 4. Around the lake are several settlements, and two of these settlements covering three survey numbers fell under our study area. One of the settlements falls in the GP while the other comes under a BBMP ward. The lake is situated at the edge of a rapidly urbanizing part of Bengaluru, and evidence of this is visible in the network of roads, apartments, businesses and industrial units that surround the lake, especially to its western side. At the same time, we observed that the lake continued to be accessed for grazing and fodder collection, and to a limited extent, fishing. We also recorded evidence of garbage dumped into the lake, and observed patches of hyacinth weed growing on the surface of the water. It is difficult to believe today that this lake had helped the city during a time of intense water scarcity around 90 years ago.

Bengaluru is a city with no perennial water source such as a river. Its location in the rain shadow region of the Deccan Plateau has necessitated developing local sources of water. Centuries before the

modern town of Bengaluru was established by Kempe Gowda I, rulers and local residents had taken advantage of the undulating topography of the region to construct series of interconnected lakes around which settlements flourished. The mention of lakes dates as far back as the 9th century AD, where epigraphic inscriptions record the maintenance of the Agara lake during the Ganga dynasty (Rice 1905, Nagendra 2016). Rulers from subsequent dynasties also built a number of lakes and established settlements around these water bodies starting first with the *maidan* or the plains, and moving, as land became scarce, into the ridged *malnad* areas (Nagendra 2016). Kempe Gowda I and his successors constructed the Sampangi, Karanji and Agrahara lakes around the native city or *pette*. These, along with the Dharmambudhi lake supplied water to the residents (Hasan 1970). The turbulent period under Tipu Sultan and Hyder Ali too witnessed different trajectories where lakes were concerned: the father and son duo maintained lakes for agriculture, but as a strategy of war against the British, they also breached and poisoned several of these water bodies (Wilks 1817, Nagendra 2016).

With the fall of Tipu Sultan in 1799 AD, the British East India Company and later the British Crown came to exert its influence over Mysore, and Bengaluru city. The British troops were initially stationed in Seringapatnam near Mysore, but it was decided to relocate their capital to Bengaluru owing to the latter's salubrious weather. The Civil and Military Station (CMS) or the cantonment was thus established in the year 1809 (Natl. Arch. 1888a), adjacent to the *pette*. At this time, several lakes dotted the landscape. However, the establishment of the CMS necessitated the construction of new lakes such as Millers Tank series, and the Shoolay, Sankey and Halasur (also known as Ulsoor) lakes between 1860s and 1890s. Along with the Sampangi lake these tanks supplied water to the military establishment and settlements that had quickly developed around the CMS (Natl. Arch. 1888a, 1888b, 1892, Srinivas 2004, Unnikrishnan et al. 2016). For the *pette*, the Dharmambudhi and Karanji lakes, and later Sankey tank were important water sources as indicated by the archival evidence (Karnataka State Archives 1886)

However, archival documents indicate an increasing water scarcity starting in the early 1880s when poor rains affected the sources of water for the CMS (Natl. Arch. 1888b). Additionally, government correspondence and news in local dailies expressed concern about the falling levels of water in lakes such as Dharmambudhi and Karanji that supplied water to the *pette* starting as early as 1888 (Karnataka State Archives 1888, 1892a, 1892b, 1892c, 1892d, 1892e, 1893a, 1893b, 1893c, 1893d, 1893e, 1893f, 1893g). A memo dated 25 November 1892 says:

“The city is at the present time worse off for water than at any previous period in its history. It is difficult to conceive what would result on continuance of the failure of the north east monsoon. Prudence dictates that it is better to prevent the calamity than to battle with it after it overtakes a community and experience teaches that the people who drink such water as is now consumed in the city cannot do so with impunity for long”. (Karnataka State Archives 1892a)

To augment the water supply, water sources towards the north of Bengaluru were explored and water from these lakes was channelled into Dharmamabudhi and Karanji. The archival files that we accessed (Natl. Arch. 1888b, Karnataka State Archives 1888, 1892a, 1892b, 1892c, 1892d, 1892e, 1893a, 1893b, 1893c, 1893d, 1893e, 1893f, 1893g) also mention excavation of the beds of Dharmamabudhi and Karanji as a measure to increase the water holding capacity of these lakes. Works were also undertaken to improve the capacity of the lakes supplying the CMS such as the Millers Tank series, Shoolay, Ulsoor and Sampangi by deepening the lakes and diverting water into these water bodies. The water shortage for the *pette* seemed more acute and water was supplied from Sankey into the Dharmamabudhi, which had gone dry in 1888. Other lakes such as Kempapur, Agaram, Hennur, Hebbal, Nagavaram, Jakkur and Rachenahalli were all considered as potential sources of water (Natl. Arch. 1888b, 1893a, 1893b)

However, these efforts proved futile and there was an increasing realisation that local sources of water that comprised lakes in CMS and *pette* would no longer be sufficient for the growing city. As an alternative, the construction of the Chamarajendra Water Works that involved constructing a reservoir across the Arkavathi river, was proposed. The water impounded in this reservoir created the Hessarghatta lake and with its completion filtered water was delivered to the *pette* and the CMS for the first time on 7 August 1896 (Natl. Arch. 1930, 1931).

The Hessarghatta scheme was initiated keeping the growing population of the *pette* and the city in mind. In 1892 when the scheme was initiated, the population of the city was 1,80,366 (Natl. Arch. 1931). The water from Hessarghatta was estimated to be an adequate supply for a population of 2 lakhs at the rate of 10 gallons per head per day for a period of 20 years: this included residents of both the CMS and the *pette* (Natl. Arch. 1930, 1931). However, the scarcity of water began to be felt as early as 1907, just 10 years after the Hessarghatta scheme was initiated owing both to increase in population beyond what was projected and increase in consumption. The consumption per head per day that was assumed at 10 gallons per day turned out to be too low, and actual consumption amounted to 13 gallons per head per day (Natl. Arch. 1931). The population too had increased beyond what was projected: from 1,59,000 in 1901 (Natl. Arch. 1926a) to 2,37,496 (*pette* 1,18,556 and CMS 1,18,940) in 1921 (Natl. Arch. 1931). To deal with the crisis, rationing of water to 9 and 10 gallons per day per person was initiated (Rao 1961).

The archival files we accessed indicate that by 1925, the water supply from the Hessarghatta scheme had also begun to dwindle. Initial attempts to improve supply included raising the height of the weir by 5 feet that would ensure a supply of 6 million gallons per day per head for 2 years with a minimum rainfall. Arrangements were also made for augmenting the supply available in the Hessarghatta lake by breaching some tanks in the vicinity that included Madhura and Kolathur. In spite of these efforts, in 1925 the Hessarghatta lake had gone completely dry (Natl. Arch. 1926b, 1926c, 1930, 1931). This marked the beginning of acute scarcity with the Hessarghatta scheme now having water sufficient to supply the CMS and *pette* only up to 30 April 1926, and that too

if it rained for a month more. But no water could be expected till the northeast monsoon set in 5 months later in September. In a meeting held on 8 February 1926 that was presided over by the Resident, who was the representative of the British in the Mysore court, a temporary measure was proposed to pump water from the Y Chetty lake situated 10 miles east of Bengaluru city, to the Hebbal Filter beds (Natl. Arch. 1926c, 1926d), one of the larger lakes in our study area. In fact, an earlier correspondence dated 30 October 1882 mentions that no investigations had been made of the possibility of looking at the chain of existing tanks to the east of the city to supply water to Bengaluru, referring possibly to the Y Chetty lake (Natl. Arch. 1888a).

According to the archival records the Y Chetty lake had a total drainage area of 112 sq. miles with an independent catchment of 7.63 sq. miles (Natl. Arch. 1926e). A conservative estimate given in the files indicated that the lake held about 225,000,000 gallons that could last the CMS and the *pette* for 2 months beyond 30 April 1926 after allowing for percolation and evaporation. This was definitely not adequate for Bengaluru, but till such time that alternate sources could be found, the Y Chetty lake was seen as a supplemental source (Natl. Arch. 1926c, 1926d).

While the Y Chetty scheme was being put into action, drastic measures to further reduce water consumption were considered. Suggestions included cutting off private connections and forcing people to fetch water from a few points along the road and cutting off piped water from entire localities that would force people to use and in turn maintain their wells. However, in the instance of the latter it was feared that it may lead to residents moving into localities where the piped supply was maintained leading to overcrowding in these areas. The influx of population into Bengaluru needed to be stopped and residents were to be encouraged to leave the city till the water situation had improved (Natl. Arch. 1926c). The administration argued that drastic rationing will have to be undertaken to keep consumption down and hoped that:

“[...] the public will heartily cooperate with them in their efforts and resort to the strictest economy to avoid any serious shortage of water in Bangalore” (Natl. Arch. 1926c)

The work of laying pipes from the Y Chetty lake to the Hebbal Filter Beds was initiated in March 1926, and a trial pumping was carried out on 15 April (Natl. Arch. 1926d). The urgency to access this source of water is evident from a note dated 30 April 1926 from the Office of the Garrison Engineer to the Secretary to the Resident in Mysore that says that:

“[...] the supply of water in Hesserghatta Tank is practically exhausted and consequently the Civil and Military Station will have to rely on the supply from Yelemallappa Chetty Tank from this date”. (Natl. Arch. 1926d)

In July 1926, a spell of rains resulted in two lakes — the Kalkeri lake and another lake mentioned as point 2845 in the vicinity of Y Chetty lake — filling up. It was estimated that if the water from these tanks was channelled into the Y Chetty lake, the latter would receive an additional supply of

200 million gallons. Water from the Hoskote Chikkakere, another lake upstream of Y Chetty was also channelled into Y Chetty. This meant that together a total quantity of 500 million gallons or 125 days' supply at 4 million gallons per day could be available. Thus, even in the absence of rainfall this would ensure that the *pette* and the CMS would have a supply of water till November 1926 (Natl. Arch. 1926d, 1933). The Y Chetty lake thus became a supplemental, yet important source, of water for the growing city of Bengaluru in 1926. Along with the water from the Hessarghatta lake these waterbodies were seen as providing 3 to 3.5 million gallons per day until 1933 (Rao 1961).

But Bengaluru continued to expand. The population in 1931 was 3,06,470 (*pette* 1,72,357 and CMS 1,34,113) (Natl. Arch. 1931). Water scarcity was once again a crisis causing great difficulties to the residents (Rao 1961). The Y Chetty scheme was anyway envisaged as a temporary measure, and the efforts now turned toward finding a more secure and final solution to the water problem of Bengaluru. The Thippagondanahalli scheme (henceforth TG scheme) was proposed that involved building a dam across the Arkavathi river at Thippagondanahalli near the 20th mile of Bengaluru on Magadi Road. The TG scheme was expected to provide a daily supply of 6 million gallons for a population of 3 lakhs, and later 20 gallons per day for a population of 4.5 lakhs. The scheme on which work began on 15

March 1930 (Natl. Arch. 1931) was inaugurated on 15 March 1933 by the Maharaja of Mysore who in his speech said:

“[...] in proceeding now to turn on the first supply of Thippagondanahalli water to the City of Bangalore I hope that I shall be turning on a stream that will carry to the City an ever increasing supply of health and prosperity.” (Natl. Arch. 1933)

The TG scheme continued to be the chief source of water for the city till into the 1970s when the Cauvery Water Scheme was introduced (Table 2 and Figure 2)

Figure 2: Broad timeline of water crisis faced by Bengaluru: 1800 to 1970

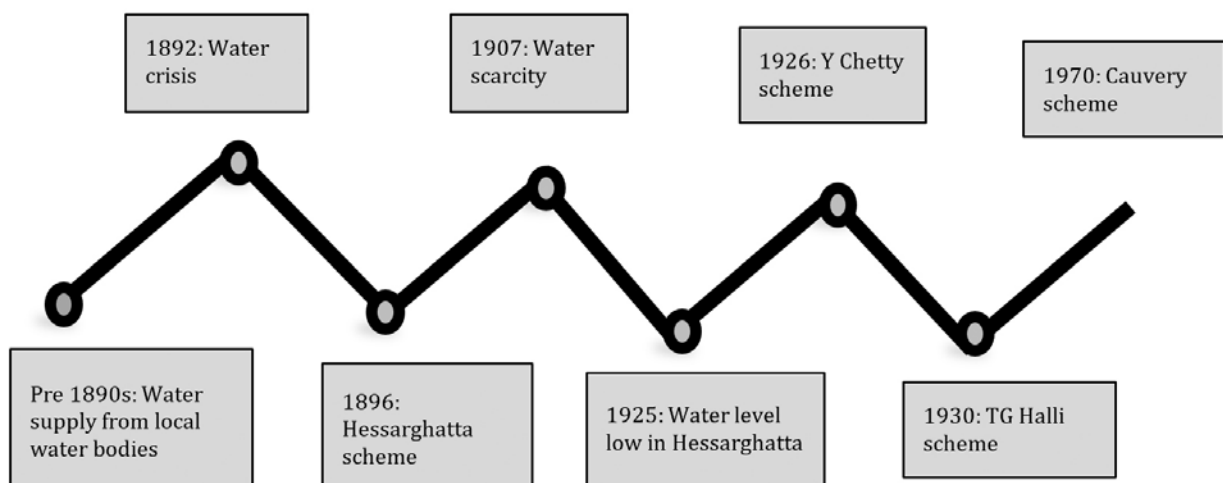


Table 2: Bangalore Water Supply: 1900 - 1965

Years	1901	1931	1934	1941	1947-48	1951	1952-58	1959-60	1961-65
Bangalore's population	158976	306476	360000	406760	700000	778977	8-11.5 Lakhs	13.39- 14.3 Lakhs	15 -17.5 Lakhs
Yearly supply in million gallons	650	1251	1738	2030	3080	3965	4265-4368	6500 (app.)	6600 (app.)
Daily Average Supply (MGD)	1.78	3.20	4.77	5.60	8.50	10.90 (app)	11.7 to 12.1	17.5 to 18.0	18.0 to 18.5
Per capita per day in gallons	11.0	10.4	13.30	13.80	12.0	14.0	14.0 to 10.50	13.50 to 13.60	12.0 to 10.60
Sources of supply	H	H & Y	T	T&H	T&H	T&H	T&H	T&H	T&H
Note: H=Hessarghatta; Y=Y Chetty; T= Thippagondanahalli Source: Table taken from Rao 1961									

At present, much of the city core is supplied by the Cauvery water that is sourced from 100 km away. In fact, according to a file we accessed, the Cauvery was suggested as a water source for Bengaluru as far back 1887, as a solution to the problem of depending on scanty rainfall to replenish local tanks. It also cautioned that the Cauvery scheme would have to be carefully considered for its financial aspects as the capital expenditure and maintenance costs could be very high: the estimated cost was put at a crore with additional recurring expenditure of lifting the water over a distance of 80 miles (Natl. Arch 1926a, 1926c). Today the Cauvery Water Project supplies 1350 MLD water to a population of 8.5 million. But the water problems of the city show no sign of being resolved: in the years to come it is projected that the city will suffer a crisis with the demand for water far exceeding supply (Saldanha 2016).

Conclusion

In this paper we have looked at the present status of 31 lakes in the PUI of Bengaluru city. We find that the lakes have taken different trajectories as the city has sprawled into the periphery, and that has resulted in conversions, degradations and encroachments to the water bodies. The conversions have meant that the multiple benefits local residents and migrants derived from these lakes are lost forever, as are the ecological roles that these commons supported (Mundoli et al. 2017). The degradation of the lakes is an example of a typical process in a PUI. PUIs are a "complex mosaic of rural, urban and natural sub-systems" (Allen 2003: 136), characterized by unplanned urbanization, environmental degradation and high levels of inequity (Ewing 2008, Kundu et al. 2002). The PUI are landscapes of transition where the rural and urban exist alongside each other and the land use changes are rapid and unplanned. The clear dichotomy between the rural and urban that once directed planning, no longer holds good in the context of PUIs, especially in the Global South where the PUI landscape is often a contested space. The processes of change in the PUI are a result of environmental, social and political drivers, both local and distant. Interventions to address the issues in PUI require that a number of knowledge gaps are addressed but focus should

be on understanding the interactions between humans and natural resources in the PUI, which are sites of both growth and degradation (Simon 2008, McGregor et al. 2016).

PUIs support the expansion of cities but also serve as dumping sites for the wastes of an expanding city. The lakes in the study were situated in the PUI of Bengaluru, which is witnessing rapid changes to accommodate both business and residential needs. Apartment complexes and gated communities are being constructed ringing many of these lakes, and glass fronted multi-storied offices are a ubiquitous sight close to lakes. These are all indicative of the development of Bengaluru as the “Silicon Valley of India” in the recent decades (Carlson 2017). At the same time as we found in our research, garbage and construction debris, and waste generated by urban consumption were found dumped on the lake bed and land around several lakes. An abandoned quarry between two lakes is being converted to a landfill. While the quarry site is spread over 85 acres, the landfill is in an area of 0.5 acres. However, dumping activities are expected to be extended into other abandoned quarries close to this site (Roy and Manjunatha 2016). One of the lakes adjacent to the quarry is still in a good condition and is accessed by local residents for grazing, fodder cultivation, some cultivation of millet and fodder grass, as well as fishing on lease. The impacts of the landfill are yet to be felt but remain a concern for the future. Several lakes exist in a good or relatively good condition supporting a number of ecological services and are accessed as commons for livelihood and subsistence use primarily by livestock owners and urban migrants (Table 1).

From our archival data, we found that the Y Chetty lake, one of the lakes in the study area, was a local water body that once served the needs of the city during a time of severe water crisis. While the lake is in a good condition, it is showing signs of degradation with garbage dumped and water hyacinth growth. Pollution tests indicate the presence of severe microbial pollution making the water unfit for human consumption with health issues recorded among local residents. The sources of the pollution include agricultural runoff and waste let into the lake by a company (Usha et al. 2008). The changing land use of the lakes and its surroundings, as well as the status of these water bodies as the city extends further into the PUI is thus a major cause for concern. Bengaluru’s lakes were the lifelines around which the city grew from medieval times. For a city without access to a perennial water source, lakes were critical to meet the daily needs of a growing population over the centuries (Nagendra 2016). The paper presents both the historical use of Y Chetty lake especially as a source of water during a time of scarcity and the continuing current uses of the lake in supporting livelihoods, subsistence and cultural needs of local communities. This continuity in multiple uses of the Y Chetty the lake for more than a century emphasizes its integral place in the city and makes it imperative to preserve similar water bodies in the city. This is also a reminder that while we may go farther and farther in our quest for water and natural resources to meet the demands of an expanding city such as Bengaluru, it is these local sources that will serve us in times of future need as the case of Y Chetty lake has shown.

Additionally, we also argue that the changing perceptions about the lakes – manifest in the way they are being restored – are also problematic. Primarily, their conversion to public or private spaces undermines their role as commons and results in the alienation of vulnerable urban groups. Riverfront development, be it the case of the Sabarmati in Ahmedabad or the Yamuna in New Delhi, has been a process of gentrification that leads to exclusion of targeted groups. The Yamuna river since historical times has defined the aesthetics of the city of New Delhi (Sharan 2015). The river has also been an urban commons supporting many different uses especially for a large population of urban poor who had made its banks their home. In preparing the city for the Commonwealth Games of 2010, however, hutments of urban poor whose lives and livelihoods were closely linked to the Yamuna were selectively targeted for demolition (Baviskar 2011, Sharan 2015). The cleaning of the riverfront reflected the vision of the urban elite of Delhi who viewed the urban poor as pollutants (Baviskar 2011). The concern for the degraded ecological state of the river, believed to be the result of waste dumped by the slum dwellers, was selective, considering riverfront properties and luxury apartments discharging their waste were allowed to come up in place of the slums. The case of the Sabarmati Riverfront Development Project in Ahmedabad highlights a similar process of gentrification. While the original residents were forcefully displaced without proper rehabilitation facilities, a real estate developer was given the right to develop waterfront recreational facilities (Desai 2012, Mathur 2012). This process of gentrification is visible in Bengaluru's lakes too, and together with the processes of privatization, has helped exclude vulnerable groups from accessing these commons (D'Souza and Nagendra 2011, Baidur 2014, Unnikrishnan and Nagendra 2015, Unnikrishnan et al. 2016a, b, Mundoli et al. 2017). In our study sites, we found that many lakes had been restored by constructing fences, landscaping, laying walkways and developing play areas for children. Additionally, in the case of the privatized lake, entry was restricted to those who could pay a charge. These lakes are no longer accessible to traditional users who grazed cattle or collected fodder and leafy vegetables. There are several instances of local citizens and government officials coming together to revive and restore polluted lakes across Bengaluru, and these are positive examples of how citizens can collaborate to protect urban ecological spaces (Enqvist et al. 2014, Nagendra 2016). Legal battles have also been fought in the court to protect lakes from being converted to private spaces and to protect them from encroachment by powerful builders in Bengaluru (Public Interest Litigation (WP No. 817/2008), 2008, Patil 2011, Public Interest Litigation (WP No. 222/2014)2016. Alienation of certain groups and preventing them from accessing the resource has thus been a cause of great concern, and this needs to be addressed especially in the current context where cities are becoming unequal spaces in the process of urbanization (MHUPA 2011).

Since historical times, the large number of lakes in Bengaluru have provided the city with water and supported livelihoods (Nagendra 2016). As we have seen in this paper there have been many changes to the status of the peri-urban lakes owing to urbanization, as well as a shift in perception

from a commons to a public or private resource. Both need to be addressed. Lakes may not be able to support the water requirements of the entire city, but protecting them can enable recharge of groundwater that in turn can replenish existing wells as in the past, in addition to serving several other ecological functions (Mundoli et al. 2017, Unnikrishnan et al. 2017). However, it is also extremely critical to acknowledge the multiple uses of these lakes especially their use as commons that still persist in the PUI of Bengaluru. Cities are heterogeneous and unequal spaces, and levelling the uneven playing fields is imperative in building inclusive cities. We recommend that a commons outlook towards governance of resources (Weston and Bollier 2016) is imperative to face the challenges of rapid urbanization of cities such as Bengaluru. This will require new ways of conceptualising ecological spaces in cities — not in the dichotomy of public or private that serve only specific uses — but as commons that embrace diversity and heterogeneity of use that characterize Indian cities. Thus, in the case of urban commons their management will require a mix of *de jure* and *de facto* rights as suggested by Schlager and Ostrom (1992) where the right to access is public, but withdrawal and management rights are retained with local communities. Right to alienation here lies with the State, but the State needs to itself see these lakes as commons, thereby supporting and enabling their use as a shared resource.

Acknowledgement

Research for this paper was supported by two grants from the Azim Premji University. We would like to thank Enakshi Bhar for her assistance with spatial analysis and creating the study area map. We thank Tushar Goel for his help with delineation and mapping of the watershed. We gratefully acknowledge the interviewees who generously gave their time and contributed to this study.

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About Azim Premji University

Azim Premji University was established in Karnataka by the Azim Premji University Act 2010 as a not-for-profit University and is recognized by The University Grants Commission (UGC) under Section 22F. The University has a clearly stated social purpose. As an institution, it exists to make significant contributions through education towards the building of a just, equitable, humane and sustainable society. This is an explicit commitment to the idea that education contributes to social change. The beginnings of the University are in the learning and experience of a decade of work in school education by the Azim Premji Foundation. The University is a part of the Foundation and integral to its vision. The University currently offers Postgraduate Programmes in Education, Development and Public Policy and Governance, Undergraduate Programmes in Sciences, Social Sciences and Humanities, and a range of Continuing Education Programmes.



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