Water crisis through the analytic of urban transformation: an analysis of Bangalore's hydrosocial regimes

By Michael Goldman and Devika Narayan

Abstract: This paper explores intensified water crisis in Bangalore (or Bengaluru) in India by using the analytic of three hydrosocial regimes: the catchment-based regime, the hydraulic regime and the speculative urban regime. It uses a wide range of qualitative interviews, scientific reports and secondary sources to analyze shifting urban trajectories, agrarian relations and their interlinkages with water. Historical ruptures (in the realm of governance, urban growth and changing urban–rural dynamics) allow one to highlight the complex role of speculative logics that shape urban expansion and water scarcity.

KEYWORDS

Water crisis; speculative urbanism; political ecology; global cities; Bangalore

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Introduction

Water shortage has plagued Bangalore (or Bengaluru) in India for many decades, but it is only recently that government officials, journalists, non-governmental organizations (NGOs) and citizens have adopted the language of crisis. In 2017, news headlines reflected this anxiety:

> Dry fact: Bengaluru is paying the price for killing its water bodies. (News Laundry, 2017)
>
> Bengaluru water crisis: Karnataka faces severe scarcity, 160 of 176 taluks (or sub-districts) declared drought-hit. (Financial Express, 2017)
>
> City of burning lakes: experts fear Bangalore will be uninhabitable by 2025. (The Guardian, 2017)
>
> Water Crisis: Is Bengaluru headed for Day Zero? (Times of India, 2018)

In early 2018, reportage on the water problem again surged with a BBC (2018) report naming Bangalore as the second most likely city in the world (behind Cape Town) to run out of drinking water in the near future. The year 2018 saw the city's largest lake catch fire multiple times due to the abundant toxins and debris that

were dumped in it. The previous year, the lake had been in the news for spewing large quantities of toxic foam onto the streets (Upadhya, 2017). Meanwhile, hydrologists, historians and geo- graphers are also beginning to portray the water situation in India's cities as a crisis (Lele et al., 2013; Mehta, Goswami, Kemp-Benedict, Muddu, & Malghan, 2013; Ranganathan, 2010). The shift in the discourse characterizing Bangalore's water situa- tion, from water shortage to crisis, offers an opportunity for academic reflection (Prakashi, 2017; Raj, 2013a, 2013b; Ramachandra & Aithal, 2016a).

In this paper, we argue that the main features of Bangalore's urban transformation – growing from a mid-sized town into the 'Silicon Valley of Asia' with promises of global- city infrastructure and expansion – are rooted in distinct practices of urbanization that are coupled with shifts in hydrosocial territorial use. This notion of hydrosocial territories comes from Boelens, Hoogesteger, Swyngedouw, Vos, and Wester (2016) who use it to capture the relational dimensions central to the making and unmaking of water scarcities and crisis. Their conceptual themes of the centrality of 'territorialization' and the 'politics of scalar territorial reconfigurations' not only underline the significance of interactions among social uses of land and water but also lead us to consider relational and scalar dimensions. We build on their work by conceptualizing Bangalore's interactions with its hydrological resources in terms of hydrosocial regimes, or relatively stable periods where sources and distributions of water and their spatial and social features develop and yet become limited due to continual urban expansion fuelled by different engines of growth. Here, we take as our starting point political ecology's foundational argument that natural and social processes are co-constitutive, always influenced by the contexts of political economies and ecologies in which they are situated.

We examine Bangalore's water infrastructure through the lens of its three hydro-social regimes: the catchment-based regime, the hydraulic regime and the speculative urban regime. Like recent scholarship of the political ecology of water (Swyngedouw, 2009; Bakker, 2010; Budds, Linton, & McDonnell, 2014), we call for a 'repoliticization' of water such that we account for the relative and uneven distribution of water scarcity and abundance. We add to their approaches by making visible new sociopolitical pressures on an already fragile, crisis-oriented hydrosocial terrain, showing how these pressures result from growth-based and then speculative dynamics. For example, we demonstrate the growing importance of finance capital in its extractive capacity, first through debt financing of the state's water infrastructure, and then its funding of economically and ecologically unviable, speculative projects through its onerous-debt financing of developers and city agencies. Here, we discuss the prevalent speculative urban tendency to bank on rural land values continuing to increase and people's investments to rise, which is linked to the imaginary that the intense water woes in both the city and the

countryside will resolve themselves without disruptions to the model of speculative urban growth and governance.

By delineating these trends as 'regimes' rather than straightforward chronologies, we want to underscore the point that it is not possible to separate colonial, state-capital and neoliberal eras of water use neatly since these hydrosocial dynamics are nested and overlapping. Instead, we prefer to stress key ruptures, events and conjunc- tures in which the political–ecological landscape changes dramatically (Sheppard et al., 2015). Our approach demonstrates how Bangalore's history of water struggles and crisis, when embedded in an understanding of shifting urban–rural relations and scalar power dynamics across (local–national–global) governance and economic structures, can reveal the central importance of hydrosocial territory-making and the ways its integrity can be undermined (Hommes, Boelens, Harris, & Veldwisch, 2019).

The analysis that follows is based on a combination of primary and secondary data sources. For the first two regimes we identify, the data come primarily from historical documents and reports, complemented by interviews by the authors of those works and other experts who are knowledgeable about Bangalore's water history. Our characteriza- tion of the third regime is based on our extensive research on the remaking of Bangalore as a 'global city'. Part of this research has involved conducting interviews (during the period 2007–16) with individuals working within the municipal water utility, Bangalore Water Supply and Sewerage Board (BWSSB), and with its hired consultants (e.g., Larsen and Tubro, PricewaterhouseCoopers), and current and retired administrators. We have also interviewed farmers, land brokers, real estate developers, water experts, water brokers, senior government officials, ecology researchers and low-level bureaucrats about themes related to water in Bangalore as part of a larger research project on the making of Bangalore into a global city, and use those interviews to inform this analysis. Although our larger project on speculative urbanism studies the transformation of the city as a whole, much of the data we present here focus on the area in the northern part of Bangalore, around the new international airport and information technology (IT) and biotech industrial zones. The last two data sources include published and unpublished studies and reports on the current water crisis, and a series of public events on water in Bangalore in which we participated, including two we co-organized in 2014 and 2016. Interviews with people who conducted action research and surveys on water use and agriculture in the early 1990s have given unique access to a historical timeline that has been corroborated by scholars of the region's ecological history.

The catchment-based regime (I)

Making the city possible

The first hydrosocial regime is characterized by an intricate network of people-made wells, lakes and tanks linked by channels and contoured embankments that were constructed by local residents, rulers and eventually the colonial government (Mathur & Da Cunha, 2006). We briefly discuss its evolution and explore the destruction and decline of this elaborate, decentralized system.

The 'catchment-based hydrosocial regime' has its origins in the era of the rule of the Maharaja of Mysore, expanded in the British era of urban development and continued with post-Independence public works projects. In their 2018 report, Mundoli, Manjunatha and Nagendra explain the history of the city of Bangalore as rooted in the construction of water infrastructure, dating back to 1537 AD, when Kempe Gowda I initiated the construction of Sampangi, Karanji and Agrahara lakes surrounding what is still the centre of the old city (Mundoli, Manjunatha, & Nagendra, 2018). As it is a plateau region with no perennial river and in the rain shadow of the Deccan Plateau, 900 metres above sea level, people constructed Bangalore's water infrastructure by using the undulating landscape, creating a wetlands environment of numerous water-holding facilities – called kere, lakes, irrigation tanks, reservoirs or ponds – some as large as 1.7 square miles.

Ramachandra, the most prominent scholar on the topic, calls the built-up ecosystem a 'wetlands treasure' of maintained forests, to create what was once admired as India's 'garden city' (Ramachandra et al., 2016c). When the British East India Company and later the British Crown took over the city, starting in 1799, the military settled in its cantonment and constructed a series of channel-linked, gravity-driven water tanks (e.g., Miller, Shoolay, Sankey and Ulsoor tanks) to supply ample water, at least for the cantonment and its surroundings. In 1896, a major reservoir was built across the once- thriving Arkavathi River north-west of the city: Hessarghatta lake. Its water was filtered naturally as it moved through the rural channels to the centre of the city. At the time, Bangalore had about 180,000 people and this system promised to deliver approximately 10 gallons per person per day; but use in the British-occupied cantonment was higher and therefore new projects were required, as well as strict rationing for the Indian population.

According to our interviews and historical accounts, the areas surrounding the city before the 1970s were richly fertile with planted forests, pastures (known in the local language of Kannada as gomalas), and water infrastructure that were supported, main- tained and protected through overlapping political, cultural, material, and religious rules and norms, locally enforced. Some forests (gundu

thopes) were protected shrines; some water tanks were religious artefacts; and typical village water-use practices allowed for food crops to be irrigated from the lakes only when the rains were insufficient, thus maintaining the recharge capacities of the water tanks and lakes built in their area (Mundoli et al., 2018; Mundoli, Manjunatha, & Nagendra, 2016). Planted crops were commonly low-water consumers.

In the villages we studied to the north of the city (incorporated as part of the expanded 'global city' as of 2007), villagers repeatedly stressed their dependence on, and the vitality of, the networked lakes, a watershed necessary to generate water for rural and urban needs. Today, they argue, the watershed and catchment have been damaged, and many of the lakes and channels built over with new urban and industrial structures. For example, in the eight villages displaced by the construction of the airport, completed in 2008, residents who were still in place and those resettled stated how they once shared the use and maintenance of their local lake, Bettakote (interviews in 2015, 2016 and 2017). Many of the lakes had been linked by channels across the region, and water overflow filled lakes on a lower gradient, and water that flowed over lake banks allowed for an extra crop seeding for local farmers.

H. S. Sudhira, a scientist who has mapped the region's old and new water infra-structures, suggests that the system was dense and intricate (Figure 1). Sudhira has used mapping technologies to find old water channels buried beneath existing buildings, including government ones. In our interviews with him, he explained that it was not monsoon rains alone that allowed for human settlement across the region; rather, large water tanks were carefully crafted to store water and were a vital 'commons' that relied on community management. The vast undulating terrain around the city, when con- toured by labourers, functioned as a water catchment system with water flows cascading from one water body to another, and contained water percolating down, replenishing the aquifers below (Mathur & Da Cunha, 2006).

Sudhira stresses the damaging consequences of destroying this system:

> Once we started to concretize (i.e., pour concrete over) the countryside (and) turn our backs on the catchment system, in all its complex and fragile components, in a short time we began to destroy the carrying capacity of the city. (interview, June 2018)

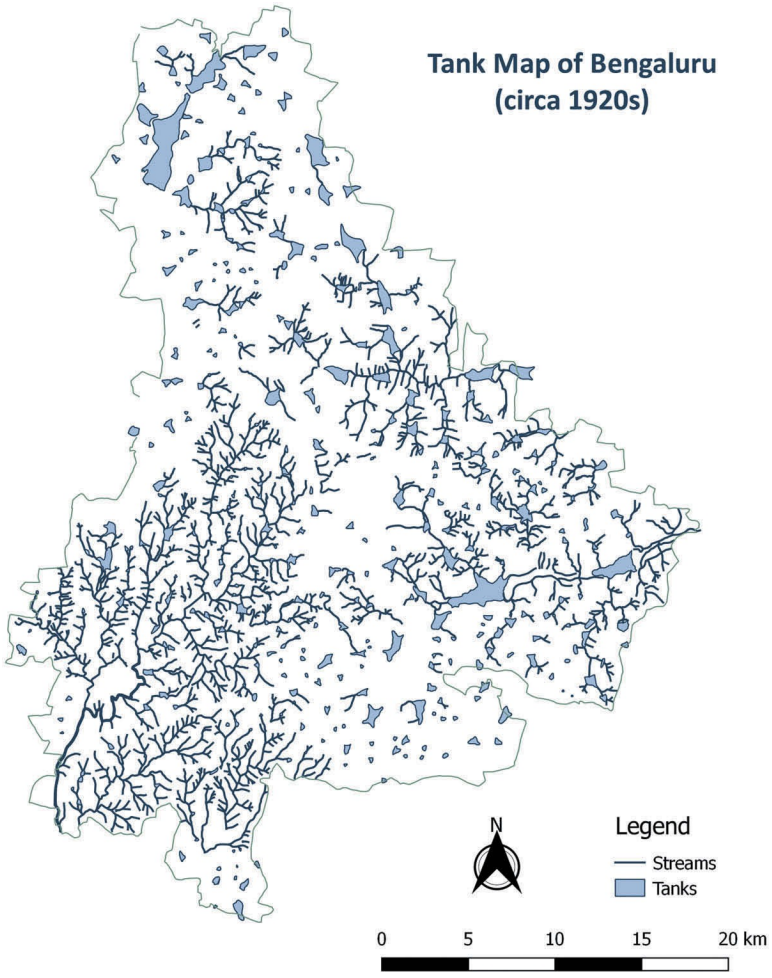

Figure 1. Map of the early 20th century dense network of tanks and canals. Courtesy: Sudhira (2018).

By building over and eroding the catchment system:

the farming communities suffered the most. But it affects us all. [...] Just look at the maps (showing us a series of time-lapsed maps), and you can know why when it rains in the city now, it floods instantly. There is no place for the rain to go. We have completely forgotten how this city was built. (interview, June 2018)

In a survey of data from the past four decades, leading ecologists found that the built-up (and concretized) area of Bangalore increased by 584% and the vegetation correspond- ingly declined by 66% (Ramachandra, Aithal, & Sanna, 2012). At the Indian Institute for Science, Ramachandra and his team conducted research on Bangalore's water

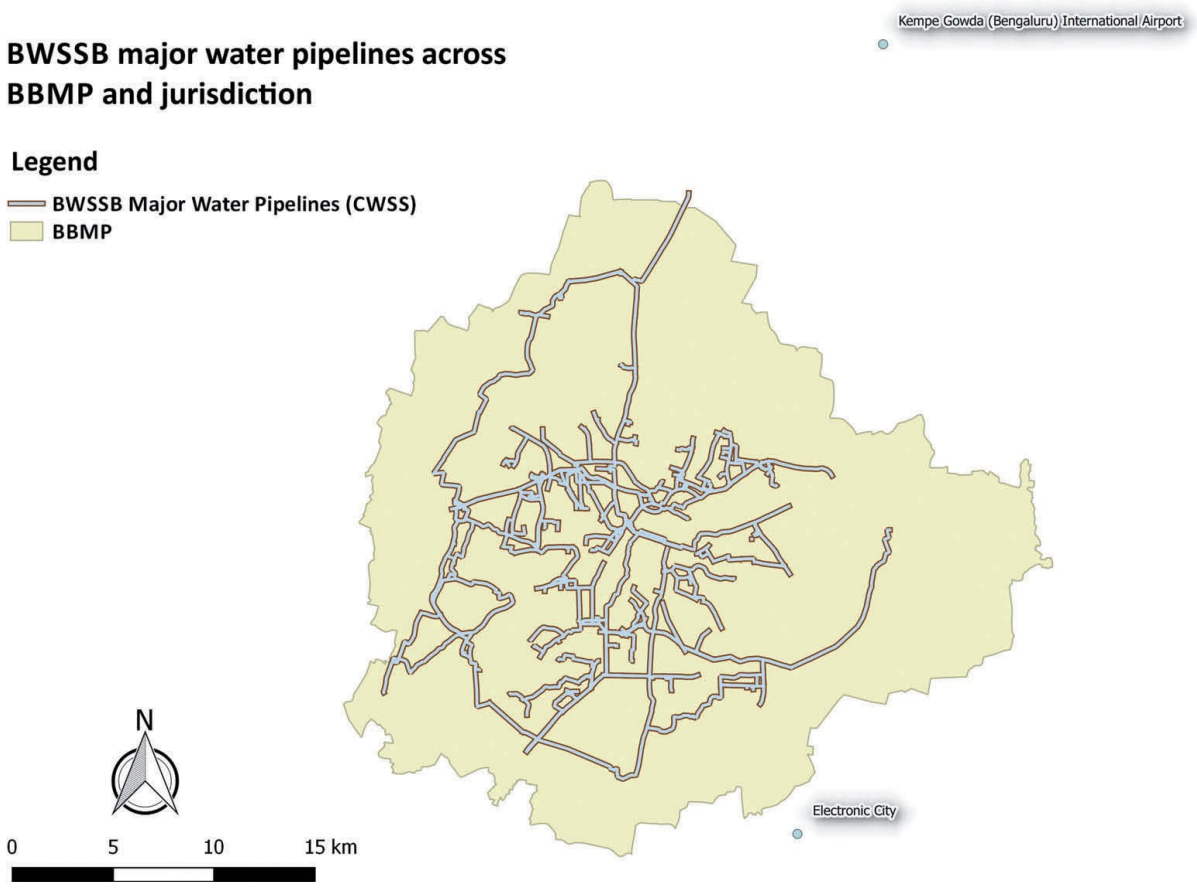

Figure 2. Map of the major Cauvery water supply system. Courtesy: Sudhira (2018).

bodies, within the city boundaries, from 1973 to 2015, and found that 80% of the 105 water bodies have been encroached upon, converted from lake to dry bed to urban real estate, with 'lake catchments [...] used as dumping yards for either municipal waste or building debris' (Ramachandra & Aithal, 2016b). While many have disappeared and converted into prime real estate, the remaining channels, or rajakaluves, are extremely polluted, transporting toxic sludge from north to south through the city.

A resident living alongside Varthur Lake to the south of the city started an NGO to protect the lake, one of the region's largest, from its slow death. He demonstrated how the water that ran from north to south through Bangalore drains into the second largest lake in the region (at 440 acres with a catchment area of 230 km^2), Varthur Lake, on the city's outskirts, as well as to the region's largest lake linked to it, Bellandur (the region's largest at 9000 acres). He explained:

Only 25 years back, we would bathe, fish, and drink from the lake. The waste water that flowed from the center of the city would take more than two days to wind its way into Varthur lake; in that time, it would be filtered along the way, a natural process, through the

city's and village channel system running north to south, without any major disturbance to the quality of the lake. (interview, July 2018)

Varthur has become the dump site for an estimated 40% of the urban sewage water from the city, and since 2015, it has caught fire and frothed over with industrial contaminants and sewage waste repeatedly. Ecologists based at the ATREE Research Centre found that the only water that does flow out of the city through the once-robust water infrastructure southward is wastewater, much to the dismay of farmers dependent on this water to irrigate their fields (Thomas, Lele, Srinivasan, & Jamwal, 2017). As we show below, the water-use habits developed around the catchment systems were gradually replaced with the introduction of the piped-in Cauvery water system, and the unregulated technology of bore wells, both of which changed the dynamics of water access and generation for the city.

The hydraulic regime (II)

Expanding the city

The second hydrosocial regime is defined by public infrastructure constituted of piped water imported from the Cauvery River approximately 100 km from Bangalore. Here we look at the history, contestations and disparities associated with this system of water distribution. The new water system represented a major shift in the way water was governed and distributed, closely tied to a new model of urban growth driven by the expansion of public sector industries and based on expensive and burdensome loans from international finance institutions such as the World Bank. The new centralized governance structure changed the logic of water distribution and infrastructure man- agement and created highly uneven social and ecological consequences.

In the period between the 1940s and the 1960s, post-independence Bangalore emerged as a hub of government-funded industries in, among other fields, radar, aeronautics, telephone and electronics, establishing Bangalore as India's 'Science City'. This new phase of urban expansion put pressure on the existing water infrastructure such that 'by the 1960s, a public debate was raging around the need for alternative water options' as Bangalore's water demands surpassed what the region's water bodies could provide (Ranganathan, 2010, p. 43). During this period, the local system of networked tanks and wells, and the two major reservoirs (Hesaraghatta and Tippagondanahalli) with their Arkavathi river base, were replaced by a second water infrastructure, which defines this hydraulic regime.

At the time, there was much discussion about the substantial cost of pumping water uphill to Bangalore's plateau. The main obstacle for the government was financing. The World Bank stepped in and offered a solution that had a dramatic effect on the

regional ecology, the city's possibilities of expansion and also the region's governance structure. In 1964, the World Bank agreed to lend large amounts of capital over a series of loans on the condition that the State of Karnataka empower an 'independent' parastatal agency to oversee this water infrastructure. The municipal water utility, Bangalore Water Supply and Sewerage Board (BWSSB), would become accountable only to the international finance institutions that issued the loans and to the state's chief minister (Heitzman, 2004). The World Bank saw this as the most propitious way to create a powerful state agency that stood apart from local politics and the so-called back- wardness and provinciality that it blamed for India's stalled progress. In fact, the World Bank had created one of the most powerful city-building agencies with little account- ability to the public (Ranganathan, Kamath, & Baindur, 2009).

In the Cauvery Water Supply Project, water became a highly extractive, centralized and financially indebted enterprise. It was ruled by two forces: a parastatal agency (BWSSB) detached from public participation and oversight, beholden to the interna- tional finance institutions and the obligations of a loan contract; and the chief minister of the State of Karnataka, a political actor whose party elections are often dependent on promises of cheap resources to the voting public and construction contracts to select elites. Under this centralized-extractive regime of governance, water became an asset used to generate revenues to help pay back a loan, and its perceived scarcity conjured a dependency upon new rounds of lending by the international banks, and new political promises by the state's political leaders.

Consequently, the BWSSB became the most indebted and yet one of the most powerful parastatal agencies in Bangalore, owing more than US$35 billion to interna- tional finance agencies in 2017 alone, and yet a key agency deciding which of the new residential and industrial developments would get the crucial asset of water, an impor- tant input for value creation for investors. Reports reveal that the new loans negotiated in January 2018 with the Japanese government for a fifth stage of this project are valued at an additional US$1 billion with undisclosed interest rates and loan costs (Express News Service, 2018; Rath, 2017). Over the decades, the BWSSB has become increasingly focused on ways to manage its financial debt and to attain cost recovery from water fees rather than produce an equitable and sustainable city water distribution system.

Leo Saldanha, the director of one of the most prominent environmental organizations in Bangalore, the Environmental Support Group (ESG), and a seasoned researcher since the 1980s, tells the story of the Cauvery water system by foregrounding the politics of distribution and allocation, suggesting that power relations were embedded in the very anatomy of this water infrastructure. First, it prioritized the city of Bangalore over the rest of Karnataka, and within the city, the

BWSSB prioritized the upper- and middle-class neighbourhoods. This reflected a regional political shift to the needs of the metropolitan region, and only certain segments of it, at the expense of the countryside where the bulk of Karnataka's population lives. He explains:

[With the] favoring [of] metropolitan areas [...] farmers tended to be the losers. Farmers in 2008 actually tried to block water to Bangalore. It was a huge protest. There were (similar) riots in the 90s. The State aggregates water as a resource and you can see the disparities in the dynamics of water sharing. Today less than one half of Bangalore's water demands are met by the Cauvery. A lot of the water is allocated to middle- and upper-class areas, which means half of the city's population is tapping groundwater to survive, yet groundwater levels have fallen so sharply that many can't live off it. In one neighborhood, after a lot of government petitioning (and no results), (residents) used dynamite to blow a hole and put in a network of pipes to divert the water. (interview, July 2016)

Today the city has a population of over 10 million and the public water utility, the BWSSB, pumps around 1500 MLD (million litres of water per day) from the Cauvery River (Rajashekhar, 2015). It is distributed unevenly across the city and comes nowhere close to meeting the current water demand. By one estimate, if averaged across the population, the city's residents would have access to 75 litres per capita per day (LPCD), which falls short of the 150–200 LPCD regarded as an international standard for a metropolitan city such as Bangalore (Raj, 2013a, 2013b). But of course, the water is not evenly distributed, with Karnataka officials promising and delivering dedicated pipelines exclusively to industrial estates including the new airport and the IT corridor. As well, the city boundaries have so rapidly expanded that their water infrastructure has not been able to keep up with the sprawling periphery, despite periodical augmentation in water from the river. The spatial unevenness results in middle-class and elite house- holds in the central areas receiving the majority of the limited water connections, while poorer communities and newly incorporated ex-rural communities rely on shared hand pumps or private water markets (Merchant, Mohan Kumar, Ravindra, Vyas, & Manohar, 2014; Ranganathan et al., 2009). In 2007, the municipal boundaries of the city were redrawn such that the BWSSB's responsibilities grew by 333% to include eight more municipalities and 110 villages, without scaling up funds and capacity, leading to a desperate lack of institutional infrastructure (Zaerpoor, 2012). Between 2011 and 2013, the BWSSB increased its withdrawal from the Cauvery from 900 to 1400 MLD. However, during this same period, its administrative boundaries excluded most of the newer peripheral neighbourhoods of the city, yet added Electronic City to the east and the airport complex with its residential complexes and Aerospace special economic zone (SEZ) to the north.

A senior administrative officer overseeing a major portfolio for the Karnataka government, one who publicly claims he is not corrupt (purportedly installing a

closed- circuit television (CCTV) camera in his office), spoke of this special treatment:

> We meet every day talking about the crisis of water, at the highest levels. But all the activity around water is happening below us, and we do nothing to stop it. For example, some areas get dedicated pipelines directly from the Cauvery, while many parts of the city and rural go without. (interview, June 2015)

This official was referring to the dedicated Cauvery pipeline to the airport and the exclusive line to the IT corridor. The largest developers are making demands that they too need a dedicated pipeline to the Cauvery system in order to ensure viability for their future large-scale residential projects. He further expanded on the politics of water allocation: 'There is displacement by land, but this is displacement by water. With farmers losing access to water, and other interests demanding theirs, water has become a serious political issue.'

As current and retired administrators have acknowledged to us, the focus of the Cauvery water system has been to raise capital and expand the piped system, but based on a cost-recovery logic that privileges large consumers and large loans, not farmers or the majority of city dwellers off the public water grid. As the city managers and developers bet on an increased flow of Cauvery water – against scientific evidence that the river's volume is decreasing and the flow is less stable – they shift their priorities away from catchment water governance practices. No longer basing calculations on the limits of the water catchment and lakes infrastructure, instead it is based on the potential future revenue from higher volumes of water, which is a starkly different, risky and highly speculative calculus (Nair, 2005).

Economist Sharadini Rath explains the problem this way:

> All loans to the State are hidden in the parastatals (such as BWSSB, the manager of the Cauvery project), and they are terrifying. They are like those futuristic monsters in the movies that keep growing and take over the city! BWSSB's debt is so huge, it's crazy. From my study, it is clear that the city and State governments only have land to sell, in hopes of paying off some of its debts. What a way to run a city. (interview, June 2016)

Speculative urban regime (III)

Land and water as financial assets

The third regime is defined by growing dependence on groundwater and the burgeon- ing of a private water market serviced by the proliferation of trucks (locally called water tankers) transporting water into and around the city. This

regime is characterized by rapidly escalating real estate value and large-scale commercial and industrial projects that are unviable from economic and ecological standpoints. In this section, we high- light the unregulated, fragmented and crisis-oriented water infrastructures and their intersection with speculative urban dynamics.

This regime reflects the post liberalization (1991–present) era of city growth and its entanglements with the imperatives of global-city making. Bangalore, during this period, entered a period of boom, directly triggered by the growth of the IT industry and its promises of a new urban cosmopolitanism based on the high-consumptive lifestyles of the fast-growing professional class (Upadhya, 2016), with its fresh appetite for investing in portfolios of commercial and residential assets. This growth period has made tremendous demands on the city's already strained water infrastructure and pushed the city toward crisis. Bangalore has lost 79% of its water bodies in four decades and its built-up area has increased from 8% to 77% in this period, with acceleration occurring in both categories since the mid-1990s. Since 1997, the water table has fallen from 10–12 to 76–91 m, with over 40% of the population relying on groundwater (Shekhar, 2018).

Overuse of groundwater and proliferation of private water markets

Much of the population is compelled to find alternative, informal means of meeting their water needs. Individual households, depending on their economic abilities, draw upon multiple sources of water (private bore wells, Cauvery water, water trucks), while the BWSSB provides water to only some parts of the urban core, particularly older professional class neighbourhoods and business complexes. Others illegally siphon water from the Cauvery water pipelines that run directly through neighbourhoods that have not been granted access (interviews with Saldanha, June 2016, and a real estate consultant, June 2016).

Around the time when the first few phases of the Cauvery scheme were implemented (1970s), the technology for the high-speed drilling for groundwater and the installation of electric pumps (versus hand pumps) slowly became available. Over the past 15 years, this technology has proliferated and it is now common for water to be accessed directly from under one's own property with bore wells or else from private tanker operators selling groundwater pumped from farm land. The digging of bore wells and the private water market are unregulated, and there is no formal monitoring or regulation of groundwater extraction. More than half the city's water supply is met from local groundwater, from household wells and the tanker market (Lele et al., 2013). In the rural periphery where farmland is being converted into urban real estate, farmers who are able to hold onto a sliver of land sell their

groundwater beneath it to a thriving market distributed by private water tankers or trucks.

In 2015, 105,500 private bore wells were registered with the BWSSB, while over 200,000 bore wells were estimated to be unregistered (Basu, 2015). The mining department compared withdrawal and recharge and found that groundwater is being over- drawn by 378% (Basu, 2015). Across Karnataka, according to Minor Irrigation Department estimates, 5000 bore wells are being sunk every month; in many cases, they are replacing existing bore wells that have dried up (Kanathanda, 2017). When asked about the depth of new bore wells, farmers and urban residents stated that water tables from 300 to 400 feet have dropped in the past five to seven years to as low as 1300 feet, which is inaccessible to most people who depend on limited incomes, and at these depths often accesses toxic water.

The gap between limits of municipal water and ever-increasing demand opened up the space for a vibrant, private water market. Water tankers estimated to be in the many thousands in number emerged as an industry around the early 2000s, and have increased in numbers exponentially since 2010 (Ravishankar, 2018). A researcher who requested data from the BWSSB summarized the findings: the BWSSB had not given out any licences for commercial tankers to transport water, and it has 69 water tankers of its own. 'The remaining 3,000 to 4,000 water tankers are illegal' and 'make an annual turnover of around Rs. 1,000 crore (US$150 million)' (Deepika, 2017). Private tankers supply water to a wide range of customers, including low-income neighbourhoods, gated residential complexes, factories, hospitals, malls and hotels. The supplier market is also heterogeneous: It comprises of both small-scale, independent entrepreneurs working outside the law as well as the 'grassroots tentacles' of large-scale public and private utility companies (Ranganathan, 2014). Working-class and poor communities are dependent on neighbourhood hand pumps (which are now increasingly running dry) and the occasional water truck, while the middle- and upper-class neighbourhoods rely on private bore wells (beneath their property), partial supply of Cauvery water and the regular visits by water trucks. Late at night, one can see the city streets crowded with trucks weighed down with sloshing rural water supplies.

Although the key distribution agents are called by some a 'water mafia', this market functions as a mafia not necessarily in the sense of an economic monopoly wherein price is controlled and arbitrarily increased, but in the political sense of securing loyalty and reinforcing vote banks for politicians. While a set of actors do indeed dominate the distribution of water, this market also works as a tool for political parties and individuals to gain votes and reinforce electoral support. A senior bureaucrat overseeing water projects explained:

The water tanker economy is symbolic of changing political power. It used to be that politicians would get votes by providing public taps, and those were fairly permanent. But today, they only supply tankers [of water], which can be offered in exchange for votes and withdrawn if necessary [especially once elections are over]. (interview, July 2016)

Painted on the side of some of these cylindrical shaped trucks are the images of local MLAs (members of the legislative assembly) and other politicians who drum up political support, votes and favours through their sponsorship of the distribution of water to constituencies. Here, we see the messy blending of economic, political and ecological factors, and the entanglement of different markets (land, water, politics).

Speculative urban and water dynamics

In this hydrosocial regime, we find the prominence of the political discourse of global- city-making that promises the 'productive' dimension of rapid urban growth, that is, better jobs, 'world-class' infrastructure, upwardly mobile class consumption patterns and limitless real estate development. This focus, however, fails to take seriously the ecological and social implications of the recent shift of business logic and activity centred on large-scale land acquisition and related financial speculation. Changes in land use and the expansion of the city are driven not just by the spread of industrial expansion, built infrastructures, new residential and commercial localities but also by speculative strategies for making 'money from money' – the spread of strategies for making financial gains that include debt finance, land used as collateral, real estate investment trusts (REITs), initial public offerings (IPOs) and share price fluctuations, and land acquisition for speculation. These financial strategies do not necessarily lead to greater production or wiser infrastructural management.

In 2005, to support the national and Karnataka governments' sales pitch for Asia's newest global city, land protection laws changed to allow foreigners to buy land and for land brokers to convert rural land more easily into urban real estate. With these dramatic nationwide reforms, the central government made it possible for anyone to convert rural land into a financial asset without any promise or commitment to make it 'productive' for the economy, which was the official criterion for rural-to-urban land transfers before the 2005 legislation (Levien, 2018). To Bangalore's north, there was a rush to acquire tens of thousands of acres surrounding the new international airport and its promise to turn the region into the northern wing of the new global city, creating urban real estate with unlimited value potential. Rumours that aerospace and IT/biotech firms were ready to move in sparked land value increases such that Bangalore had never before seen. In the Devanahalli area, we found farmers whose land had been acquired early for 500,000 rupees per acre (approximately US$7000), which, in 2017, sold for as high as 50,000,000 rupees (US$700,000), a 9900% value increase. As one land broker explained: 'Much of the

land sold by small farmers exchanged hands 8 to 10 times, with most of the land value hikes not landing in their bank accounts, but in the hands of land brokers, government agents, and devel- opers' (interview, July 2015).

Bangalore's global-city transformation began in the late 1990s with the boom in the software sector capturing the imagination of investors locally and worldwide, and it thrust the farming community into a risky and volatile environment. Many of the small farmers, mostly low caste and Dalit, were being pressured to sell immediately for 'piles of cash, the likes of which most small farmers had never seen before', explained a Dalit farmer advocate. 'How could they ask for more, they had no idea that that same plot of land would be sold the next day for many times the price they received' (interview, July 2015).

As noted above, much of the land surrounding the city is within a protected 'green belt' of village commons, government forest and ecological terrain that supported the complex water catchment system. Thus, this era of the land rush included the acquisition of the land on which the water catchment system was built. Whereas under the previous hydrosocial regime, the catchment suffered from neglect and encroach- ment, starting in the mid-1990s, it was being actively and aggressively dismantled so it could be converted into an asset for the real estate industry (with its roots in the political establishment). With this land rush came the necessity to find systemic water alternatives to both the catchment system and the Cauvery, since they both proved inadequate in meeting the needs of the rapidly expanding city. Consequently, the speculative-urban hydrosocial regime is marked by a dramatic rise in private bore wells being sunk and tapped, and the rapid growth and spread of a private water market in which rural bore well water is distributed by thousands of water tankers plying the city streets, collectively sucking dry the water aquifers.

Speculative investment in real estate and the changes in land and water use are inextricably tied to the hollowing out of the agrarian economy over several decades. Agriculture no longer provides a sustainable means of livelihood for small, highly indebted farmers in the region, and the state offers much less support than in the past, except low-wage income when there is no employment (Indian Institute of Science, 2015; Sainath, 2013; Vasavi, 2009). Our research in areas surrounding the airport documents the steady decline of agricultural livelihoods that makes it easier for the real estate market to access and convert land and water resources into commodities, the latter pumped by farmers as their last, but not lasting, asset to sell. The depletion in surface water and reliance on groundwater have affected agricultural and cropping patterns in the area significantly. Residents of these villages drew our attention to the falling water table by noting that bore wells were drying up (interviews in 2014, 2015 and 2016). One farmer in Bettakote village in

the Devanahalli area said, 'We know that borewells reduce ground- water. But what else do we do to live? We have to live don't we?'

As water scarcity increases, poor farmers with small tracts of land do not have sufficient resources to invest in bore wells and hence they grow dependent on wealthier farmers for work. Small farmers who have bore wells find it difficult to bear the repair and maintenance costs the bore well requires when pumping at such a deep level. We were told about many instances of bore wells going dry. An official at Bettakote Gram Panchayat (a local governing body) estimates that 175 bore wells have been dug in just this village alone over the past 10 years. (The once sprawling 300-acre Bettakote lake was drained and encroached on by the airport authority in 2008.) Many non-elite villagers in the region, including those who own some land, have now turned to extremely low paid, daily wage work. There is an evident shift in labour from agricultural to non-agricultural occupations, as water scarcity is forcing villagers to stop farming. Interviews with teachers and principals at two schools near the airport complex suggested that local students are no longer drawn to agriculture and their parents actively discourage them from farming. Farmers attribute water scarcity in the region as a primary reason for why agriculture has become untenable (interviews in July–August 2015 and 2016).

Grandiose master plans of development projects, and the financial imperative to hoard land to anticipate these future projects' expansion, remain strangely impervious to the fact that water represents a limit: neither Cauvery water nor the crippled catchment system can accommodate the global city. Similarly, the notion that private tankers can indefinitely feed the proposed industrial, residential and commercial zones is untenable (Mahapatra, Chanakya, & Ramachandra, 2011). Even though research conducted three decades ago documented the water shortage in this area (Asian Institute of Technology, 1990; Reddy, Venugopal, Reddy, Madhukeshwar, & Lingaraju, 1992), it did not prevent the government from identifying the Devanahalli region for large-scale airport development project and an array of potential future industrial and residential projects including luxury gated communities and IT campuses.

Ironically, the spike in land value has recently prevented the government from following through with land-acquisition plans for these future ambitions as it gets ensnared by the very process in which it has participated. A top-level bureaucrat in Karnataka's administration admitted:

It's going to be difficult to develop anything close to Bangalore. Land is not available, the cost is very high. Huge shortage of land. There is also a shortage of water. That airport area is very deficient of water. If you want to purchase a thousand acres then you have to spend a thousand crore rupees ($150 million). Is it worth it? It's exorbitant. It's very easy for industry to come in when land is cheap. So the high land costs in Karnataka are causing a

bit of a set back to the setting up of industry. Beyond the airport we have reserved 1000s of acres for industrial activities. (interview, June 2015)

Government agencies acquire land from farmers with no guarantees of industrial buy- in or use; the land is no longer designated as for farming only, and it loses its protective designation as 'green belt', so that fertile land and the rural water infrastructure become officially incorporated into the speculative real estate economy. In the airport region, land prices have increased greatly over the past decade, jarring the local economy and setting new priorities led by land bankers, members of government, the business community and, more recently, foreign financial institutions. Moreover, the state, despite very low interest from industry, continues to acquire land even when it cannot afford to. It goes to extreme lengths, including taking on additional debt to secure this land. For instance, in 2014, it borrowed 1000 crore rupees (US$150 million) to fund land acquisition on behalf of the IT sector (Kumar, 2014), an industry that is not looking to build new facilities and offices. These shortfalls have had a tumultuous effect on the land-based economy. For example, no companies have committed to build and move into the IT Investment Region, even while the government has been acquiring land from farmers who were displaced and paid a pittance for their land and paid nothing for their dependence on the surrounding commons land (interviews in 2014– 17). Moreover, employment growth in the IT sector in Bangalore has faltered, with the sector laying off thousands of employees in 2017 and moving into less labour-intensive services (Narayan, 2017; Sridhar, 2017; Subramanian, 2017). The IT sector no longer can absorb the growing workforce, making the trend of investing in land and water for speculative purposes more prominent by comparison.

Because there is no industrial interest in the site, the price of land offered to farmers is relatively low; but because land prices are relatively low, the business of acquiring land becomes a speculative enterprise in its own right – buy and sell rather than build. A senior official candidly expressed grave concerns about the plight of the airport region and ominously mentioned 'vested interests' that link government departments with 'the real estate mafia'. In this revealing interview he cited the 'misuse of land conversion laws where land is legally converted simply to increase its value' and continued to say with deep scepticism: 'and they claim the area will develop despite water shortage and huge jumps in land value!' (interview, June 2016).

These critical voices within the upper echelons of the state's bureaucracy demonstrate the extent to which the peri-urban zone is governed by the logic of speculative urbanism (Goldman, 2010, 2011). The lure of real estate markets and land speculation overrides long- or even medium-term considerations of a land-based productive economy and/or sustainable water infrastructure. Officials at the

local planning authority acknowledged to us that the water shortage was a major unresolved issue and there were no concrete plans to address it. Meanwhile, global-city plans drive land acquisition, displace communities and encourage the selling off of the ecological commons and waterscapes.

On 1 January 2014, the city government was forced to declare itself bankrupt when the public banks refused to lend any more money or manage its insurmountable debts. The banks required collateral as liability for the city's debts, and the city offered a portfolio of public buildings and land, including the town hall, a maternity hospital, central public markets, and cemeteries and slaughterhouses (Chaturvedi, 2014). Because of the risky strategy of offering tax-free and subsidized land and water, global-city infrastructural projects never earned city agencies enough money to support these speculative projects. A 2013 audit of the Bangalore City Corporation, the body that runs the city, found that monthly expenditures for basic maintenance, salaries/pensions etc. were being paid from high-interest bank loans and not property taxes and user fees – a risky and unsustainable mode of governance.

In sum, we find that water is simultaneously a problem, a crisis, a limit and an opportunity to access land from distressed farmers. Water crisis is not solely an urban or a rural phenomenon, but intersects with the policies of rural–urban disinvestment and speculation. Under the imperative of speculative urbanism, the value of land and water, as well as those who live off of them, is being heavily discounted as a strategy to further entice financial investors to invest. This hydrosocial regime exposes the paradox of water crisis. It represents an actual limit to agrarian livelihoods but does not present an absolute limit to financial speculation and government projections of urban development. The key point here is that water scarcity is a precondition for the easy conversion of agrarian land into urban real estate and yet its scarcity does not prevent speculation and grandiose projections of urban development. However, the current water crisis is so overwhelming that state officials at various levels of the bureaucracy admit in our interviews, and the media highlight, that it has become a major obstacle. This sharp contradiction of speculative promises and realities regarding acute water shortages and untenable land prices defines this last crisis-based hydrosocial regime.

Conclusions

Of materiality and liquidity

In this paper we have analyzed Bangalore's water crisis through the lens of three hydrosocial regimes, each analytical frame featuring an entangled and complex terrain of water access, water governance and urban expansion. We have paid

special attention to the intersecting dynamics of urbanization, water systems and speculative financial logics. Relational and scalar dimensions reveal the growing influence of local, national and global forms of finance capital with disruptive effects on markets of urban and rural land, water and labour. Specifically, real estate developers have had no obligation to preserve and strengthen the existing precarious water infrastructure and state agencies have prioritized risky ventures into land acquisition and economic zone development and ignored protection and regeneration of water generation systems, including the crumbling catchment-based water infrastructure. Moreover, since the early 2000s, developers have aggressively built atop water infrastructure, affecting the survivability of the countryside as well as the city in which they have heavily invested. On the city's periphery, we find that developers – with the aid of the local planning authority – primarily acquire rural land to hoard for future profit or for water-intensive built-up economic zones, which have enticed private equity firms from as far as New York, eyeing the arbitrage opportunities as developers are cash strapped and their land banks (with sky-rocketing values) can be leveraged as collateral. Poorer farming communities on the urban periphery, meanwhile, have little choice but to sell their land and water resources. Land is bought and sold at great speed, with values rising at every transaction, even while supplies of water disappear and ecosystems degrade.

Since 2010, both the real estate sector and city government agencies have become indebted to foreign corporate lenders, and increasingly to Wall Street-based private equity firms (Goldman & Narayan, 2018). By 2017, with real estate firms' and developers' debts rising, public banks stopped lending to them, creating a widening market opportunity for Wall Street firms such as Goldman Sachs, Blackstone and KKR; they have used their powerful position in the market to obtain high rates of returns from their short-term investments in and around Bangalore. According to consultant com- pany Knight Frank, by 2017, 'close to 60% of the real estate sector's institutional funding requirement' came solely from private equity firms, 'in sharp contrast to 2010 when less than one-fourth funding came through this channel' (Rathi, 2017, p. 12). In the past few years, a string of real estate deals has earned US-based private equity firms annualized rates of returns in India much higher than their returns in China and the United States itself (Alexander & Antony, 2018). Blackstone, as one example, has become India's largest office space owner since 2014, buying up depressed assets across India's major cities and their rural peripheries, earning sizeable rates of returns and fostering a new global market in tradable securities based on the future appreciation of local rents. Because of this wealth accumulation by financial firms, the city has become economically and politically dependent upon the speculative and volatile real estate market; it is a market that can only grow with relatively cheap or discounted access to land, real estate and water.

Thus, we find that crisis pervades, expands and intensifies. The destruction of the catchment-based hydrosocial regime and the untenable exploitation of groundwater laid the groundwork for the contemporary crisis. The series of events leading up to the large-scale pollution and privatization of the city's many lakes have 'impacted the resilience of the entire city' (Nagendra, 2016, p. 174). In the 1970s, when a highly centralized, capitalized and authoritatively managed water infrastructure was devel- oped, leaders expanded the city with the promise of an abundant river water supply and the hubris to turn its back on the age-old water catchment system that built and shaped the city for generations. Today, under a speculative urbanist logic, Bangalore's tensions between hydrosocial materiality and financial liquidity have never been as profound.

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