SAWAS South Asian Water Studies

From lakes as urban commons to integrated lake-water governance: The case of Bengaluru's urban water bodies

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Abstract

Across rapidly urbanizing South Asia, erstwhile irrigation tanks or "lakes" are being swallowed into towns and cities and being given new meaning as providers of environmental amenities. The campaigns in Bengaluru city in southern India to protect and rejuvenate these lakes have managed to stave off the conversion and also privatization of these lakes, and led to participatory management of a few of them. Most lakes, however, are still degraded. Why this is so and what institutional arrangements might improve the chances of success in lake governance? Drawing upon a combination of secondary material, key informant interviews, and year-long participant observation in governmental efforts at stemming lake degradation in Bengaluru, we seek to deepen current understanding of the values associated with lakes, their bio-social nature, and the roles played by and interactions between key actors and agencies. We argue that a) the societal stakes in lakes extend beyond local users of the lake itself, whether traditional or modern, to users of water downstream and in other parts of Bengaluru; b) there are significant trade-offs between different uses and an inherent asymmetric and broader connectivity resulting from the flow of water and wastewater, and c) therefore the governance of these lakes not only needs participation of local citizens, but also coordination between and democratic control over several other agencies that are involved in managing water and wastewater and in allocating water or regulating its quality. We explore alternative institutional arrangements that might better address this need for an integrated urban lake-water governance.

Keywords: Urban lake governance; water governance; integrated management; democratic environmental governance

Introduction

As rural landscapes urbanize rapidly across South Asia, water bodies created originally for irrigation are undergoing transitions. Some have gotten paved or built over, but others are acquiring new purposes, such as providers of environmental amenities (van Ast et al., 2010; D'Souza and Nagendra, 2011). These new purposes demand not only new ways of day-to-day management but also new forms of governance that enable such management (Nagendra and Ostrom, 2014). In the Indian context, however, the response from the state to this emerging need has been slow and erratic at best (Ramachandraiah and Prasad, 2004). In most cases, it has been citizen mobilization for urban lake protection and "rejuvenation", with support from the judiciary, that has led to saving lakes from being converted into real estate and reversing their degradation to varying degrees (Nagendra, 2010).

There is now a significant literature on urban lake management and governance in India. Much of this literature is centred on the metropolitan city of Bengaluru, which is due to both the large number of water bodies that exist in and around the city and the high level of lake-centred grassroots environmental activism that has emerged there over the last decade or more. This literature has thus far focused on a few key interrelated themes. First, it has highlighted the change in meaning, purpose, or value of these water bodies in the process of urbanization, with the environmental amenity value gaining primacy for the urban middle class (Murphy, 2017), even though earlier uses have not entirely disappeared (Mundoli et al., 2014). Second, it has characterised these lakes as "common-pool resources" or as the new "urban commons" (Sundaresan, 2011), and emphasized the need to prevent the privatization of these commons (Unnikrishnan and Nagendra, 2015). The third theme has been lake governance, or specifically the relationship between citizens and the myriad state agencies that have overlapping jurisdictions and changing control as the state shifts its policies towards these water bodies (Sudhira and Nagendra, 2013). It has been argued that co-management between the municipal body and citizen groups produces better outcomes in terms of inclusiveness as compared to so-called public-private partnerships (Unnikrishnan and Nagendra, 2015), which become forms of privatization and commercialisation (D'Souza and Nagendra, 2011).

These three themes provide an interlinked argument that has shaped and been shaped by the current thinking and activism around Bengaluru's lakes: local environmental amenity or multiple local benefits as the stake, urban commons as the bio-social nature of the resource, and decentralized participatory governance as the solution, with some caveats (Sundaresan, 2011). Following a successful campaign and litigation that stopped the public-private partnerships the state had originally promoted,[1] many lakes are now being renovated by state agencies, and some of them are being successfully managed through citizen-municipality partnerships. Currently, citizen groups have signed formal Memorandums of Understanding (MoUs) with the municipal corporation in at least 5 lakes, while in many other cases they are involved in formal watchdog committees (Chetan, 2015) or play the role of an informal watchdog.

These success stories notwithstanding, the overall condition of Bengaluru's lakes - even the so-called renovated ones - is patchy and precarious to say the least. While many have been severely encroached upon, a majority continue to remain dry after renovation or are polluted (Deepika, 2016; Ramachandra et al., 2016), often resulting in fish kills (DHNS 2016).[2] Over the past couple of years, the biggest lakes, Bellandur and Varthur, have gained worldwide notoriety because of episodes of massive froth formation (Anonymous, 2016a) and repeated instances of them "catching fire" (Visser, 2015; Swamy, 2017). This is in spite of sustained citizen protest and litigation against pollution of these lakes for years. Our survey of 25 lakes where citizen groups have been active showed 20 of them either dry or severely affected by sewage.[3] This suggests that

[1] See http://www.esgindia.org/projects/events/campaign-against-lake-privatisation-bang.html for details.

[2] Out of 75 lakes monitored, 46 lakes were found to have water quality fit only for industrial cooling or irrigation, and 4 lakes had quality even below that standard (KLCDA, 2016).

[3] Strictly speaking, "sewage" is refers to only the domestic component of wastewater. However, given the popularity of the term sewage and that domestic and industrial effluents invariably get mixed up in Bengaluru, we use the term sewage interchangeably with wastewater in this paper.

citizen activism is either inadequate or misdirected, and that the problem frame[4] may need to be broadened to better explain and address lake degradation.

So the questions motivating this paper are: why do lakes - even those that have witnessed significant citizen action - remain degraded, and what institutional arrangements - beyond the enabling of citizen participation in lake management - will increase the chances of lake rejuvenation in some form.[5] We propose that the answer lies in broadening the current thinking on lake governance along all the three dimensions highlighted above: the value or purpose of lakes, their bio-social nature, and the institutional arrangements for lake governance. We argue that a) the societal stakes in lakes extend beyond local users of the lake itself, whether traditional or modern, to users of water downstream and in other parts of Bengaluru; b) the commons and common-pool resource framing ignores this inherent asymmetric and broader connectivity introduced by flowing water and wastewater and the externalities it creates, and c) therefore the governance of these lakes not only needs participation of local citizens, but also requires coordination between and democratic control over several other agencies that are involved in managing water and wastewater. In essence, we argue for thinking of lake governance as not just the governance of a set of green public spaces or urban green commons, but rather as a process of integrated urban lake-water governance.

For our data, we have drawn upon a wide range of sources. As a part of a larger study on the socio-hydrology of Bengaluru's water as a whole[6] and a specific component focused on lakes, we compiled secondary data on lakes and supplemented with an online survey on basic lake features. We interviewed leaders of 12 lake-specific citizen groups, five non-governmental organizations working on lakes,[7] and senior officials from the municipal body and five other state agencies connected with lakes. We were also participant observers in a number of lake-related incidents or events during the past two years. In particular, the first author was a member of the

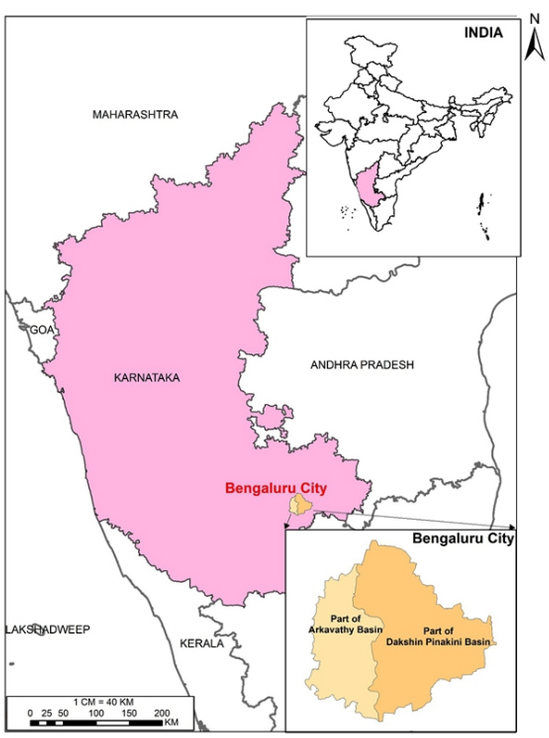

Figure 1: Location of Bengaluru city in India, and the two river basins it straddles.

[4] Framing means "to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation" (Entman, 1993).

[5] We exclude from this study the problem of lake encroachment or legal/illegal conversion into real estate. Although this was a significant factor in the past and continues to be a threat today, we are focusing this study on the management of lakes as lakes/water bodies.

[6] http://www.atree.org/BangaloreWater

[7] ActionAid, Biome Environmental Trust, Namma Bengaluru Foundation and Environment Support Group.

Government of Karnataka's Expert Committee for Bellandur Lake Rejuvenation constituted between May-August 2016, and has been serving since February 2017 on the subsequently created Bellandur Lake Monitoring Committee that is supposed to oversee implementation of the earlier committee's recommendations. This provided valuable first-hand observations, data, and documents on the process of lake governance, supplemented by the second author's observations in public hearings and field visits associated with the Expert Committee. Interactions with scientist colleagues at ATREE specifically studying the ecology and hydrology of two of the lakes, Jakkur and Kaikondrahalli, added to this pool of information.

The paper is organized as follows. In the next section, we present a basic overview of Bengaluru's lakes, and the larger context of water and wastewater management in Bengaluru. Following that, we narrate three events that provide food for rethinking lake governance. We then draw upon these events and other material to show how the problem is bigger than the framing of "lakes as urban commons" in all three dimensions - stakes, nature of the resource, and institutional arrangements - and propose an "integrated lake-water governance" framework. We then explore the implications of this analysis for the governance of Bengaluru's lakes. Finally, we discuss the benefits of such broader framing in thinking about and acting on urban lake governance.

Bengaluru's lakes and Bengaluru's water

Much has been written about Bengaluru and its lakes (Gowda and Sridhara, 2007; Patil et al., 2011; Ramachandra et al., 2014; Nagendra and Unnikrishnan, 2016), both existing and now-extinct ones (e.g., Unnikrishnan et al., 2016).[8] Here, we shall highlight only some key but lesser-known features. The first thing to note is that none of these 200-odd water bodies[9] are "lakes" in the sense of naturally

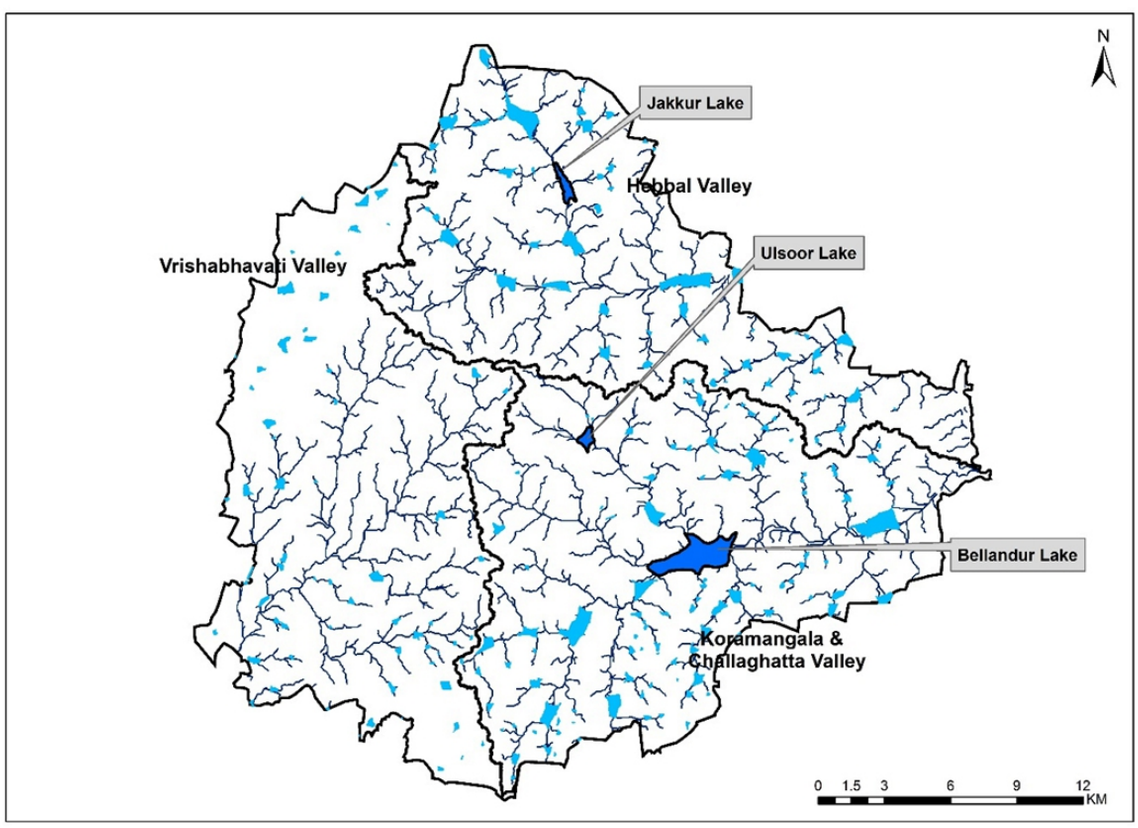

Figure 2: The three drainages or "valleys" of Bengaluru city, showing the major streams and the lakes or waterbodies indicating the three lakes focused on in the text. [Source: ATREE Ecoinformatics Lab]

[8] The literature we refer to here is only that which is related to socio-ecological dimensions of lake management and governance. There is a larger literature on the physical and ecological aspects of lakes (e.g., Jumbe and Nandini, 2009; Samal et al., 2011). Some of this also touches upon management questions (Ramachandra et al., 2015), but does so in a cursory or a-theoretical manner.

[9] KLCDA (2016).

formed water bodies; all of them are human-made. The vast majority of the lakes that are today within Bengaluru city limits were reservoirs constructed originally for irrigation in a rural landscape. The other few,[10] mostly in the heart of the city, were constructed as water supply reservoirs either by the early ruler, Kempe Gowda, or the British (Meenu et al., 2015), although none of them are being used for water supply today.

The second feature is that these "lakes" are interconnected. The 800 km^2-odd region that is presently Bengaluru city is located on a plateau at 825 m-940 m above MSL, straddling a ridge that divides the Arkavathy river basin from the Dakshina Pinakini river basin (see Figure 1). It receives about 900 mm rainfall annually. Trapping stormwater runoff by constructing earthen bunds across second- and third-order streams was a technology that developed over centuries in this and the larger peninsular region of Karnataka, Andhra Pradesh, and Tamil Nadu (Vaidyanathan, 2001). A high density of these reservoirs in this region made the landscape look like a network or cascade. As one reservoir filled and overflowed, its overflow was directed along a narrow path in the erstwhile stream, called a *raj kaluve* or a royal channel, which was given official status to prevent encroachment and consequent interruptions in the movement of stormwater (see Figure 2).

The third feature is that even before the villages surrounding Bengaluru got swallowed into the city, many of these irrigation reservoirs had stopped being used as sources of irrigation due to two reasons: the decline of agriculture as the city sucked in labour from its surroundings, leading to a large-scale switch to eucalyptus cultivation (Thomas et al., 2015), and the switch to groundwater as the primary source of irrigation with the emergence of borewell technology (Srinivasan et al., 2016). This switch also led to the drying up of many of these reservoirs.

The fourth feature is that even when these irrigation reservoirs were functioning, there is no evidence that they were a genuine "commons". It is well documented that irrigation water was provided only to those who happened to hold land in the command area of these reservoirs, which amounted to typically less than 20% of the agricultural landscape in a village and belonged largely to the elite of the caste-differentiated village (Shah, 2003). Other uses of the water in the tank such as washing and bathing were perhaps open to all, but were always secondary to irrigation use. Even fishermen generally had to pay to get fishing rights in the reservoir (Gurunathan and Shanmugham, 2006; Shivakumar and Cheluvaraju, 2016).

The fifth feature is that currently, the major use of these lakes (where they have water, see below) is recreation, aesthetics, and conservation. This is a consequence not only of the lost function of irrigation but also of the changed demographics of the surrounding populations, where a large urban middle-class, riding on the IT-wave that has driven Bengaluru's dramatic growth, has emerged. These uses have been bolstered by a particular template that has been followed by state agencies in their lake "rejuvenation" projects, viz., dredging to increase lake storage capacity, constructing bunds around them to prevent the influx of sewage as well as walkways, creating parks and playing areas on the edges of these lakes, and constructing earthen islands in the middle of each lake and planting them with trees – creating a kind of bird habitat (D'Souza and Nagendra, 2011; Baindur, 2014).

The sixth and associated feature is the high level of activism demonstrated by individual citizens and groups of individuals living around and enjoying the use of these lakes primarily as green spaces. Bengaluru now has 22 such groups known as "Friends of Lakes" (FOLs) that actively discuss, monitor, campaign and participate in lake management or lake-related decisions in various ways. While some have filed public interest litigations (PILs), others have taken out petitions, used their contacts in the government, or pestered city officials to take various measures for lake protection and management (Nagendra, 2010; Sundaresan, 2011; Murphy, 2017). Some of these efforts have also consciously tried to make lake management more inclusive by accommodating fisherfolk, washermen, and even idol immersion in some fashion (Sundaresan, 2011; Nagendra and Ostrom, 2014).

Finally, the official institutional arrangements for the management and governance of these lakes are

[10] These are Sankey tank, Ulsoor lake, and Miller's tank. Miller's tank was emptied and built up decades ago. The other two are being used for recreational purposes only.

confusing and in constant flux. The original irrigation reservoirs were being managed by local communities through customary arrangements until early 20th century, when they were taken over by the colonial government. The policy was continued by the Government of Karnataka after independence and state reorganization. The Minor Irrigation Department (MID) was the custodian (manager) even as the Revenue Department was designated as the owner of these reservoirs. On the other hand, the Fisheries Department auctions the fishing rights in these water bodies. When the water bodies became part of Bengaluru city or its fringes, Bengaluru Development Authority (BDA)[11] was given custody of many of them, while others were transferred to the Karnataka Forest Department (KFD) and a few original tanks to the municipal corporation. A Lake Development Authority (LDA) was set up in 2002, ostensibly for lake rejuvenation using funds from various external donors, but was caught in a controversy because it attempted to lease out lakes to private companies. A Karnataka Lake Conservation and Development Authority (KLCDA) was formed under a new law in 2012, but it has custody of only four lakes, and is largely playing the role of providing technical support. Custody of most of the lakes in Bengaluru is shifting back and forth between the municipal corporation - Bruhat Bengaluru Mahanagara Palike (BBMP) - which has 109 and BDA which has 92 (KLCDA, 2016). KFD has custody of five lakes, and the Fisheries Department continues to control fishing rights in all the lakes.

We now discuss the larger context of Bengaluru's water and wastewater within which these lakes currently function. As mentioned above, none of the lakes are used directly to supply water today. As the city grew, water supply reservoirs were created first at Hesaraghatta (24 km northwest from city centre) in the 1890s and then at Thippegondanahalli (27 km west from the city centre) in the 1930s. As these also became insufficient, a series of approximately 100 km long pipelines were constructed starting from the 1960s from the Cauvery River to the south in order to pump water 300 m uphill to Bengaluru. Today, all the surface water used within Bengaluru, which is estimated to meet about 60-70% of total water consumption in the city, comes from the Cauvery. Hesaraghatta and Thippegondanahalli do not supply any water anymore, as they are virtually dry for the above-mentioned reasons mentioned.[12]

If irrigation has ceased due to changes in the land use from agricultural to urban use, and if these lakes are also not being used as water sources, one would expect them to be filled up during the monsoon and stay largely full (minus evaporative and infiltration losses) for the rest of the year. However, the actual picture is of two extremes - some lakes are full but with sewage, while other lakes are dry for most of the year. The absence of water results from a combination of depleted groundwater tables in the peripheral region, blocked stormwater inlets due to unregulated construction or solid waste dumping, and the construction of bypass drains, meant to block sewage, that in some cases also prevent most of the stormwater from entering the lake. The presence of pollution, basically sewage, is the result of two factors - a rapidly growing city with a poor sewerage network, especially in the newly urbanized periphery; and inadequate sewage treatment capacity, i.e., a functioning capacity of less than half of the sewage quantity generated in the city (Jamwal et al., 2014). It is also partly the consequence of the traditional practice in the older parts of Bengaluru, as in most other towns in India, where grey water (non-toilet water) is discharged into stormwater drains.

Three events

During the course of our engagement with Bengaluru's lakes over the past two years, three events associated with three well-known lakes - Ulsoor, Jakkur and Bellandur - located in the central, northern, and south-eastern parts of the city, respectively (see Figure 2) and the responses that emerged to these events from civil society, experts, and the state agencies provided interesting insights into the lake problem in Bengaluru. We analysed these events using our three-level framework of the value of lakes, the nature of the bio-social system, and the institutional arrangements linked to the achievement or enhancement of these values in this bio-social context.

[11] BDA is another parastatal agency created by the state government to 'develop' the city in a planned manner. Its main activity is the acquisition of agricultural land on the edge of the city and its planning and development into residential and commercial areas. It is independent of the elected municipal body.

[12] See Srinivasan et al.(2015) and Penny et al.(2016) for a fuller explanation of this drying.

Fish kill in Ulsoor Lake

On the morning of 7 March 2016, visitors to Ulsoor lake, one of the oldest and most popular lakes in the heart of the city, found thousands of fish lying dead on its banks. News channels broadcast videos of the fish kill, interviewed the residents and the corporator of that ward, and newspapers reported at length on the incident (Aravind 2016; Khanna, 2016).

The first author of this paper was invited to a panel discussion on a local TV channel the same evening. In the discussion, for members of local FOL groups and some environmentalists, the fish kill was a symptom of general neglect and overfishing. Their solutions focused on planting more trees, improving facilities, and banning fishing (because they suspected fishermen of adding unknown chemicals). For others, the problem was the lake had not been adequately desilted. Another expert pointed to butcheries and tanneries in the catchment, criticising their "inhuman" practices and suggesting that animal waste and heavy metal pollution was the cause of the fish kill. The Chairman of the Karnataka Pollution Control Board (KSPCB) said they could not comment until they completed tests of the water quality, but assured that the culprits would not be allowed to go scot free.

A colleague at ATREE then tested the water quality of the lake and found very low levels of dissolved oxygen (0-1.5 mg/L versus the minimum required of 4 mg/L) and high levels of ammoniacal Nitrogen (1.7-8.1 mg/L versus the maximum limit of 1.2 mg/L)[13] to be the proximate cause of fish death (Rao, 2016). The low level of dissolved oxygen was in turn the result of inflows of sewage that was entering the lake from three stormwater drains even though the main drain (or *raj kaluve*) from the west that carries most of the sewage had been made to bypass the lake. These stormwater drains have thousands of houses along them that could potentially be discharging sewage, and therefore KSPCB's promise of punishing the culprits could of course not be implemented. After much back and forth between the KSPCB and the Bangalore Water Supply and Sewerage Board (BWSSB), the latter has committed to set up a lakeside sewage treatment plant (STP), provided it gets adequate land for this purpose.

Threat to Jakkur Lake

For the past several years, Jakkur lake in northern Bengaluru has been touted as an example of a successful socio-technical solution to the problem of lake death (Baradwaj, 2014). Jakkur lake (about 64 ha in area) was rejuvenated as per the abovementioned template in 2008 (Vimos, 2008). In 2004, a 10 million litres per day (MLD) capacity STP had already been set up by BWSSB on land allotted to it from within the erstwhile lake area. The treated water from this STP is now being released into the constructed wetland portion of the lake, from where it overflows into the rest of the lake. While a significant amount is then lost to evaporation and infiltration, the rest flows into the next lake downstream (Rachenahalli lake).

A lake lovers group, supported by a local philanthropist, has entered into an MoU with the municipal corporation (BBMP) and its members monitor the functioning of the STP, watch out for illegal sewage entering the lake, maintain the facilities around the lake, and conduct various activities for lake lovers (Anonymous, 2016b). Some sewage still does enter the lake, but overall the lake's water quality has been quite high and the lake has attracted a large number of birds (Desai, 2013).

Sometime during 2016-17, however, Karnataka Power Corporation Limited (KPCL) made an agreement with BWSSB. KPCL will pay for upgrading the capacity of the Jakkur lakeside STP to 15 MLD and its technology to tertiary treatment, and will then use all the treated water for its gas-based thermal power plant coming up in nearby Yelahanka (KPCL 2014). KPCL's environmental clearance stipulates that no water will leave the power plant premises (SEIAA-K 2015), which means all the 15 MLD will be used up. But BWSSB officials gave contradictory and varying information about the quantum of water to be sold to KPCL and the quantity that might be available to feed Jakkur lake (Joshi, 2016). BWSSB's basic position is that treated water is their property and they can choose to sell it if they wish. KPCL is offering a significant price, in addition to paying for STP upgradation, making the decision a simple one in BWSSB's eyes. The FOL group is still trying to figure out how it can prevent the destruction of the lake that is critically dependent upon treated water.

[13] http://cpcb.nic.in/Water_Quality_Criteria.php

From our interviews, it became apparent that none of the actors involved have estimates of the level of inflows required to just balance the losses due to evaporation and infiltration in Jakkur lake. Neither do they have any idea of how the cessation of overflows from Jakkur will impact downstream Rachenahalli lake. The "rights" of Jakkur or Rachenahalli lake users are non-existent, as the MoU regarding Jakkur lake confers the authority on the lake lovers group to manage the lake as a fixed piece of land rather than any rights over the water entering or leaving the lake. At the time of writing this paper, the future of successfully rejuvenated Jakkur lake continues to be in limbo.

Frothing Bellandur lake

Bellandur lake is the largest water body within Bengaluru city limits, covering 370 hectares. It is the last but one lake in the so-called Koramangala-Challaghatta valley, a watershed covering 279 km^2 or about 40% of Bengaluru city. Bellandur lake receives a summer-time (non-monsoon) inflow of around 550 MLD, of which about half is treated effluent from the STP located on its upstream edge and the rest is untreated sewage flowing in through various stormwater inlets and even official BWSSB sewers that directly discharge into the lake (Expert Committee, 2016). Bellandur lake overflows into Varthur lake and eventually the overflow from Varthur is utilized by farmers downstream before the stream joins the Dakshina Pinakini river.

Bellandur lake has never been rejuvenated along the lines indicated above, probably because of its sheer size and the volume of flows.[14] Being on the periphery of Bangalore city till the 1990s and adjacent to the old airport and military lands meant that it did not till recently have a large lakeside middle class population. Lakeside residents were largely villagers in various settlements of Bellandur and Iblur village, supplemented now by an increasing number of apartment residents. These residents have been protesting against the pollution of the lake for several decades, and had filed a case in the Karnataka High Court as far back as 1998. The High Court's orders in the case led to augmenting the capacity of the STP (Ramamurthy, 2016), but the sewage inflows have always been far higher and from multiple inlets.

In 2015, the Bellandur lake problem reached its peak. In that April, froth at the lake's overflow weirs repeatedly blocked or endangered road traffic and then in May the froth at one weir caught fire. Such heavy frothing was again reported later in November. Not only did citizens complain vigorously, but videos of these incidents went viral, and Bellandur achieved worldwide notoriety. The state government was forced to respond eventually, leading to the setting up of an Expert Committee in May 2016 tasked with coming up with a diagnosis and recommendations for addressing the problem.

The deliberations of the Expert Committee (later converted into a Monitoring Committee) were complex and at times heated. One question was regarding the goal for lake rejuvenation. Most members were inclined to treat this as a "non-question" as it was "obvious" that the lake must be "restored" to its "pristine" condition.[15] It was then pointed out that the lake was human-made, and that in fact even the polluted water was being used for irrigation by downstream farmers. Once this was accepted, it opened up the possibility of setting the water quality goal depending upon the targeted use, rather than aiming for "pristine-ness".[16] The committee finally chose to aim rather high (class B, i.e., outdoor bathing quality) because the central government would not provide co-funding for any lake rejuvenation effort unless it was aiming for this level of water quality.

The most heated debate, however, was over the cause of the degradation of water quality in the lake, and therefore what ameliorative actions should be taken. A number of members were insistent that the lake was dirty, because of the pollutants that had accumulated in the sediment over decades and the grass and water hyacinth choking the water. Therefore a "cleanup", using technologies for de-weeding and dredging, was essential. Others pointed to not only the heavy costs of doing this in such a large lake, but the futility of doing so when the source of pollution lay outside the lake, viz., the inflow of

[14] The same holds for Varthur lake, which is also quite large (180 ha).

[15] Many have argued publicly that these water bodies are 'wetlands' (Ramachandra et al., 2013; Sahu 2016) and are therefore protected under various court judgements and the imminent wetland conservation legislation (see http://www.indiaenvironmentportal.org.in/ content/439733/order-of-the-supreme-court-of-india-regarding-wetland-conservation-in-india-08022017/).

[16] See CPCB (2012).

untreated sewage. The next solution proposed was to build bypass drains as has actually been done in the case of most upstream lakes (see, e.g., Ulsoor lake above). This was eventually rejected as simply being a case of externalizing the problem to the downstream Varthur lake. Eventually, the discussion focused on why so much untreated sewage was coming, from where, what BWSSB's plans were to treat it, what the bottlenecks were in these plans, etc. It became clear that BWSSB was the most important actor in the matter, and it was asked to commit to some reasonable timeline for addressing the problem of raw sewage inflow. Lake cleanup was proposed to be taken up *after* incoming untreated sewage was reduced. It was recognized that "there may be no easy or quick techno-fixes, and that even long-term solutions will need a combination of technological, ecological solutions with social processes" (Expert Committee, 2016).

Ironically, soon after the Expert Committee's report was accepted by the state government and some steps towards its implementation commenced in January 2017, the National Green Tribunal (NGT) ordered a series of actions that completely ignored the Expert Committee's diagnosis. It ordered for the lake to be cleaned up within a month, closure of all industries in the catchment regardless of their compliance with existing standards, and transport of untreated sewage over long distances for treatment (NGT 2017a). At the time of writing this paper, the NGT is also pushing for immediate desilting of the lake, ignoring the Expert Committee's position that desilting should only be considered after the inflow of untreated sewage has ceased. It has also indiscriminately ordered that large apartment complexes within the Bellandur catchment must treat their own sewage, even if they are already connected to BWSSB's sewerage network (NGT, 2017b).

The second irony is that while the Expert Committee focused on the question of sewage treatment to ensure that raw sewage eventually stops entering the lake, the Government of Karnataka has sanctioned a massive project to divert all treated water from the lakeside STPs at Bellandur to Kolar district, ostensibly to recharge the severely depleted groundwater table there by filling 126 erstwhile irrigation tanks with this water (Express News Service 2017). So instead of diverting sewage away from the lake, this project will actually divert treated water away from the lake. If and when all incoming sewage is treated, and then so diverted, this may mean that the lake is left empty to capture stormwater runoff. While this may not be an entirely bad idea for Bellandur,[17] it goes to show that even state-sponsored discussions of lake rejuvenation are entirely disconnected from the question of who owns the wastewater of Bengaluru. Neither the rights of downstream farmers nor the right of Bengaluru city to reuse its treated wastewater have been recognized by the government.

A third ironic development is that even while the Expert Committee was converted into a Monitoring Committee chaired by the Commissioner of BDA to oversee the execution of the recommendations, the state government decided to handover the control of all of Bengaluru's lakes back to the MID. As an agency that has no experience or expertise in managing lakes for non-consumptive use, the MID is even more distant from and unaccountable to urban citizens than BDA and certainly BBMP. It seems like lake governance has come a full circle (Lele and Srinivasan, 2017).

Insights: stakes, relationships and institutional arrangements

The above brief summary of the three events as well as data gathered from other sources provide important insights into how the problem of lake governance needs to be reframed and readdressed along the three dimensions: stakes, bio-social relationships, and institutional arrangements. A stake (and stakeholder) analysis tells us whose and what kind of interests are involved. An analysis of the bio-social relationships linking these stakes to human actions helps understand the potential synergies and trade-offs between stakes and also how various actors, including those who may have no interest in the resource, may affect each other. This then enables one to ask whether the institutional arrangements for decision-making match the needs of the situation, i.e., the stakes and the bio-social processes linking them that create the "problem".

[17] There are also major doubts over whether the proposed groundwater rejuvenation can actually happen in Kolar. The root cause of groundwater depletion is unregulated pumping. Since that has has not been addressed, whether the gains will be anything but short-lived, and whether these gains are sufficient to justify the costs are major questions.

Table 3: Stakes, stakeholders and their status

No.	Stake	Stakeholder	Status of stake
1.	Irrigation	Local villager	Past
2.	Bathing, Drinking Water	Local villager	Past
3.	Fodder	Local villager	Past or declining
4.	Livestock washing	Local villager	Past or declining
5.	Clothes washing	Local villager	Past or declining
6.	Fishing	Contractor and out-of-state fisher folk	Current
7.	Idol immersion	Communities in that part of Bengaluru	Current
8.	Biodiversity (Birds, aquatic life)	All citizens (?)	Current & Future
9.	Aesthetics and micro climate	Neighbourhood residents	Current & Future
10.	Recreation	Neighbourhood residents	Current & Future
11.	Micro-climatic benefits	Citizens in that part of Bengaluru	Current & Future
12.	Groundwater recharge	Neighbourhood residents, but larger community if it is shipped out by tankers	Current & Future
13.	Storage of storm water for supply	Communities in that part of Bengaluru	Future
14.	Storage of treated water for supply	Communities in that part of Bengaluru	Future
15.	Irrigation	Far downstream villagers	Current/Future
16.	Irrigation	Farmer in next district	Future

Stakes and stakeholders

The literature on Bengaluru's "lakes" does sometimes talk nostalgically of the golden past (Unnikrishnan and Nagendra, 2014), but it is clear that if there are no farmers in the locality, these tanks cannot be used for local irrigation. Furthermore, the water quality is simply not adequate for use in drinking or bathing. The current visible stakeholders in the lakes are primarily, and increasingly, the middle-class urban citizens who would like to use the lake as a green space for various purposes, and to a lesser and declining extent those who would like to use the water body for subsistence purposes (fishing,

washing, fodder collection, etc.).

What the Jakkur and Bellandur lake events show, however, is that there is also a major societal stake in the water in the lake, or rather water that is flowing through the lake system. If this is treated water, BWSSB considers it as its private property that can be sold to users who are willing to pay for it. The state government also treats such water as its property, pumping it off to Kolar to appease a farmer lobby. Downstream farmers, weak though their voices may be, also see this water as their customary right (Jamwal et al., 2014; Vishwanath, 2017). Simultaneously, lake activists are touting the groundwater recharge benefits of this water in a region where groundwater levels have dropped alarmingly (Ramachandra and Mujumdar, 2009).[18]

Looking ahead, other water resource-related, rather than biodiversity conservation related, uses of lakes are being proposed. One idea is that lakes could store treated water that can then be supplied to neighbourhoods for reuse (CSE 2012). Alternatively, lakes could be rainwater harvesting structures where again the stored stormwater could be pumped out regularly and used locally in a city running short of water.

This sequence of past (or outgoing), current, and future stakes in lakes and the water moving through or stored in them is captured in Table 1. The list is much longer than the local stakes that have dominated the discourse. Note also that the stakeholders need not be citizens living in the immediate vicinity of the lake, they could be many kilometres downstream or in the next district over. Even in the case of fishing, our interviews with fishermen revealed that the person who won the fishing rights auction and all of his employees were from out of state, not at all from the neighbourhood.

Bio-social relationships

How are the stakes or uses related to each other? Some of the uses of the lake or the lake water are non-competing or jointly produced. For instance, a full lake provides aesthetic pleasure to nearby apartment dwellers, habitat for birds and fish, and green space for various ways of enjoying the lake as an environmental amenity. Even the washing of clothes is a relatively low consumption (and low pollution) use, as is washing of livestock.

But some of the uses clearly compete strongly with each other. Each drop lost to groundwater recharge is that much less water available downstream, or for farmers in Kolar, or for local supply. Similarly, local use or reuse will deprive downstream or distant irrigation users.[19] In fact, even the environmental amenity use is not really non-consumptive as keeping a lake filled implies significant losses to evaporation. For instance, in the case of Jakkur lake, of the approximately 8 MLD continuous inflow from the STP, about 3 MLD is lost to evaporation during the peak summer months, about 2.5 MLD to recharge, and only the remaining 2.5 MLD goes downstream (Veena Srinivasan, ATREE, unpublished data). Thus, there are clear trade-offs between different uses of water, including its amenity use and other overtly consumptive uses.[20]

How are these stakes affected by other actions? Answering this question is central to understanding why a lake degrades, and from which perspective. The Ulsoor and Bellandur cases show the close connection between activities of individuals, households, or agencies in the catchments of the lakes and the condition of the lake (and therefore the flow of benefits to the lake or water users). Urban domestic water use by definition generates return flows—only about 20-25% of the gross water used by a household is consumptively used. This return flow happens all year round, as there is little seasonal variation in urban water use. In a densely populated urban catchment, this flow can be as much as the annual stormwater runoff, but is distributed across the year. Whether the return flow in the form of sewage, gets treated or not, enters the stormwater drain or not, bypasses the lake or not, and is diverted to industrial use or not end up determining the

[18] One other frequently mentioned benefit from lakes is flood control (e.g., Ramachandraiah and Prasad, 2004; Ramachandra et al.,2012). But we have not included this in Table 1 because the requirements of flood control (keeping the lake empty so as to trap the occasional flood when it comes) are antithetical to the way the lake would be managed for all other benefits (keeping the lake full). Moreover, if there were no lakes, the water would actually have drained off more quickly from the Bengaluru plateau, so it is a mistake to think of lakes as conferring flood control benefits.

[19] In theory, reuse in urban areas could again generate 70% return flows. However, it is likely that much of the reuse, especially of treated water, will be for gardening, hence consumptive in nature.

[20] To put things in perspective, 3 MLD can support the domestic water requirements of 30,000 people quite comfortably.

condition of the lake. BWSSB, the manager of much of Bengaluru's water and wastewater,[21] is thus a major actor influencing the fate of its lakes.

Similarly, paved or built-up urban catchments generate much more storm runoff than rural catchments. Moreover, they are more likely to encroach upon stormwater drains. If the latter are choked, they will cause flooding in the catchment. But if not, the storm runoff into the lake will be much higher than in a rural setting, and subsequent baseflows will be much lower, especially if the groundwater has anyway been depleted. Thus, the management of stormwater drains by BBMP, the overall management of runoff, and the status of groundwater in the catchment significantly influence lake conditions.

Indeed, the influences may come from even further "upstream". Much of Bengaluru's water supply comes from the Cauvery river, and so in that sense much of the sewage flowing towards the lakes is Cauvery water. This links Bengaluru's lakes to the decisions of the Cauvery Water Disputes Tribunal (CWDT). Similarly, the impacts of lake-level decisions extend downstream. Not only are downstream lakes within the city affected by upstream ones (as when the sewage bypassed by upstream lakes enters Bellandur and Varthur lakes), but lake-level decision can also get entangled in river basin disputes. For instance, the CWDT has assumed that 80% of the water pumped from the Cauvery by Karnataka for urban use returns to the Cauvery. But in fact, a large fraction of the water pumped to Bengaluru ends up in the Dakshina Pinakini river basin, which is separate from the Cauvery. The downstream state of Tamil Nadu may lay claim to this water, even as the Government of Karnataka proposes to send it off to Kolar arguing that it is "Karnataka's share of water".[22] In other words, while lake land and lake biota might be a common-pool resource at a local scale, lake water certainly is interconnected at a much larger scale, and in certain unidirectional ways (e.g., upstream actions impacting downstream users). An "upstream-downstream interconnected, multi-stakeholder socio-hydro-ecological resource" might be a more appropriate description than a "common-pool resource".

Institutional arrangements

How then do the formal institutional arrangements, i.e., the distribution of roles and responsibilities amongst state agencies, fit the needs of this multi-stakeholder, interconnected socio-hydro-ecological resource? How are the custodial, developmental, regulatory, and coordination roles within government being distributed and discharged?

As indicated earlier, lake governance (even in the simple paradigm of green space management) is highly fragmented and in constant flux, even in the simple matter of who should be the custodian of Bengaluru's lakes. The decentralization laws passed in the mid-1990s decreed that local water bodies are to be in the custody of the third-tier of government, which is the elected municipal body; in this case BBMP. So the starting point for lake governance should be making BBMP the custodian of all lakes. This has clearly not happened. Only about half of the water bodies are with BBMP, the others are still largely with BDA, and a few with KFD, KLCDA (the privatised ones), and MID. Neither parastatals such as the BDA nor state government departments such as KFD or even MID have any special skills in managing urban lakes for environmental amenities or local non-irrigation use. In addition, they do not, by definition, have direct downward accountability to the citizens of Bengaluru.[23] Discussions with lake activists indicate that while individual officers in all agencies can be helpful at times, on the whole the BBMP's lakes wing has been more supportive and responsive than other agencies. Yet, even as the Expert Committee was working towards its recommendations on Bellandur lake rejuvenation, the state government reversed its order on transferring custody of Bellandur lake to BBMP, leaving it and many other lakes in the custody of BDA.

At the same time, the entire discussion on BBMP versus BDA, KFD or LDA/LCDA suffers from a major limitation. It focuses attention on the management of lakes as green spaces analogous to public parks. In

[21] We say "much of" because around 30% of water use comes from groundwater pumped by more than 4,00,000 borewells operated by individuals across the city.

[22] Sentiments voiced in the Expert Committee deliberations.

[23] The department's report to their state-level ministers, whereas the governing boards of the parastatals are stacked with bureaucrats and political appointees from any part of the state. There is also no statutory or customary practice of public hearings, or even responsiveness to RTI requests.

the process, the management of the water and treated or untreated wastewater, which makes the green space a lake, is overlooked.[24] Water supply is largely controlled currently by the BWSSB, and even if groundwater pumping is entirely unregulated, the disposal of effluents (whether originating in Cauvery water or groundwater) happens in stormwater drains and sewer lines, the latter owned by BWSSB. BWSSB is the producer of both negative (untreated sewage) and positive (treated sewage) externalities for lakes. It is also potentially the beneficiary of the positive externality of groundwater recharge by lakes, and could even consider using the lakes as repositories of treated water or stormwater for local use. But as the above events show, BWSSB is far from internalizing these ideas. Its historical focus has been on pumping surface water from distant locations and distributing it, whereas local water, ground or surface, has never been part of its thinking.[25] On the other hand, wastewater is simply a nuisance on which investment and attention has always been lagging. BWSSB has, however, begun to pay more attention to wastewater reuse. The Jakkur lake experiment based on treated water inflows thrived as long as BWSSB was not thinking of selling that water, but is now in jeopardy precisely when BWSSB starts doing the "right" thing of "monetizing" treated wastewater. This points to not just a lag in BWSSB's *technical* thinking, but the whole question of coordination and accountability. Similar to other parastatals, but perhaps more so, BWSSB lacks transparency and downward accountability to the citizens of Bengaluru (Lele et al.,2016). This in turn makes it difficult to bring about any coordination between its short- and long-term plans and those, say, on the lake front.

What about the role of environmental regulation? Urban catchment runoffs and return flows are almost by definition polluted, and so ensuring that lake water meets certain quality standards so as to not endanger aquatic life nor pollute groundwater water or downstream agriculture and thereby endanger public health, requires an environmental regulator to play a role - in this case, KSPCB. But KSPCB's entire focus has been on enforcing discharge standards on industries and, to some extent, on STPs while paying little attention to ambient water quality. This is not just an executive choice. There is, surprisingly, no statutory requirement in India that ambient water quality meet any particular standards depending upon the use it is to be put to (Jamwal et al.,2016).[26] Under public pressure, KSPCB has initiated some monitoring of lakes, but when asked, they do not have any systematic schedule or framework. They have also supposedly initiated "Watchdog Committees" (Chetan, 2015), but neither their roles and responsibilities, the authority they will be given to discharge these, and the process for their constitution is clearly spelt out anywhere. They remain, at best, manual and qualitative supplements to KSPCB's weak technical monitoring of lakes.

Lake management also has downstream and off-site impacts on water *availability*, and managing these impacts requires regulating water use and diversion at a level beyond the lake and even the city, a role for a state-level regulator. At the moment, the state government is both proposer and disposer of how water may be transferred across all jurisdictions, be they individual lakes, BWSSB, BBMP, districts, sectors, and so on. Furthermore, this process is entirely non-transparent and hence hardly accountable.[27] A Karnataka State Water Council was proposed as part of a World Bank-supported water sector improvement project[28], but was never implemented. The idea of state-level regulatory authorities, as attempted by Maharashtra state, comes with its own pros and cons. That in a water-scarce region water transfers or allocation across regions would be a highly political matter is a given, but these decisions need to have some element of broader democratic process, such as transparent sharing of plans, public hearings about them, etc. This is missing so far and is significantly affecting the future of Bengaluru's lakes.

Finally, the state government also has the authority to assign roles and responsibilities, support their execution, and ensure their coordination across

[24] Or at best it is treated as a nuisance requiring a one-time fix, namely, a bypass drain.
[25] BWSSB has no hydro-geologists or wing for groundwater use and/or regulation.
[26] What exist are "water quality criteria" that are used to simply indicate what purpose a water body may or may not be put to (CPCB 2012).
[27] For instance, the detailed project report (plan) for the Kolar project is not in the public domain, although construction has already begun.
[28] KUWASIP, http://www.kuidfc.com/kuwasip.php

actors. From all the evidence and experience presented so far, it is clear that the state government has not thought about how to organize lake governance beyond the physical space of the lake. Indeed, there is room to believe that the manner in which it has transferred lake custody to different agencies was influenced not just by objectives of lake conservation but often with an eye to the real estate that the lake land represents. Custody with BDA has often translated into BDA officially but illegally converting lake land into real estate, or the land being otherwise handed out for various public and private purposes (Koliwad et al., 2016). Similarly, the LDA was simply a vehicle for spending donor funds, not meant to play a role beyond rejuvenation projects. The recent move to handover all lake management in Bengaluru to MID, coming on the heels of the move to pump all treated water from the STP near Bellandur to Kolar district, suggests that the state government wants to continue its control over land, financial resources, and now Bengaluru's water and wastewater as well, even after these waters enter the lakes. In fact, leaked government correspondence shows that this move was a response to objections from the KLCDA to the Bellandur-Kolar treated water transfer project.[29]

Not surprisingly then, the role of the KLCDA has been quite unclear and confusing. Ostensibly, this agency was to have sweeping powers and jurisdiction: custodianship, planning, rejuvenation, monitoring, policing, evicting encroachments, technical support, and so on. The supposed advantage is having management in the hands of a specialized body, but it is again a parastatal governed by bureaucrats and unaccountable to the citizenry of Bengaluru, and in practice is completely under-staffed. It has announced its own "Lake Wardens" programme, which again looks like a sop to citizen participation with no authority delegated. Meanwhile, the KLCDA's documents talk about it playing a coordinating role across agencies, providing technical support (which actually translates more into regulation, as it "ratifies" renovation plans, rather than helping to make them), and doing monitoring (which it seems to outsource to others). It has, however, no "teeth" by which it can actually ensure coordination between BWSSB and individual lake plans. KLCDA officials do not sit on BWSSB's board, and in the musical chairs of IAS and IFS[30] officers that constitutes parastatal boards (and even municipal top echelons), it is unlikely that one parastatal can be held accountable by another one.

The literature on polycentric governance (Schlager and Blomquist, 2000) tells us is that 'single agency' governance, of the kind proposed under the KLCDA Act and advocated by KLCDA heads (e.g., Basappa, 2009) will not work. It is simply not possible to integrate all necessary resources and jurisdictions under any one agency, environmental processes will always "escape" any single jurisdiction. For instance, KLCDA might take over custodianship of all lakes, but it cannot also manage Bengaluru's water and wastewater, a resource crucial to lake management. Moreover, allowing a parastatal agency such as the KLCDA to take over lake management also creates a democratic deficit.

Two important actors driving lake protection and rejuvenation in Bengaluru are citizen groups and the judiciary. Citizen action, primarily by residents around lakes but also supported by a number of activists and non-governmental organizations, has certainly been the prime mover for reimagining and renovating lakes. Citizens have fought against privatization, demanded funds for lake renovation and management, filed court cases and monitored renovation activities. While most of the action has been around specific lakes, there have also been court cases filed against the lake privatization policy as such and against lake degradation in general. But lake lovers groups have been generally slow to engage with BWSSB and its wastewater policy. Only in the last few years, some groups of full-time activists and advocacy groups are beginning to emphasize the wider context in which lakes are embedded (e.g., Vishwanath, 2017).

The judiciary has displayed a commitment to environmental issues. The High Court made the government expand the capacity of the STP next to Bellandur lake and later on banned the privatization of lakes. It has also sought to prevent further encroachment of existing lakes. More recently, as

[29] At the time of publishing this article, the Karnataka legislature had in fact completed this move by repealing the KLCDA Act and amending the Karnataka Tank Conservation and Development Authority (KTCDA) Act to include urban lakes as well, legitimising MID control (Government of Karnataka, 2018; Bharadwaj, 2018). The above discussion, however, applies equally to the MID or any new KTCDA that might be created.

[30] Indian Administrative Service and Indian Forest Service - two of India's central government services.

seen in the Bellandur case, the National Green Tribunal has been very active, pushing the state government to act quickly to address lake pollution. But as documented above, judicial impatience can be counter-productive. The judiciary also tends to use the essentialist language of "wetlands" and consequently, some of the resultant orders lack a strong scientific foundations - such as the order imposing a 75m no-construction buffer around "lakes/wetlands". Ultimately, the judiciary cannot and should not micro-manage how complex socio-environmental problems are dealt with – e.g., which industries to shut down, which apartments to impose STPs on, which drains to build - as these are all decisions within the domain of the executive and should remain so.

In short, in spite of pressure from citizens and the judiciary, the formal institutional arrangements

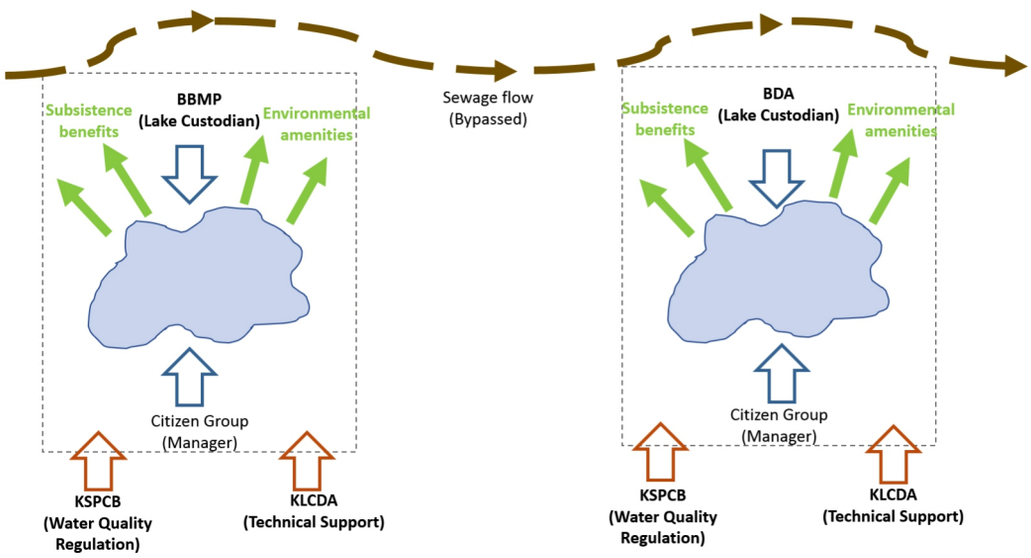

Figure 3: Institutional framework for lake governance as "urban commons". Dashed arrows indicate water and sewage flows, solid arrows the flow of benefits, and hollow arrows the actions by social actors.

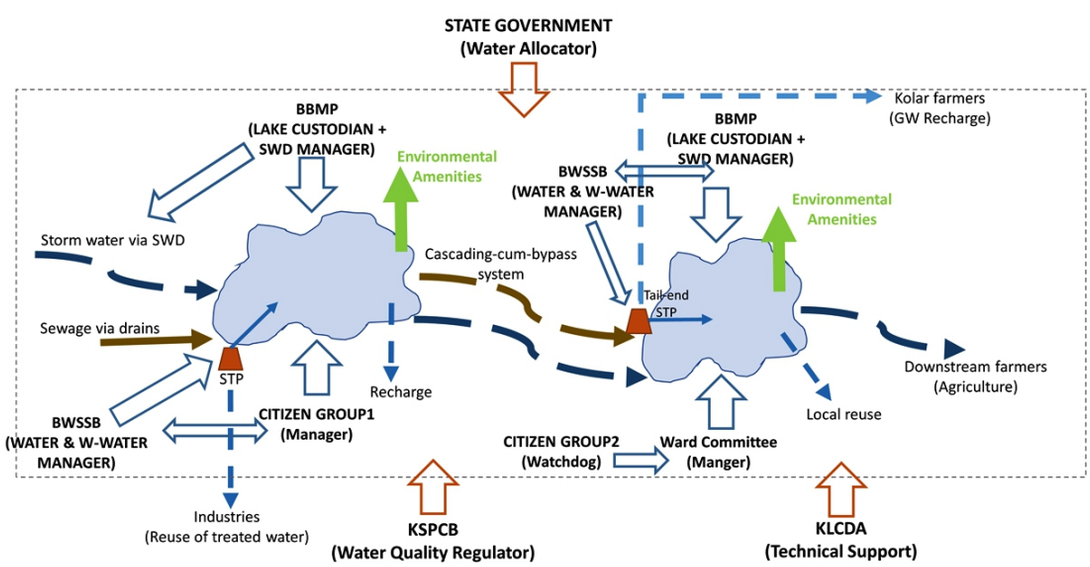

Figure 4: Institutional framework for lake governance as an interconnected, multi-scalar, socio-hydro-ecological resource. Dashed arrows indicate water and sewage flows, solid arrows the flow of benefits, and hollow arrows the actions by social actors.

suffer from multiple lacunae, namely, changing custodians, no mechanism for coordination with or accountability of the water-wastewater utility, no clarity about who owns the wastewater,[31] no clarity on overall water rights, and incomplete and feeble environmental regulation.

Implications for integrated urban lake-water governance

How can one conceptualise and move towards improved urban lake governance in Bengaluru? Following our three-part analysis of stakes and stakeholders, bio-social nature and institutional arrangements, it follows that we need a broader understanding of the stakes/stakeholders and the bio-social nature of lakes, from which new implications for institutional arrangements can be drawn. The former seems to be happening slowly, at least amongst a subset of full-time activists. In a recent paper, Enqvist et al. (2016) refer to "second generation lake groups"[32] as those who are aware of the larger context, particularly the importance of lakes for groundwater recharge and for local water in general. This understanding not only needs to spread wider, it also needs to deepen by including the possibilities of using lakes as structures from which the collected stormwater and/or treated wastewater can be used for local water supply, and the complex trade-offs that these new functions might involve. For instance, the evaporative losses from using lake as environmental amenities or the need to reduce lake water levels at the end of summer (and even mid-monsoon) if they are to have space to receive and store the monsoon (or returning monsoon) rains.

What does this broader understanding imply for institutional arrangements for lake governance? The current framework of lakes as "urban commons" is captured schematically in Figure 3, and an alternative "integrated lake-water governance" framework is presented in Figure 4. The biophysical 'framing' differs significantly between these two frameworks. In the former, sewage is a nuisance that must be diverted. In the latter, sewage gets treated and used locally where possible and so lakes become a part of the water management system of the city and its links with downstream farmers.

The institutional arrangements required differ correspondingly. In the commons framework, citizen groups and the official custodian of the lakes (shown in Figure 3 as BBMP or BDA) are the main actors involved and the planning and management is lake-specific. The collective action that is required is first to get some operational control for citizens over individual lakes and then to manage each lake to serve its (possibly multiple) local functions. Who the official custodian is does not matter too much, as long as they are willing to devolve control over these localised 'green spaces' to local groups. In terms of management, the main decision-making is a negotiation or coordination between different 'local' uses/users, such as traditional uses for fishing and clothes washing, and newer uses for jogging and conservation.

In the integrated framework, local-level collective action is necessary not sufficient, because the factors influencing lake functioning and the stakeholders involved are at larger scales. The first level of negotiation and coordination has to be between lake planning and management on the one hand and water and stormwater and wastewater planning and management on the other. In particular, lake plans need to be factor in BWSSB's wastewater plans, or conversely, BWSSB's plans for supplying water and handling sewage need to respect the needs of current lake (green space) users and potential lake water users in each neighbourhood. For instance, if lakes are to store treated water, small lakeside STPs rather than large centralized STPs must be part of BWSSB's vision. If treated water or rainwater stored in lakes is to be used in neighbourhoods for, say, landscaping, appropriate pipelines and pumping arrangements will have to be made by BWSSB. Moreover, if groundwater recharged by lake water is not to simply cross-subsidise the profits of private tankers who pump from near the lake, better regulation of the tanker industry and of groundwater would be required. Clearly then, not only technical coordination with BWSSB, but sustained citizen interaction to make BWSSB decentralise its whole approach to water and wastewater management would be required (similar to the decentralisation of lake management). The hollow arrow linking BWSSB and citizen groups indicate such an interaction. Eventually the interaction would have to lead to more citizen and expert representation on BWSSB's

[31] As a colleague at ATREE put it, claiming ownership over effluent from Cauvery water is one thing, but BWSSB wants to claim ownership of effluents generated even from the use of private borewell water.

[32] Although our interviews suggest that these are full-time water/lake activists/professionals/researches.

governing body than exists today, i.e., democratization of BWSSB (Vaidya, 2016). This citizen-BWSSB interaction is shown at the bottom left in Figure 4.

Coordination is also required between BBMP's management of stormwater and the managers of individual lakes. Also required is coordination between upstream and downstream lake managers, because upstream decisions have downstream implications. This strengthens the argument for having BBMP as the sole custodian of all lakes within Bengaluru, as it is the duly elected body representing, working for and answerable to Bengaluru's citizens.[33] This is depicted at the top of Figure 4. The custodianship must include rights to regulate fishing as well, which are currently vested in the Fisheries Department.

How is this 3-way coordination between BBMP, BWSSB and citizen groups to be achieved? The conventional approach for citizen involvement has been to set up lake-level committees. KLCDA had come up with a template for MoUs between lake custodians and communities, or even including companies that might be willing to contribute funding from corporate social responsibility (CSR) initiatives. But these MoUs have no legal enforceability. Citizen groups in this model have remained as watchdogs, with no teeth or operational control. BBMP's MOUs with a few citizen groups wherein day-to-day management is delegated to the group are an improvement, but they need to be converted into contracts to become secure and legally enforceable (Figure 4, left). In this case, steps would also have to be taken to ensure the democratic functioning and accountability of these groups, such as by linking them to ward committees, which represent the lowest tier of urban governance. Alternatively, the management function could be assigned to the ward committees themselves, with citizen groups playing a watchdog role (Figure 4, right).

Simultaneously, one would need mechanisms for making BWSSB more open and accountable to BBMP and the citizens of Bengaluru. The process of establishing more democratic control and accountability over BWSSB will, of course, not be an easy one. Some have suggested that scarcity of Cauvery water in the periphery would give citizens the freedom to determine what happens to their wastewater (Enqvist et al., 2016). To an extent, the requirement that large apartment complexes - which tend to be built in the peripheral region - treat their own wastewater gives citizens the ability to mobilize treated wastewater without BWSSB's concurrence. But it is not clear that this alone will be enough, given that the costs of moving water are always high, and there are environmental restrictions on the disposal of treated water. Changing the governing structure of BWSSB to include direct citizen representation, expert representation and BBMP representation, and changing its mandate to make it responsible for integrated urban water and wastewater management would be necessary (Lele, 2017).

Finally, at the state-level, mechanisms would be required for the allocation of Cauvery water to the city of Bengaluru and for setting limits on how much of this imported Cauvery water and local water (surface or ground) can be used and reused within its boundaries as against its obligations to downstream or offsite stakeholders. One possible mechanism for this allocation is independent state-level water resource regulatory authorities, but the experience from Maharashtra is mixed (Wagle and Warghade, 2010; Wagle, Warghade and Sathe, 2012). Alternatively, existing state-level decision-making could be made more transparent and participatory through the route of public hearings by a state-level water allocation committee that would also contain independent members (these citizen-state interactions are not shown in so as to not clutter the diagram). These city-rural or city-downstream allocations would have to be nested within the inter-state allocation mandated by the CWDT.

Are there other functions to be fulfilled? The kind of complex governance proposed in Figure 4 will require an enormous amount of information and understanding of inter-linkages and processes. Current research is led by a few dedicated researchers, and systematic monitoring, especially of water/sewage flows, is almost non-existent. Therefore monitoring and technical support is an important function that a dedicated agency could still

[33] This is not to say that BBMP is a perfectly functioning democratic institution. In a city of 9.6 million people, a municipal corporation of 200 wards means an average of 50,000 people in each ward, making even ward-level participation in governance quite challenging, not to mention the political resistance to institutionalizing such participation through (for instance) ward committees. But a democratically elected body has the long-term potential for accountability that a para-statal does not.

play and this could extend to all urban lakes in Karnataka (see Figure 4, bottom right). We have denoted it as KLCDA, but this would a version of the erstwhile agency, one with a narrow mandate but substantial technical resources to fulfill it.

The water quality regulation function would still be played by KSPCB (see Figure 4, bottom left). But to make this regulation meaningful, it would have to set legal standards for ambient lake water quality, and then monitor and enforce pollution of multiple types and at multiple scales. Again, for this work would require a much more transparent and participatory process than is currently followed by KSPCB; this would mean a restructuring of their governing bodies as well (Lele and Heble, 2016).

Concluding remarks

Understanding the causes of any environmental problem and proposing solutions requires one to frame the problem in some way that identifies stakes (and hence defines what is degradation), bio-social relationships (thereby enabling the pinpointing of the proximate causes of such degradation in the form of trade-offs between stakes, absence of collective action amongst users, or externalities caused by some others), and institutional arrangements (that explain the existence of the proximate factors to some extent). Different framings prioritize different values or stakes, different bio-social processes, and different solutions. While no framing is perfect, there can be effective or less effective framings (cf. Entman, 1993).

The discourse on urban lake governance in India has tended to frame the lake problem as primarily a problem of managing the urban commons, similar to urban green spaces. Environmental amenities for modern middle-class urban citizens and subsistence uses for traditional users are the main direct benefits of these commons and the main drivers of citizen activism. But other benefits such as their role in groundwater recharge are also spoken of.[34] But an implicit assumption is that these benefits can be made available simultaneously if the lake is rejuvenated, i.e., that there is a potential win-win. Trade-offs are under-emphasized. Even documents that explicitly mentioned trade-offs (e.g., Anonymous, 2017) do not actually spell out the nature and extent of the trade-offs. This framing of multiple but synergistic benefits facilitates the characterisation of the resource as a common-pool resource, which can be saved and regenerated through local-level collective action typical under common property regimes.

This framing is important and useful for certain purposes, especially to trigger citizen action. The idea of "commons" as synonymous with "publicly accessible spaces" galvanized citizens in Bengaluru to oppose the privatization of lakes launched by the erstwhile LDA under the (misnamed) "public-private-partnership" concept. This "commons" framing, coupled with the idea of these water bodies as inherently "good"[35] has also helped galvanise opposition to the loss of lakes through the grabbing of their lands for real estate.

But as we have argued above, the commons framing is inadequate to explain and solve the problem of lake degradation. Urban lakes are inextricable parts of the water and wastewater system of modern cities. Water is neither a win-win resource, nor is it simplistically common-pool, as it moves uni-directionally. Water consumed, diverted or polluted upstream affects downstream users but not vice-versa. Even the so-called "non-consumptive" use of lakes as environmental amenities actually leads to significant evaporative losses. This does not fit the characteristics of common-pool resources, nor will common property or collective action produce win-win solutions for all. Citizens in the vicinity of Bellandur lake are up against the actions of several million citizens in the Bellandur catchment who may never visit Bellandur lake and may not particularly care about how their outcomes affect the lake. In what sense then is Bellandur lake an urban commons?

One needs to therefore locate the bio-social nature of lakes within ideas of upstream-downstream linkages, catchment-lake linkages, water-wastewater linkages, groundwater-surface water linkages and engineered linkages across multiple scales of stakeholders to trigger a different process of thinking about solutions. The solutions also then need to go beyond the lake. The rejuvenation template currently focuses on desilting, bunding and walkway construction, island creation, bypass drain

[34] Nagendra (2010) says "Groundwater recharging constitutes probably the most critical use of lakes in water-starved Bengaluru."
[35] Hence invoking terms such as "lakes" and "wetlands", and not "water bodies" or "tanks".

creation, tree planting, park creation, fencing, etc. This fits the needs and abilities of agencies such as LDA because they can design and propose civil engineering plans with this template to support their requests for funds, and then execute the "works". Citizen participation then gets reduced to ensuring proper implementation of the rejuvenation project and proper monitoring and subsequent maintenance of the lake—that is, of its trees, paths, lights, fences, and so on.

What our analysis suggests is that the intertwining of urban lakes with water and wastewater means the intertwining of urban lake governance with water-wastewater governance, what we call integrated lake-water governance. This draws our attention to the agencies beyond the lake custodian who affect lakes - the water-wastewater utility and state government that may allocate and transfer treated water away from the city or a downstream state that may demand a status quo in return flows - and the institutional arrangements, political economy, and cultures shaping their decisions. Integration is then about both coordination between these agencies, lake custodians and lake managers, as well as democratizing their decision-making. This includes empowering the third tier of government (the urban municipal body) to take custodianship of its lakes, and to demand the cooperation of parastatals that are often ostensibly set up to address the same city's water and wastewater problems. This applies not just to Bengaluru but potentially all south Asian cities trying to manage urban lakes in the face of landuse transformation, wastewater generation and freshwater shortages.

This is not to suggest that integration or democratization are easy to achieve or a panacea for urban lake-water problems. We have not, for instance, looked into the political economy of water, wastewater or urban lake and land management. Factors such as the unabated growth of Indian cities, which are putting pressure on a city's resources and amenities, are also significant. However, the broader framing of lake-water governance proposed here can galvanize more fruitful thought and action around this admittedly "wicked" problem (Rittel and Webber, 1973).

References

Anonymous. 2016a, June 5. Bellandur froth poisons Yemlur lake now. Deccan Chronicle. Retrieved from http://www.deccanchronicle.com/nation/current-affairs/050616/bellandur-froth-poisons-yemlur-now-in-bengaluru.html. (Accessed on 21st August, 2017)

Anonymous. 2016b, July 13. Jakkur lake rejuvenation : Lessons in impact of strong community leadership. Sustainability Next. http://sustainabilitynext.in/case-study/jakkur-lake-rejuvenation-lessons-in-impact-of-strong-community-leadership/ (Accessed on 25th October, 2017)

Anonymous. 2017. Reimagining urban lakes: Understanding and managing tradeoffs, pathways to restoration, institutions and stakeholders. Public presentation. Bengaluru: Biome Environmental Trust. (Accessed on 18th August, 2017)

Aravind, I. 2016 March 20. Bengaluru's Ulsoor Lake turns into fish graveyard: Is pollution plaguing water bodies? The Economic Times. (http://economictimes.indiatimes.com/news/politics-and-nation/bengalurus-ulsoor-lake-turns-into-fish-graveyard-is-pollution-plaguing-water-bodies/articleshow/51473174.cms.

Baindur, M. 2014. Bangalore lake story: reflections on the spirit of a place. Journal of Cultural Geography 31 (1): 32-56.

Baradwaj, A. 2014. Awareness and participation towards encouraging sustainable urban water management: A case study of the Jakkur lake, Bangalore. M.A. thesis. Department of Design, Aalto University, Helsinki, Finland.

Bharadwaj, K. V. A. 2018, April 1. Governor signs lake amendment. The Hindu. Retrieved from http://www.thehindu.com/news/cities/bangalore/governor-signs-lake-amendment/article23404400.ece. (Accessed on 1st April, 2018)

Basappa, B. 2009. Conservation and management of urban lakes. Presentation made at Brainstorming session on conservation and management of urban lakes in Bangalore held at Centre for Ecological Sciences, Indian Insititute of Science, Bengaluru on 26 September 2009.

Chetan, R. 2015, September 26. Ex-IAF officer wins his war. Bangalore Mirror. Retrieved from http://bangaloremirror.indiatimes.com/bangalore/cover-story/G-B-Athri-Madivala-Lake-BWSSB-BDA-LDA-KSPCB/heroesshow/49109108.cms. (Accessed on 26th August, 2017)

CPCB (Central Pollution Control Board). 2012. Water Quality Criteria. New Delhi: CPCB. Available at http://cpcb.nic.in/Water_Quality_Criteria.php.

CSE (Centre for Science and Environment). 2012. Excreta Matters. New Delhi, India: CSE.

D'Souza, R. and Nagendra, H. 2011. Changes in public commons as a consequence of urbanization: The Agara lake in Bangalore, India. Environmental Management 47 (5): 840-850.

Deepika, K.C. 2016, May 1. 'Well-maintained' and 'rejuvenated' lakes fare no better. The Hindu. Retrieved from http://www.thehindu.com/news/cities/bangalore/well maintained-and-rejuvenated-lakes-fare-no-better/article8541895.ece. (Accessed on 22nd May, 2016)

Desai, P. 2013, August 31. Jakkur Lake: a potential model for urban water sustainability. The Alternative. Retrieved from http://www.thealternative.in/society/jakkur-lake-a-potential-model-for-urban-water-sustainability/. (Accessed on 21st August, 2017)

DHNS. 2016, September 8. Dead fish found floating on polluted Varthur lake. Deccan Herald. Retrieved from http://www.deccanherald.com/content/569178/dead-fish-found-floating-polluted.html. (Accessed on 21st August, 2017)

Enqvist, J., Tengö, M. and Boonstra, W.J. 2016. Against the current: rewiring rigidity trap dynamics in urban water governance through civic engagement. Sustainability Science 11 (6): 919-933.

Entman, R.M. 1993. Framing: Toward clarification of a fractured paradigm. Journal of Communication 43 (4): 51-58.

Expert Committee. 2016. Expert committee report on rejuvenation of Bellandur lake. Bengaluru: Department of Urban Development, Government of Karnataka.

Express News Service. 2017, February 7. City's treated sewage water to flow to kolar by August. The New Indian Express. Retrieved from http://www.newindianexpress.com/cities/bengaluru/2017/feb/07/bengalurus-treated-sewage-water-to-flow-to-kolar-by-august-1567840.html. (Accessed on 7th February, 2017)

Gowda, K. and Sridhara, M.V. 2007. Conservation of tanks/lakes in the Bangalore metropolitan area. Management of Environmental Quality: An International Journal 18 (2): 137-151.

Gurunathan, A. and Shanmugham, C.R. 2006. Customary Rights and their Relevance in Modern Tank Management: Select Cases in Tamil Nadu. Paper presented at Workshop on "Water, Law and the Commons". Organised by International Environmental Law Research Centre (IELRC) at Delhi, 8-10 December 2006.

Jamwal, P., Lele, S. and Menon, M. 2016. Rethinking water quality standards in the context of urban rivers. Paper presented at Urbanization and the Environment: Eighth Biennial Conference of the Indian Society for Ecological Economics. Organised by INSEE at Bangalore, 4-6 January 2016.

Jamwal, P., Thomas, B.K., Lele, S. and Srinivasan, V. 2014. Addressing water stress through wastewater reuse: Complexities and challenges in Bangalore, India. In: Proceedings of the Resilient Cities 2014 Congress, organised by ICLEI – Local Governments for Sustainability, in cooperation with the City of Bonn and the World Mayors Council on Climate Change. Bonn, Germany, 29-31 May 2014.

Joshi, B. 2016, December 29. Yelahanka Power Plant could kill Jakkur Lake. The Economic Times. Retrieved from http://economictimes.indiatimes.com/news/politics-and-nation/yelahanka-power-plant-could-kill-jakkur-lake/articleshow/56231589.cms. (Accessed on 27th August, 2017)

Jumbe, A.S. and Nandini, N. 2009. Impact assessment of heavy metals pollution of Vartur lake, Bangalore. J. Applied Nat. Sci. 1: 53-61.

Khanna, B. 2016, March 20. Sewage, excess fish polluted Ulsoor Lake, says report. Deccan Herald. http://m.deccanherald.com/section.php?url=/content/535670/sewage-excess-fish-polluted-ulsoor.html&secid=7&p=1. (Accessed on 20th March, 2016)

KLCDA (Karnataka Lake Conservation and Development Authority). 2016. Revival of Bengaluru lakes. Paper presented at Workshop on "Bring Back the Lakes", organised by KLCDA. Bengaluru, India, 13 June 2016.

Koliwad, K.B., Kumaraswamy, H.D., Gopalakrishna, N.Y., Yavagal, B.R., Suresh Kumar, S., Haris, N.A., Puttannaiah, K.S., Krishnappa, M., Sudhakar, K., Gopalaiah, K., 2016. Report on Lake encroachment in Bangalore Rural and Urban areas (House Committee Report). Karnataka Vidhan Sabha Secretariat, Bangalore.

KPCL (Karnataka Power Corporation Ltd.). 2014. Form I, Pre-Feasibility Report and Proposed Terms of Reference (TOR) for proposed 1 x 350 MW Yelahanka Combined Cycle Power Plant (CCP). Bangalore: KPCL.

Lele, S. 2017, April 25. Investing crores but passing the buck. Economic Times. Retrieved from http://epaperbeta.timesofindia.com/Article.aspx?eid=31815&articlexml=ET-By-Invite-Investing-Crores-but-Passing-the-25042017002030. (Accessed on 18th April, 2016)

Lele, S. and Heble, N. 2016, June 16. Changes in pollution board undermine accountability. Deccan Herald. Retrieved from http://www.deccanherald.com/content/552524/changes-pollution-board-undermine-accountability.html.

Lele, S., Kuttuva, P. and Heble, N. 2016, December 6. BWSSB's Wrong Approach. Deccan Herald. Retrieved from http://www.deccanherald.com/content/585028/bwssbs-wrong-approach.html.

Lele, S. and Srinivasan, V. 2017, August 4. Death knell for citizen-led lake governance. Deccan Herald. Retrieved from http://www.deccanherald.com/content/626305/death-knell-citizen-led-lake.html.

Meenu, S., Pavanika, T., Praveen, D., Ushakiran, R., Vinod Kumar, G. and Anjum, S.V. 2015. Ulsoor lake: Grey to green. Indian Journal of Science and Technology 8 (28):1-6.

Mundoli, S., Manjunath, B. and Nagendra, H. 2014. Effects of urbanisation on the use of lakes as commons in the peri-urban interface of Bengaluru, India. International Journal of Urban Sustainable Development 7 (1): 89-108.

Murphy, A. 2017. Making Space in a Megacity: The Evolving Stewardship of Bangalore's Urban Lakes. Master's thesis. Stockholm Resilience Centre, Stockholm, Sweden.

Nagendra, H. 2010. Maps, Lakes and Citizens. Seminar 613: 19-23.

Nagendra, H. and Ostrom, E. 2014. Applying the social-ecological system framework to the diagnosis of urban lake commons in Bangalore, India. Ecology and Society 19 (2): 67.

Nagendra, H. and Unnikrishnan, H. 2016, February 1. Rediscovering history: the saga of Sankey tank. The Hindu. Retrieved from http://www.thehindu.com/news/cities/bangalore/rediscovering-history-the-saga-of-sankey-tank/article8177006.ece. (Accessed on 9th February, 2016)

NGT (National Green Tribunal). 2017a. In the matter of: D. Kupendra Reddy Vs. State of Karnataka & Ors. and Court on its own Motion Vs. State of Karnataka. M.A. No. 440 of 2017 dt. 19 April. New Delhi: NGT.

NGT (National Green Tribunal). 2017b. In the matter of: D. Kupendra Reddy Vs. State of Karnataka & Ors. and Court on its own Motion Vs. State of Karnataka. M.A. No. 589 and 592 of 2017 dt. 18 May. New Delhi: NGT.

Patil, N.K., Prabhakara, K.S., Sadashivaiah, A.S., Ramamurthy, P.B., Srivastava, I.B., Meena, B.L., Siddaiah, Srinivasachari, P.N., Saibaba, K.S., Mukunda, H.B., 2011. Preservation of Lakes in the city of Bangalore. Committee report. Bengaluru: High Court of Karnataka.

Penny, G., Srinivasan, V., Dronova, I., Lele, S. and Thompson, S. 2016. Spatial characterization of long-term hydrological change in the Arkavathy watershed adjacent to Bangalore, India. Hydrology and Earth System Sciences Discussions 22 (1): 595-610

Ramachandra, T.V., Aithal, B.H. and Kumar, U. 2012. Conservation of wetlands to mitigate urban floods. Resources, Energy and Development 9 (1): 1-22.

Ramachandra, T.V., Aithal, B.H., Vinay, S. and Lone, A.A. 2013. Conservation of Bellandur Wetlands: Obligation of Decision Makers to Ensure Intergenerational Equity. ENVIS Technical Report 55. Bangalore: Energy & Wetlands Research Group, Centre for Ecological Sciences (CES), Indian Institute of Science (IISc).

Ramachandra, T.V., Aithal, H.B., Vinay, S., Setturu, B., Asulabha, K.S., Sincy, V. and Bhat, S.P. 2015. Vanishing lakes interconnectivity & violations in valley zone: Lack of co-ordination among para-state agencies. ENVIS Technical Report 85. Bangalore: Centre for Ecological Sciences (CES), Indian Institute of Science (IISc).

Ramachandra, T.V., Asulabha, K.S., Sincy, V., Bhat, S.P. and Aithal, B.H. 2016. Wetlands: Treasures of Bangalore: Abused, polluted, encroached, and vanishing. ENVIS Technical Report 101. Bangalore: Centre for Ecological Sciences (CES), Indian Institute of Science (IISc).

Ramachandra, T.V., Mahapatra, D.M., Bhat, S.P., K S, A., Varghese, S. and Aithal, B.H. 2014. Integrated wetlands ecosystem: Sustainable model to mitigate water crisis in Bangalore. ENVIS Technical Report 76. Bangalore: Centre for Ecological Sciences (CES), Indian Institute of Science (IISc).

Ramachandra, T.V. and Mujumdar, P.P. 2009. Urban floods: Case study of Bangalore. Disaster & Development: Journal of the National Institute of Disaster Management 3 (2): 1-97.

Ramachandraiah, C. and Prasad, S. 2004. Impact of urban growth on water bodies: The case of Hyderabad. Working Paper 60. Hyderabad: Centre for Economic and Social Studies.

Ramamurthy, R. 2016. Personal communication. In person. 1 July 2016.

Rao, M.M. 2016, March 15. Result of the tests on Ulsoor lake is alarming, says researcher. The Hindu. Retrieved from http://m.thehindu.com/news/cities/bangalore/result-of-the-tests-on-ulsoor-lake-is-alarming-says-researcher/article8353922.ece. (Accessed on 15th March, 2016)

Rittel, H. W. J. and M. M. Webber. 1973. Dilemmas in a General Theory of Planning. Policy Sciences 4 (2): 155-169.

Sahu, S. 2016, April 18. Residents ask govt to save Kaikondrahalli, Kasavanahalli lake wetlands. Citizen Matters. Retrieved from http://bangalore.citizenmatters.in/articles/save-kaikondrahalli-and-kasavanahalli-lake-wetlands (Accessed on 25th October, 2017)

Samal, N.R., Saha, P., Roy, P.K., Biswasroy, M., Venkat Ramana, R. and Mazumdar, A. 2011. Limnological analysis of an urban polluted lake in Bangalore city in

India. Desalination and Water Treatment 30 (1-3): 217-228.

Schlager, E. and Blomquist, W. 2000. Local communities, policy prescriptions, and watershed management in Arizona, California, and Colorado. Paper presented at Constituting the Commons: Crafting Sustainable. Commons in the New Millennium: Eighth Conference of the International Association for the Study of Common Property. Bloomington, Indiana, USA, May 31-June 4, 2000.

SEIAA-K (State Environmental Impact Assessment Authority-Karnataka). 2015. Regarding Issue of Environmental Clearance for 1x350MW Yelahanka Combined Cycle Power Plant. SEIAA 20 IND 2014. Bangalore: SEIAA-K.

Shah, E. 2003. Social Designs: Tank Irrigation Technology and Agrarian Transformation in Karnataka, South India. New Delhi: Orient Longman.

Shivakumar, M.G., Cheluvaraju, R., 2016. Ancient irrigation systems of Karnataka. Paper presented at the panel discussion on Water Management: Learning from Ancient Wisdom and Traditional Practices, organized by Interntional Commission on Irrigation and Drainage, New Delhi, April 5, 2016.

Srinivasan, V., Lele, S., Thomas, B.K. and Jamwal, P. 2016. The transition from water scarcity to water pollution in Thippagondanahalli Halli catchment, India. Paper presented at Urbanization and the Environment: Eighth Biennial Conference of the Indian Society for Ecological Economics. Bangalore, 4-6 January 2016.

Srinivasan, V., Thompson, S., Madhyastha, K., Penny, G., Jeremiah, K. and Lele, S. 2015. Why is the Arkavathy river drying? A multiple-hypothesis approach in a data-scarce region. Hydrology and Earth System Sciences 19: 1905-1917.

Sudhira, H.S. and Nagendra, H. 2013. Local Assessment of Bangalore: Graying and greening in Bangalore – Impacts of urbanization on ecosystems, ecosystem services and biodiversity. In Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P. J., Mcdonald, R. I., Parnell, S., Schewenius, M., Sendstad, M., Seto, K. C. and Wilkinson, C. (Eds), Urbanization, biodiversity and ecosystem services: Challenges and opportunities. pp. 75-91. Dordrecht: Springer.

Sundaresan, J. 2011. Planning as commoning: transformation of a Bangalore lake. Economic and Political Weekly 46 (50): 71-79.

Swamy, R. 2017, February 17. Bengaluru's Bellandur lake catches fire again, toxic smoke over IT city's suburb. India Today. Retrieved from http://indiatoday.intoday.in/story/bengaluru-bellandur-lake-fire-pollution/1/884948.html.

Thomas, B.K., Eswar, M., Kenchaigol, S.D., Srinivasan, V. and Lele, S. 2015. Enhancing resilience or furthering vulnerability? responses to water stress in an urbanizing basin in southern India. Paper presented at ICARUS Fourth Global Meeting, organised by University of Illinois at Urbana-Champaign, Urbana-Champaign, 7-10 May 2015.

Unnikrishnan, H., Manjunatha, B. and Nagendra, H. 2016. Contested urban commons: mapping the transition of a lake to a sports stadium in Bangalore. International Journal of the Commons 10 (1): 265-293.

Unnikrishnan, H. and Nagendra, H. 2014. Unruly Commons: Contestations around Sampangi Lake in Bangalore. NMML Occaisonal Paper, New Series No.39. New Delhi: Nehru Memorial Museum and Library.

Unnikrishnan, H. and Nagendra, H. 2015. Privatizing the commons: Impact on ecosystem services in Bangalore's lakes. Urban Ecosystems 18 (2): 613-632.

Vaidya, A. 2016. Bangalore's Dead Fish Are Just a Symptom of the Time Bomb that Lies Ahead. The Wire. http://thewire.in/2016/03/21/bangalores-dead-fish-are-just-a-symptom-of-the-time-bomb-that-lies-ahead-25320/ (Accessed on 25 October, 2017)

Vaidyanathan, A. (Ed) 2001. Tanks of South India. New Delhi: Centre for Science and Environment.

van Ast, J., Bouma, J.J. and Bal, M. 2010. Governance Values of Water Systems in The Netherlands and India. Paper presented at the 7th Annual Work Conference of the Netherlands Institute of Government (NIG). Maastricht, Netherlands, 25-26 November 2010.

Vimos, T. 2008. Development of Jakkur and Sampigehalli Lake. Detailed Project Report (DPR). Bengaluru: Bangalore Development Authority.

Vishwanath, S. 2017, July 7. Cities must respect river basins. The Hindu. Retrieved from http://www.thehindu.com/life-and-style/homes-and-gardens/cities-must-respect-river-basins/article19232543.ece. (Accessed on 22nd August, 2017)

Visser, N. 2015. India's Bellandur lake is so polluted it caught fire. The World Post. 20 May: http://www.huffingtonpost.com/2015/05/19/india-lake-pollution-fire_n_7315038.html (Accessed 25th October, 2017)

Wagle, S. and S. Warghade. 2010. New laws establishing independent regulatory agencies in the Indian water sector: Long term implications for governance. South Asian Water Studies 2 (1): 49-77.

Wagle, S., S. Warghade and M. Sathe. 2012. Exploiting policy obscurity for legalising water grabbing in the era of economic reform: the case of Maharashtra, India. Water Alternatives 5 (2): 412.