Transition Theory and India’s Groundwater Management Systems
A Case Study of Bengaluru

GOGOL DATTA

Contemporary India is witnessing rapid urbanisation, and groundwater resources have been overexploited almost to the point of depletion. In addition to urbanisation, the changing trends in agriculture also put additional pressure on groundwater resources. While the model groundwater bill has undergone several iterations to address the issue, a critical look at the work of some non-governmental organisations and a case study of Bengaluru through the lens of transition theory help shed light on community-driven, participatory groundwater management approaches.

India’s water problems in the not-so-distant future will have two main drivers—(i) the rapid pace of urbanisation, which will lead to at least 50% of the country’s population living in cities by 2030 (Hindu 2017), and (ii) the pervasive dependence on groundwater for practically all aspects of water usage (Bhanja et al 2017). A question that arises is: How would dependence on groundwater in an urbanised environment be a driver of water problems? This is crucial because groundwater does not feature in urban planning in India. In “Urban Water Systems in India: A Way Forward,” Mihir Shah (2014) lists the following reasons for groundwater being a “blind spot” in urban water management issues.

(i) Most urban utilities are not able to acknowledge the private extraction of groundwater in towns and cities. (ii) Water demand and supply in large cities like Mumbai, Bengaluru, etc., is very difficult to track, owing to the “fuzziness” of administrative boundaries between the various sub-sectors of the civic bodies—the old city, the suburban sections, peri-urban areas and the surrounding rural fringes. (iii) Household surveys cannot capture the granularity of the data of individual household groundwater requirements, for it is often seen that the supply of water to the household is often greater than that provided by formal systems. (iv) When small towns grow into big cities, this transition phase is accompanied by groundwater pumped privately or through tank water supply from wells in the nearby rural areas. (v) Urban growth requires construction of housing complexes, which almost exclusively rely on groundwater resources.

Therefore, to borrow the popular parlance of “what cannot be measured cannot be managed,” we are several steps behind while taking into consideration our water requirements. The above-mentioned two drivers make the water scarcity problem a persistent one, for the roots lie in the societal structure and institutions (Rotmans 2005). The solutions to this problem require changes both in thinking and action, which is particularly difficult in the Indian society which is prone to exhibiting risk averse behaviour (Gupta and Singh 2014). One way of arriving at a solution might be through transition management. Before delving into how transition management can help in solving the problem of water supply, there needs to be a reason as to why one should use transition management as a tool for solving such persistent problems, which I elucidate ahead.
Transition Management

“Our normal methods parse social reality into fixed entities with variable qualities. They attribute causality to variables—hypostatised social characteristics—rather than agents; variables do things not social actors. Stories disappear” (Abbott 1992: 428). There are two ways in which historical events are explained; one uses stochastic methods to find causal effects and the other finds narratives that showcase broad patterns. The former method is known as variance theory, which aims to show the changes in outcome variables as a result of variations in independent variables; the latter is process theory, which looks at events rather than causal variables (Abbott 1992).

Process theories require detailed historical background and are causally deeper than variance theories (Grin et al 2010). Transitions are essentially process theories that “articulate more specific guide plots that guide narrative explanations” (Grin et al 2010: 98). Water in the society has different values; an economic value determined by some kind of pricing mechanism, an ecological value manifested as regulation services for ecosystems and a social value determined by cultural and emotional attachments (Van der Brugge et al 2005). In this context, India, with its ecological biodiversity and sociocultural and economic growth, presents a degree of complexity that would be higher and much more nuanced, with layers of subtleties in terms of narrative effects, compared to other countries.

Therefore, using transition theory would be a step in the right direction to analyse India’s groundwater management issues. To highlight the complexities, let me quote some examples. India’s geological diversity often leads to different geological conditions not only in the country, but at times in single villages as well. H Kulkarni and P V Shankar (2009) have divided the aquifer typology of the country into broadly seven categories. In India, urbanisation happens in four stages, with each stage having a different groundwater requirement. In addition to typology, this too creates a complexity in terms of water management systems. Some examples of the economic values of groundwater are mentioned in Mukherji and Shah’s (2005) work, where the size and impact of India’s groundwater economy is calculated to be three times more than the surface water management systems. Some of the conceptual views, population dynamics, politics and the natural environment. The meso level is characterised by regimes, which are artefacts that can be defined along the seven dimensions of technology, infrastructures, industry structure, policy, knowledge, user practices and application domains (Berkhout et al 2004). This level is concerned with preserving the status quo, because the dynamics are determined by their dominant practices, rules and shared assumptions, social norms, interests, rules and belief systems that underlie strategies of companies, organisations and institutions and policies of political institutions which are often geared towards preserving the status quo and thus towards optimisation and protecting investments rather than system innovations. (Van der Brugge et al 2005: 167)

At the micro level, individual actors, local practices and niches operate for alternative changes based on the coupling

Concepts from Transition Theory

Transitions are societal changes that happen over a long duration of time, usually 25 to 50 years, due to a convergence of various ecological, economic, cultural, institutional, technological and developmental processes operating at various scales (Van der Brugge et al 2005). A key example of successful transition management is the Dutch energy sector transitioning from coal to gas/oil-based systems in the 1960s, with the sector being the policy arena where transition theories have had maximum impact (Kern and Howlett 2009). The fourth national environmental policy plan of the Netherlands put transition management as a key policy approach to solving persistent problems like climate change, loss of biodiversity and other issues (Loorbach and Kemp 2005), leading to transition theories gaining mainstream acceptance as policy processes in Europe.

In the literature on transition theory, one can outline three key concepts—multistage, in which each stage has a different speed; multilevel, which operates at micro, meso and macro levels and transition management (Van der Brugge et al 2005). The multistage concept is based on the work of J Rotmans et al (2000), characterised by four phases or stages: (i) a predevelopment stage where changes are happening under the surface, (ii) a take-off phase where a shift occurs in the whole system, (iii) an acceleration phase where the shift gains momentum due to the culmination of all the societal, economic, ecological, institutional changes that complement one another, and (iv) the stabilisation stage where a new phase of equilibrium is reached.

The second concept (multilevel) is focused on functionality and the scales at which the transition occurs (Rotmans et al 2000). This concept is derived from Geels and Kemp (2000), who use the concept of regimes. The macro level exhibits changes at a slow scale due to changes in macroeconomy, cultural views, population dynamics, politics and the natural environment. The meso level is characterised by regimes, which are artefacts that can be defined along the seven dimensions of technology, infrastructures, industry structure, policy, knowledge, user practices and application domains (Berkhout et al 2004). This level is concerned with preserving the status quo, because the dynamics are determined by their dominant practices, rules and shared assumptions, social norms, interests, rules and belief systems that underlie strategies of companies, organisations and institutions and policies of political institutions which are often geared towards preserving the status quo and thus towards optimisation and protecting investments rather than system innovations. (Van der Brugge et al 2005: 167)

At the micro level, individual actors, local practices and niches operate for alternative changes based on the coupling
of expectations, articulation processes and network formations (Kemp et al 1998).

In the predevelopment stage, regimes prevent the changing of status quos. The take-off phase is reached only when niches in the micro level are accentuated by trends changing at the macro level. There is often a cross-fertilisation of ideas from different fields to form a single consistent paradigm. This is a highly volatile phase, for a synergy needs to exist between the micro- and meso-level players to pull the regime over the edge, and if not, there could be a stand-off and a slowdown in transition. In the acceleration phase, the regime changes via the wide usage of capital, technology and knowledge. The stabilisation phase is, again, a seed bed for the next transition.

The third concept is called transition management. It consists of (i) the establishment and development of an innovation network, (ii) the generation of long-term transition pathways, (iii) the steering of transition pathways based on knowledge pathways and agendas, and (iv) the monitoring of the transition process (Van der Brugge et al 2005). In the participatory setting of the transition arena, a number of representative actors from various sectors cooperate in creative sessions and opt for a common problem and developing various solutions. Historical and current transition patterns can be analysed using the above three transition concepts for finding out the various causal patterns, temporal dynamics and successes of a phenomenon under study. Following is an overview of India’s changing groundwater policy.

**Laws on Groundwater**

Indian groundwater rules have often been derived from English cases (Cullet 2014). The first mention of the word groundwater is in the Indian Easements Act, 1882. This act becomes the starting point for legal scholars for the discussion of Indian rights. Héctor Garduño et al (2011: 13) have mentioned that “The right to groundwater has traditionally been seen as belonging to different owners is absolutely essential to establish an easement…right in groundwater can by no means defined as an easement as in this exercise of right no servient heritage is required. The existence of two heritages or tenements (dominant and servient) belonging to different owners is absolutely essential to establish an easement…right in groundwater can by no means defined as an easement as in this exercise of right no servient heritage is required.

One main case in English groundwater law is George Chasemore v Henry Richards (1859), according to which, groundwater that is “percolating through underground strata, which has no certain course, no defined limits, but which oozes through the soil in every direction in which the rain penetrates” is separated from streams and as such needs different governing laws (Getzler 2004: 308). In Acton v Blundell (1843), the court was of the opinion that “the person who owns the surface may dig therein” and any inconvenience to his neighbour “falls within the description of damnum absque injuria, which cannot become the ground of an action” (Cullet 2014: 58). Deviations in the above rule occurred in a place where groundwater flowed in defined channels (Grand Junction Canal Company v Shugar, 1871). The concept of a defined channel was applied in instances of a river flowing a few inches below its natural course during summer, where it could be said that there existed a predefined channel (Malyam Patel Basavana Gowd (dead) v Lakka Narayana Reddi and Anr, 1930) and also in places where a spring was present (Babaji Ramling Gurav v Appa Vithavja Sutar, 1924).

Meso-level legal entities lacked scientific temper till about the 1930s, and this framework of legal jurisdiction stayed the same, with the legal regime resisting changes at the pre-transition stage. The legal landscape had legitimised the concept of the deepest wells and the largest pumps. Following is an explanation in detail about how the concept of the deepest wells and the largest pumps had been legally legitimised. In the 19th century, England was going through rapid industrialisation, which required that a new set of rules be established with regards to water under the ground. The Acton case mentioned above has a very interesting history. The court had a dilemma—whether the definition of groundwater be decided by the same set of rules that regulated traceable water courses—giving it natural rights according to the riparian doctrine. However, the court decided that “to the owner of the soil all that lies beneath his surface; that the land immediately below is his property, whether it is solid rock, or porous ground, or venous earth, or part soil, part water…[T]he person who owns the surface may dig therein, and apply all that is there found to his own purposes at his free will and pleasure” (Anderson and Bogart 2019: 308). So far that, “if, in the exercise of such right, he intercepts or drains off the water collected from underground springs in his neighbour’s well, this inconvenience to his neighbour falls within the description of damnum absque injuria, which cannot become the ground of an action” (Anderson and Bogart 2019: 308).

**Damnum absque injuria** exists when people in good faith exercise their right and this causes injury to others but there is no resulting legal compensation. The Chasemore case (1859: 140) reaffirmed that “the principles which regulate the rights of owners of land in respect to water flowing in known and defined channels” are “inapplicable to the case of subterranean water not flowing in any definite channel, nor indeed at all, in the ordinary sense, but percolating or oozing through the soil, more or less, according to the quantity of rain that may chance to fall.” However, “[w]ater that actually flows like a surface stream beneath the earth’s surface, as in lava tubes or limestone caverns, is very rare … Virtually all underground water percolates through the ground” (Chasemore v Richards 1859: 147), and therefore, riparian rights do not exist, but a landowner has the usufructuary right of enjoying the groundwater under his land.

This right was enjoyed in full by Pickles, a landowner who had drained an aquifer located under his land. This aquifer was the source of water to the city of Bradford. Pickles wanted the city to purchase his land along with its groundwater resources at an inflated price. However, in the Mayor of Bradford v Pickles (1895), the court ruled that “No use of property, which would be legal if due to a proper motive, can become illegal.

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because it is prompted by a motive which is improper or even malicious” (Gronwall 2008: 908–9). The *damnnum absque injura* was applied again and the court stated that

an adjacent landowner has no property in or right to subterranean percolating water until it arrives underneath his soil... therefore no property or right of his is injured by the abstraction of the percolating water before it arrives under his land. (Gronwall 2008: 908–9)

The three above-mentioned cases had successfully laid down that all groundwater under the land of the owner is a usufructuary right, and a neighbour whose groundwater was excerpted has no cause for compensation till the water arrives under his land. The legitimacy of deepest wells and largest pumps extended globally with legal regimes across other country landscapes, exhibiting an unchanged equilibrium. For example, in the United States, a similar unchanged groundwater framework was used. Courts there were reluctant to change already established property rights, for it would result in chaos (Dellapenna 2013). This quote sums the whole legal inertia aptly, “The history of [groundwater law] is as thrilling as ignorance, inertia, and timidity could have made it” (Dellapenna 2013: 4). Currently, however, both English and American laws have diverged from the doctrine of unlimited access to groundwater by landowners, the discussion of which is beyond the scope of this paper.

**Changing Paradigms in Agriculture**

In India, the concept of unlimited access to groundwater was not suitably challenged. Another change happened in the 1960s in the policy paradigm of India. In 1959, a group of scientists, on the invitation of the Government of India, prepared a report on India’s food security. This report, known as “India's Food Crisis and Steps to Meet It” (Ford Foundation 1959), stated that India would go through a food shortage crisis, the prevention of which required urgent action to boost the agricultural productivity of the country. There were recommendations to increase the tube well programmes in areas where there was an abundance of groundwater, and also increase the number of shallow tanks for irrigation. A series of events also led to a transition in agricultural strategy.

Aditya Dasgupta (2018) highlights these events, namely the death of Jawaharlal Nehru, which brought Lal Bahadur Shastri at the forefront, who was committed to improving agriculture, the war of 1965 with Pakistan that led Indian leaders to aim towards being self-reliant for food and free from American aid against the backdrop of the Cold War, and lastly, droughts in 1966, which also heightened the agrarian crisis. All these factors led to the introduction of high-yielding variety (HYV) seeds of rice and wheat. These HYVs now spread fast in districts where irrigation infrastructure was present or aquifers were to be exploited by individual cultivators. So, the old artefact of irrigation shifted from the canal to a new paradigm of groundwater. Incentives were given to the farmers in terms of providing rural electrification and pump wells. About ₹570 crore were disbursed for electrification, which would provide energy to power pumps for irrigating agricultural land; the usage of diesel pumps rose to about 27.5 lakh in 1971; these two factors led to unprecedented groundwater usage for growing crops (Dhawan 1975).

The pattern of depending on groundwater for irrigation has still continued. For example, the irrigated area under groundwater has increased from 119 lakh hectares (ha) in 1970–71 to 331 lakh ha in the 2000s (Mukherji and Shah 2005), leading to severe depletion of the aquifers. This dependence of agriculture on primarily groundwater and intensive inputs of fertilisers led to a transition from subsistence to commercial agriculture.

A middle-class peasantry society consisting of lower caste members was formed, which constituted about 30% of the Indian population (Brass 1980). This class had increasingly become dependent on government subsidies and inputs for agriculture (Harriss 1980). These peasantry societies had accumulated wealth and were establishing their own political mobilisation capital (Wilkinson 2007). A demand for a policy to provide subsidies and agricultural incentives took place at the district headquarters and also at New Delhi (Varshney 1998). Eventually, growing agricultural mobilisation led to the decline of the Congress party, initially in various states and then at the centre too (Rudolph and Rudolph 1987).

**Groundwater and Policymaking**

The issue of groundwater had now come to the policymaking arena too. The central government was quick to recognise that unfettered access to groundwater would lead to serious quality and quantity problems for groundwater usage. So, it decided to frame a model groundwater bill in 1970, which was modified many times, where each modification managed to retain the main idea of creating a central board, which would notify areas that required groundwater management (Cullet 2014). The bill excluded public participation. It was a failure in terms of proper groundwater management, leading to a new bill of groundwater being tabled in 2016, which was aligned to common management principles of E Ostrom (1990), giving groundwater the status of a common property resource.

This primarily happened because there was a bottom-up pressure generated by niches to include people in governing the groundwater commons; the niches being groundwater conservation non-governmental organisations (NGOs) like Tarun Bharat Sangh (TBS), Managing Aquifer Recharge and Sustaining Groundwater Use through Village-level Intervention (MARVI) project founded by the Australian Centre for International Agricultural Research, Gram Vikas Naryavak Mandal Laporinya (GVNML), and Andhra Pradesh Farmer-managed Groundwater System (APFAMGS).

Each of the above-mentioned NGOs has used Ostrom’s (1990) principles of managing common pool resources as a guiding template for effective groundwater resource management. Essentially, the micro-level pressure of giving people more access to groundwater had aligned with the technology of groundwater extraction being much more accessible cheaply, via economic incentives of free electricity. The micro level had caused a change in the meso level, and therefore, the pre-transition phase of groundwater management via participation was slowly transitioning into a take-off phase. This would be
clear if one studies the work done by the above-mentioned NGOs. A comparative analysis of their work is given in Table 1.

Summarising the above developments, we can see that 1960’s India witnessed a transition in agriculture from irrigation to groundwater usage slowly, over a long period of time. Agrarian issues changed the policy paradigm as well, which resulted in a subsidy for electricity and diesel usage of pumps for extracting groundwater. This caused acute groundwater shortage in the country, which led to the coming together of (i) groundwater practitioners at the micro level, who are working towards sustainably managing aquifers in niches (like the various NGOs mentioned in Table 1); (ii) development at macro

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**Table 1: Comparative Analysis of Rural Groundwater Management Schemes in India**

<table>
<thead>
<tr>
<th>Ostrom’s Principles</th>
<th>MARVI</th>
<th>GVNML</th>
<th>APFAMGS</th>
<th>TBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Clearly defined user boundaries:</td>
<td>(a) Individuals having the right to withdraw resource units must be clearly defined.</td>
<td>(b) The boundaries of common property resource (CPR) must be clearly defined.</td>
<td>(a) Villagers in Dhundhar region of Rajasthan are involved in participatory groundwater management.</td>
<td>(a) A groundwater management committee was formed consisting of villagers of the watershed.</td>
</tr>
<tr>
<td>(2) Match governing rules to local needs and conditions:</td>
<td>(a) Bhujal jankars are local people who have been trained to provide information regarding the quantity of resource in the local conditions.</td>
<td>(a) Context-specific projects are implemented, like the chauka* system for individual farms, shared small ponds, small earthen dams called anicuts and large ponds for whole villages.</td>
<td>(a) Rules are implemented based on crop water budgeting and artificial groundwater recharge data.</td>
<td>(a) Yes, rules are based on local conditions.</td>
</tr>
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<td>(3) Collective choice arrangements:</td>
<td>Villagers have stopped deeper drilling and removed sediment from recharge structures.</td>
<td>Local villagers use the local cultural concept of <em>shramdan</em> and other cultural practices to foster collective thinking about water recharge.</td>
<td>Rules are modified by farmers based on hydrometeorology data.</td>
<td>However, there is formation of Aravari parliament and <em>sansad</em> (parliament) which frames the rules for CPR. TBS is still the most important decision-maker.</td>
</tr>
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<td>(4) Ensure universal legitimacy of rules: The rights of users to form their own organisations are not challenged by external agencies.</td>
<td>MARVI project has been presented in Bhujal Manthan, 2018 at Nagpur, in front of the Central Groundwater Board, Ministry of Water Resources, River Department and Ganga Rejuvenation.</td>
<td>Initial resistance by state-level agencies has been overcome. GVNML has been appointed as a national-level monitor to monitor Government of India’s sponsored schemes.</td>
<td>Proactive support from various government agencies is provided.</td>
<td>There is tension between TBS and the Government of Rajasthan and other NGOs coming up in the region.</td>
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<td>(5) Develop self-monitoring systems:</td>
<td>(a) A smartphone app called Mywell and an SMS data collection system are present which present water table fluctuations of 250 dug wells in Dharta watershed and 110 water wells in the Meghraj watershed.</td>
<td>(a) Village-level monitoring committees have been formed.</td>
<td>(a) Extensive groundwater monitoring is done through groundwater monitoring committees.</td>
<td>(a) and (b) There are key transparency and accountability issues with the system.</td>
</tr>
<tr>
<td>(6) Conflict-resolution mechanisms: graduated sanctions for violators</td>
<td>There should be stringent sanctions for pollutants being discharged in aquifers.</td>
<td>Strong social rules are enforced for maintaining aquifer recharge.</td>
<td>No social sanctions are present.</td>
<td>There is a sansad which has framed 11 rules or sanctions.</td>
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<tr>
<td>(7) Accessible, low-cost means for dispute resolution</td>
<td>Farmers are being empowered at village and gram panchayat levels for dispute resolution.</td>
<td>All disputes are resolved by the village committee.</td>
<td>No formal mechanism for dispute resolution is present.</td>
<td>Effective mechanism of dispute resolution is not present.</td>
</tr>
<tr>
<td>(8) Nested tiers of governing institutions</td>
<td>There is a need to link Bhujal jankars, gram panchayats and village groundwater cooperatives.</td>
<td>There is a vertical hierarchy in the organisation itself, at the base is a field coordinator, then a mid-tier manager, followed by a senior programme coordinator at the top and a governing body at the topmost level of the hierarchy.</td>
<td>Groundwater monitoring committees at village level: hydrological unit monitoring at aquifer level; projects are implemented by NGOs; no formal tie-up with government agencies.</td>
<td>TBS is an NGO. There are horizontal linkages present and also vertical linkages with many foreign organisations.</td>
</tr>
</tbody>
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*Chauka* is an innovative system of rainwater harvesting carried out in Lapodia village in Dudu block of Rajasthan (*Down to Earth* 2015). *Shramdan* refers to the concept of voluntary work of digging ponds done by local villagers.

Source: Marvi (nd, nd a); Gardullo et al (2009); Verma et al (2012); Sinha et al (2013); Sarandha (2015); Sharma (2016); Daga (2017); Datta (2018); UNESCO (2018).
levels like the concern for India's dwindling groundwater resources, especially for the agrarian society that is paving the path towards a participatory approach for rural groundwater systems, and (iii) a slow change in the perceptions about the groundwater policy at the meso level, because of the pressures that have been generated at micro and macro levels, which is evident in Milhir Shah's (2014) report and the national groundwater bill.

All the above groundwater management systems are slowly but surely transitioning towards a participatory approach. This approach is marked by the policy of decentralisation and limited government interference, ideas which are very much at the forefront of India’s economic policy since 1991. This concept of decentralisation has entered almost all the regimes of societal, legal, economic institutions in India, and eventually made a mark on the groundwater management system in the country as well. The paradigm shift on groundwater management is quite evident in the report of Shah (2016), where suggestions on revamping the various institutions governing India’s waterbodies have been placed.

In the case of groundwater management, there is a separate chapter titled “New Paradigm within the Old Structure,” where the restructuring of Central Groundwater Board (CGWB) is mentioned in detail (Shah 2016). Implementation of these suggestions effectively will lead to the old artefacts of groundwater institutions established in the 1960s and 1970s to be streamlined with new innovatory strategies of managing the aquifer resources of the country. The suggestions mentioned in the above report can be considered as an intellectual precursor to the national groundwater bill of 2016. Now, I present a case study of urban groundwater management in Bengaluru.

A Case Study of Bengaluru

Bengaluru was long known as a city of lakes; a label which it eventually outgrew as it turned into a city of burning lakes (Bhasthi 2017) and pavements. There has been rapid urbanisation in the city leading to about 1,005% increase in concretisation from 1973–2016 (Ramachandran and Athial 2016). This urbanisation has led to a drastic reduction in its natural resources (M K 2016), the discussion of which is beyond the scope of this article. However, I would like to focus on how this urbanisation has affected groundwater usage. Bengaluru's transformation into a big city has had a huge impact on its water supply. The water supply is erratic because of the following reasons mentioned in Gronwall (2008). The Bangalore Water Supply and Sewerage Board (BWSSB) supply faces problems as the main Thippagondanahalli reservoir is yielding abysmal amounts of water—about 11.7 crore litres per day according to the official website (bwssb nd). Also, the 250-kilometre-long network of pipes is 70 years old and not satisfactory. The pipes have been damaged by corrosion and the leakage is about 37%–39% (Gronwall 2008: 308).

Add to this a floating population of both commuters and people who stay in hotels, and new residential areas being added to the board's supply area, we have a Sisyphean problem of matching water demands at par with the standards of an Indian metropolis. The water board falls short by about 80 crore litres (Ghoshal and Bagchi 2019). It has a reach of about 575 square kilometres, which is 70% of the city and is slowly also catering to 110 villages that are located at the periphery (Ghoshal and Bagchi 2019). The major source of water for the bwssb is the Cauvery river, which adds about ₹60 lakh to the costs due to the need for pumping the water upstream (Ghoshal and Bagchi 2019). The only recourse for citizens becomes the well-known water mafia (Ranganathan 2014). There was a time when a water tanker used to cost about ₹80–₹300 (Gronwall 2008). However, now it costs about ₹700–₹2,000 in summer (Ghoshal and Bagchi 2019). The depth of borewells in the city has reached enormous proportions from 500 feet to 1,500 feet, and yet, water is hard to find.

The apartments do not want a water connection because they need to be pay ₹1 lakh for a supply that is still erratic; and many residents also paid this price during the construction of the apartments (Ghoshal and Bagchi 2019). For slum dwellers though, most of the water is supplied by public stand posts, which according to a study conducted in 1999 number to 23,000, of which about one-fourth are borewells and hand-pumps (Gronwall 2008). Of these, only 6,000 are legally connected and political pressure leads to the continuation of services to the illegal entities for votes (Connors 2007). Therefore, it is very difficult to estimate the demand and supply of water for Bengaluru, because the actual amount of groundwater being extracted in the city is not being monitored.

There are often doomsday predictions of how Bengaluru will soon run out of water from BBC (2018) to NITI Aayog (2018). However, these predictions are slightly inaccurate. For example, the NITI Aayog (2018) report based itself on other sources that had not extrapolated data accurately to give specific predictions. Coming back to the discussion, one of the most profitable business ventures in Bengaluru seems to be the water tank business, which has proliferated on the basis of illegal drillings. The Karnataka Groundwater Authority is supposed to give permission for drilling borewells and register the already existing wells, but it has never monitored the situation, nor ever rejected any application for drilling (Gronwall 2013).

The bwssb is more concerned with transporting water and there is no effective policy towards the groundwater situation, with the mandate of having a hydrogeologist on the board yet to be implemented (Ghoshal and Bagchi 2019). The lakes in Bengaluru, which are located at the peri-urban interface, are severely impacted by urbanisation (Mundolia et al 2014) and had once upon a time served as sociological niches. They have now either become too polluted or have been simply restored and they have lost their cultural and economic provisioning services.

For example, the Agara lake underwent a change in management from community management to being managed by state agencies, and this has led to the lake changing into an urban spot for leisure from a landscape which was once a source of fish and fodder (D’Souza and Nagendra 2011). However, Bengaluru has a very active niche in terms of citizen participation. From The Ugly Indian to Vishwanath’s Biome,
Meera's Citizenmatters.in, and collectives like Friends of Lakes, Bengaluru's residents have relentlessly pushed for change for effectively managing the groundwater resources of the city. This development of a niche is a direct result of the city's mercurial asce in India's information technology capital.

G Connors (2007) mentions S M Krishna, the then chief minister of Karnataka, who formed a task force named Bangalore Agenda Task Force, with the aim of reforming the city's main service providers. This led to the emergence of a new breed of NGOs like Janaagraha and Public Affairs Centre, which were led by leading information technology professionals and management experts. These NGOs slowly uprooted the traditional NGOs and communicated directly with S M Krishna and senior Indian Administrative Service officers of the state. Civil society in this new form directly influenced the bureaucracy and exhibited good governance to the citizens of Bengaluru (Heitzman 2004). The government was also held accountable by the citizens (Paul 2002). An innovative idea was to present a citizen's report card which depicted the satisfaction of Bengaluru's residents in terms of the civic amenities provided by the government authorities (Paul 2002).

Analytical ideas and political connections entered the civil society space, leading to a transition from grassroots NGOs with less mobilisation capacity to NGOs, which resonated with Bengaluru's middle class. This process of spillover of ideas has also influenced the management of the groundwater resources of the city. Technological ideas are spilling over from the country's top information technology hub to influence governance paradigms, like monitoring borewells using internet of things to predict when the water supply will come. For example, Nextdrop is using these technologies for making recommendations. Summing up, there is an innovation arena in place where various actors like civil society, the bureaucracy and the residents of Bengaluru are trying out innovative solutions for water management. At the micro level, there is a slow movement being generated to form a participatory and interactive consensus approach towards effectively managing the city's groundwater, shifting from the largely bureaucratic system of governance.

Conclusions

The groundwater problems in India have been caused due to human activities over the last 50 years. Large-scale human interventions have made the system highly unsustainable. Couple that with the rapid scale of urbanisation that a city like Bengaluru is facing, we get a system that is unsustainable, unsafe and highly erratic. Based on documentary research, it can be concluded that groundwater management has some innovative niches, which if given enough room to sustain and mature, may lead to a fundamental change which will be more participatory and inclusive. The historical developments in Bengaluru suggest that in urban India, groundwater systems in terms of Bengaluru's management are at the pre-take-off stage.

An important demarcation point would be the 1970s when the groundwater model bill was just introduced. Slowly, there was influx and cross-fertilisation of other ideas which finally led to a more composite bill on groundwater in 2016. This bill, although progressive in nature, is still a bill that needs to be enacted as a law. Space for groundwater innovation was created through various water NGOs, which later opened up the innovation arena for major institutional change. However, unless old regimes and artefacts like the CGWB are suitably reformed, these transitions may not take off and instead may stay confined to the micro level only. Whether the road ahead to groundwater management is as sure as gusts of wind blowing or as uncertain as chasing a gust of wind—only time will tell.

NOTE

1 For more stories of successful participatory groundwater management systems, see Planning Commission (2012–17).

REFERENCES


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