Competition and conflict for groundwater:
The Urban context and the potential for cooperation

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Introduction

Groundwater is used by more than 1.5 billion urban dwellers worldwide, although there is no systematic and comprehensive data to quantify trends (Foster et al, 2010). Groundwater resources will continue to form an important element in urban water supply given that global urban population is expected to nearly double to 6.4 billion by 2050, with about 90% of the growth in low-income countries and a predicted increase in the number of urban slum dwellers to 2.0 billion in the next 30 years (Foster and Vairavamoorthy, 2013).

Furthermore, India's groundwater usage is significant with statistics available for irrigation and rural drinking water supply. Recent data from various sources clearly indicates that 'urbanizing' India also has a significant groundwater-footprint (Kulkarni and Mahamuni, 2014). Three recent statistics point to how at least half of urban India clearly depends upon groundwater for its various needs.

1. Averaged for 71 cities and towns, groundwater constitutes 48% of the share in urban water supply (Narain, 2012).
2. In India, 56 per cent of metropolitan, class-I and class-II cities are dependent on groundwater either fully or partially (NIUA, 2005).
3. Unaccounted water in urban areas exceeds 50% according to the CGWB's report on the groundwater scenario in 28 Indian cities (CGWB, 2011).

It can be stated that the growth of cities in India is enabled by groundwater. Similarly the formation of new urban areas is also enabled by groundwater. Formal institutional response to emergence or growth of urban areas has always lagged the needs on the ground. In this context, recourse to groundwater – accessed through private wells & borewells and water tanker & bottled water markets - then begins the single largest coping strategy. In addition, multi-sourcing of water in towns and cities is becoming the norm with groundwater contributing alongside formal institutional piped water supplies that rely on surface water projects. Formal urban water supply in India has rarely, if at all, considered groundwater resources in its planning.

It is but natural, that in the above context, competition for groundwater in urban areas is a consequent outcome. Sometimes competition becomes conflict that may or may not be obviously seen. Urban (water) governance is yet to completely acknowledge the significance of the role of groundwater in the urban context, let alone respond to competition and conflict for the same. This paper attempts to describe this competition in Bengaluru. It however, attempts also to juxtapose 'competition' with narratives of interesting responses that the lived experience of water problems has inspired from some of Bengaluru's actors – responses that can be construed as forms of cooperation – and from which key lessons for groundwater management can perhaps be learnt.

Bengaluru : The Context

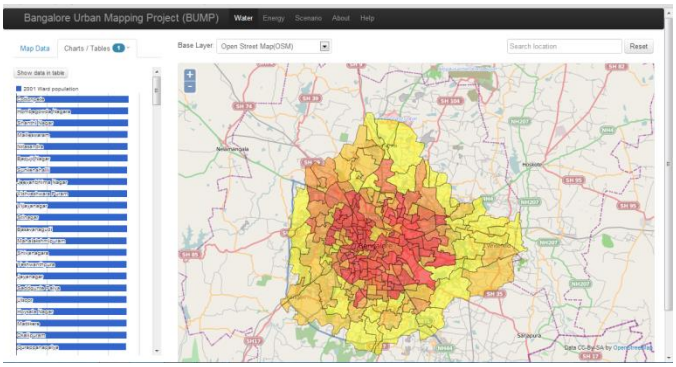
Bengaluru's formal institution for water supply and sanitation is The Bengaluru Water Supply and Sewarage Board (BWSSB). The city officially sources its water from the river Cauvery. The conflict between the state of Karnataka and the state of Tamil Nadu over the waters of the river Cauvery is very well known. In the month of September 2016 (during the writing of this paper), Bengaluru encountered a complete shut-down for multiple days following riots in the city, over the sharing of Cauvery river waters with neighboring state of Tamil Nadu. This river source is approximately a 100 km away and 300m below the city thus representing an incurred cost of Rs 28/Kilo Litre to pump into the city. The official numbers[1] state that the city has around 7,40,000 domestic connections, 42,100 non-domestic connections and around 2641 industrial connections. Connections are all metered. Tariffs are all volumetric with increasing block tariffs for different domestic (except households in high rises) and non-domestic categories. Domestic category tariffs are highly subsidized (except households in high rises) – especially in relation to the cost incurred by the city to get this water.

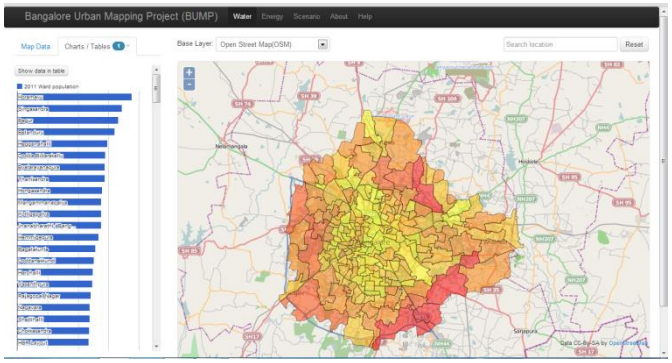
Bengaluru has seen very rapid demographic, economic and geographic growth in the last two decades. The formal water supply institution – The Bengaluru Water Supply and Sewarage Board (BWSSB) – has not of kept pace with the growth of the city. Consequently large parts of Bengaluru on the "periphery" (which are very populous) are completely dependent on groundwater – accessed through private wells & borewells or through water-tanker and other water markets.

Bengaluru : 2001, Population : 5.1 million (Dark shades are high population density)

Bengaluru : 2011, Population : 8.4 million (Dark shades are high population density)

Source : BUMP (www. http://bangalore.urbanmetabolism.asia/geoportal/)





The BWSSB officially claims to have covered 575 sq Km out of a total area of 800 sq km with piped water supply. However supply is intermittent and unreliable in many areas where it exists. Even in the areas of Bengaluru where institutional supply exists, increased demand in the context of limited surface water availability and inefficient & iniquitous distribution has meant consumers are increasingly relying on groundwater for supplemental and/or lifeline source of water when formal supply is interrupted. A

[1] Source : The website of the BWSSB (www.bwssb.org)

study by ISEC[2] (Insitute of Social and Economic change) in 2005 estimates that the number of borewells in Bengaluru is approximately 400,000 increasing at a rate of 6500 borewells per year and extracting 750 Million Litres a day.

A quick glance at the table below suggests that approximately 40% of the total water demand in the city is met by groundwater. The following calculation considers demand of 135 lpcd in urban area. However, field experiences of practitioners of water management services suggest that the actual water consumption is beyond 135 lpcd, sometimes upto 250 lpcd.

Therefore the share of groundwater contributing to meeting the city's demand is at the least 40% and likely more – meaning groundwater use is as significant as piped water supply. Bengaluru therefore is a particularly emphatic example of the role groundwater plays in the growth and development of the city.

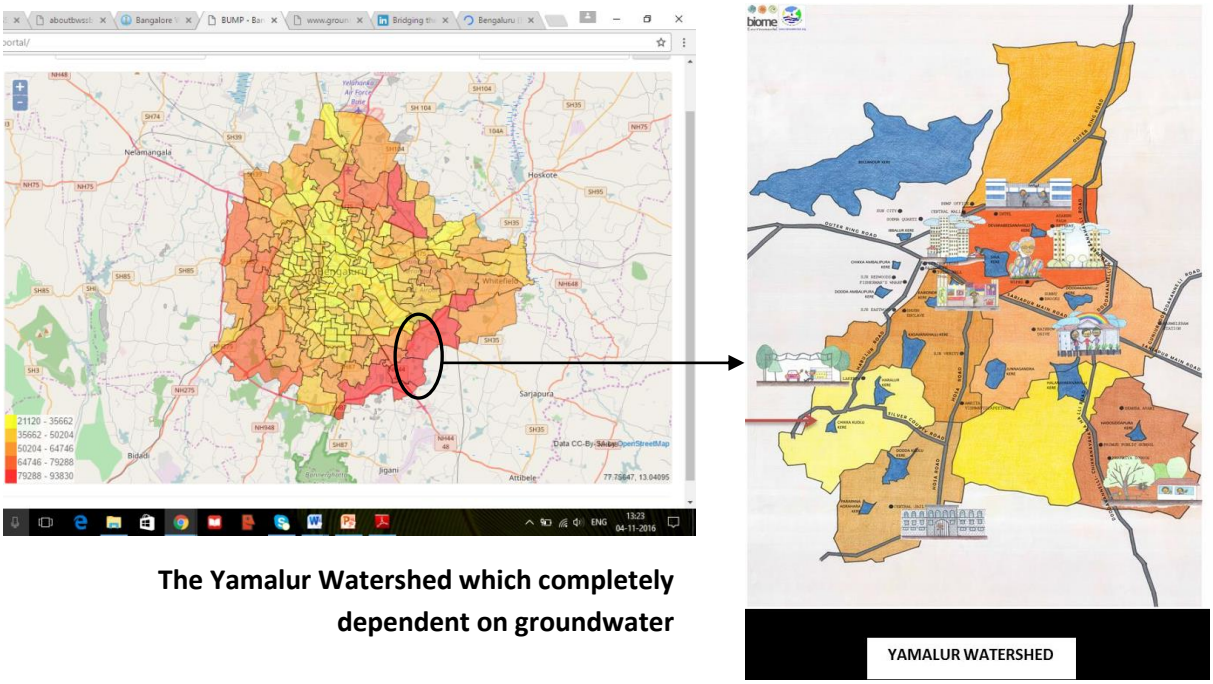
Population as per 2011 Census	8.4 million
Population in 2015	11 million
Demand @ 135 LPCD (Liters per capita per day)	1485 MLD (Million Litres a day)
Quantity of water sourced from Cauvery by BWSSB	1410 MLD
Leakages – 40%	~500 MLD
Groundwater to the rescue!	~575 MLD

While the BWSSB – a para statal - is in charge of water supply and sanitation in Bengaluru, it is also the assigned "Groundwater Authority" for Bengaluru Urban district under the Groundwater (Regulation and Control of development and management) Act of Karntataka 2011 – an institution created to "regulate" and "manage" groundwater. However, stormwaters and landuse is managed and controlled by the Bruhat Bengaluru Mahanagara Palike (BBMP, the city government) and the Bengaluru Development Authority (BDA). The official custodian of the lakes/tanks of Bengaluru is the BBMP – however sometimes the BDA takes up "development and rejuvenation" of specific lakes/tanks. There is also a recently constituted institution – the Karnataka Lake Conservation and Development Authority or KLCDA (under the KLCDA Act 2014) – whose mission is to "intensify official concern and motivate community vigilance to the extent where encroachment and pollution of the lakelands would become impossible" and whose jurisdiction is all lakes within municipal boundaries (or all urban lakes including that of Bengaluru) in Karnataka. The Karnataka State Pollution control Board (KSPCB) monitors and regulates all

[2] Urban Water Supplies dependency on Groundwater – Initial Findings in South Indian Cities, B.K Anand and K V Raju et al. This paper was presented in the "Drinking water session" of the IWMI-TATA partners meet held at Anand on Feb 24-26 2005.

forms of water (and other environmental) pollution in the city and the state. Thus there are multiple institutions effectively involved in water and groundwater governance in the city.

There are many pockets in Bengaluru which are completely dependent on groundwater as there is no piped network to supply water. The Yamalur watershed – in the south east of Bengaluru is one such area. Biome Environmental Trust in partnership with ACWADAM, with support from Wipro Technologies Ltd is currently working on a program of "Participatory Aquifer Mapping" – a techno-social experiment trying to drive participatory knowledge generation about local aquifers and evince citizen groundwater management responses from this process. The program hopes also to derive significant learnings for groundwater governance from the entire exercise. The complete dependence on groundwater has heightened the drama of groundwater competition and conflict in this geographic region of Bengaluru. The narratives and conclusions in this paper are significantly derived from the experiences of this "Pariticpatory Aquifer Mapping" program.



The Yamalur Watershed which completely dependent on groundwater

The Kaleidoscope of competition, conflict and cooperative responses

Competition and conflict for groundwater in Bengaluru is perhaps best described as an outcome of a kaleidoscope – a dynamic mosaic – of actions and responses of different stakeholders (a) seeking to fulfill their water demand and water management needs, (b) providing services that helps meet these needs, (c) negotiations and contestations *within* and between different stakeholders to secure reliable and affordable access to watsan services and finally (d) collective and individual discourse, participation and action to protect water as a common public good. While competition and conflict for water in general are a natural outcome of (a), (b) and (c) above, what the city also sees is cooperation and competition mitigating responses as a result of (d) above. In addition, competition and conflict *for groundwater in particular* is strongly influenced by the hydrogeological setting – and there are many

local "micro" variations of this within Bengaluru. The extent to which the different players have knowledge of these settings (the aquifers and their characteristics) can also influence landscapes of competition, conflicts and cooperation.

The diversity of players seeking services to fulfill their demands can be seen from three lenses:

(1) the nature of the player viz citizens living in individual households, resident welfare associations of different forms of group housing (eg: apartments and layouts), commercial establishments (eg: hotels and marriage halls), businesses (eg: software campuses), institutions (eg: educational institutions and hospitals), manufacturing (eg: industries), real estate developers (eg: for construction or to operate real estate complexes of any of the above kind) and finally citizens of slums, low income housing and informal migrant settlements.
(2) socio-economic characteristic of these players (i.e. simplistically the poor, the middle class and the rich) and the extent of political access or influence these players can have on the formal system
(3) the nature of the demand – drinking water, domestic, recreational, economic or for real estate development.

Similarly the diversity of players *providing* services can be seen along the following dimensions

(1) The nature of the service provided - this diversity is remarkable and a very critical dimension that influences competition and conflict. These service providers, it must be recognized are also the source of a lot of groundwater knowledge (true or false, good or bad) for many in the city. Some important examples are real estate development and management services, water diviners and hydrogeologists and their consultancy services, borewell digging services, bottled water services, water tanker services, waste water treatment and reuse operations services, rainwater harvesting services, water purification technology services, hydrofracturing services (and many others). It would not be untrue to say that citizens' understanding of what groundwater is and how it works is largely determined by knowledge flows from these service providers to the citizens (and the citizens' contestations of these knowledge flows with other interpretations they may have internalized from other service providers or other sources).
(2) The extent of formality or informality of the service provider – the services may be completely formal (eg: the real estate developer or Sewage Treatment Plant Service providers) or completely informal (eg: the open-well digger). This dimension of diversity has direct bearing on regulatory influence on these players.
(3) The extent of political access these service providers may have as both individual service providers and as a "sector".

All these dimensions of diversity have bearing on the behaviours of these players - which has implications for abetting or mitigating competition for groundwater. It is the largely atomized actions and responses of this diverse universe of service providers and service consumers seeking to maximize private benefit that forms the kaleidoscope of competition and conflict in groundwater. And the

kaleidoscope is that much the richer, as seeds and hope of cooperation that takes cognizance of larger public good, also emerges within its continuously changing patterns.

With these broad observations, here are some indicative narratives reflective of competition and conflict for groundwater from Bengaluru city juxtaposed with the narratives of responses that are competition mitigating or narratives that can be construed as cooperation.

Narratives Competition & conflict: For groundwater or where groundwater plays an important role

Groundwater for the poor: The corporator as a political route to access water

Bengaluru's water utility – the BWSSB – is a parastatal and therefore the people of Bengaluru do not have a *direct* political route to Bengaluru's formal water supply system through the locally elected representatives of Bruhat Bengaluru Mahanagara palike (the city corporation) – or the corporator. However the corporator is often left to respond to the political demand for water from many parts of his ward. When the utility does not or cannot respond to this demand for access to water (for any reason whatsoever) the corporators typical response is to dig a borewell in the city corporation's land and supply water free of cost - particularly to populations of the lower economic segments –through water tankers. (It is also often cited in many a discourse that corporators own tanker water businesses). This may be an important political route for the relatively lower economic segments to access water. It is the authors' observation, that this may be one way in which "leaky" distribution pipes benefit the poor, especially those in parts of the city where the utilities formal services exist but some of the poor do not get connected because of technical, financial, political or other reasons. High water tables due to leaky pipes make it easier for the corporator to supply groundwater for free. This narrative is important in that it highlights that even where formal services exist groundwater still plays a role for the poor to access water.

The Tanker water markets: Tensions between operators, consumers and the language of the city's discourse

Tanker operators and the tanker markets are often referred to as the "tanker mafia" in many narratives of the cities' discourses. The nexus between tanker water operators, local corporators or officials of the formal utility is recurrent theme in some of the narratives of tanker water markets that the city's discourse sees. Nevertheless the fact remains that the water tanker and its service is critical for Bengaluru – especially in the large and highly populous wards where the formal utility's services are still a distant dream. Practically all tanker operations are driven by groundwater, and as the city grows, peri-urban farmers are beginning to see provision of groundwater for tanker operations as an important economic proposition. This is the water that enables growth of the city and very quickly in these newly developing areas the drama of competiton for ground water plays itself out.

For example large parts of South Eastern Bengaluru (along outer-ring road in Bellandur and Sarjapur Road) have no access to municipal water supply and are completely dependent on groundwater – either from private borewells or through water tanker markets. Tanker water operators here have been providing water at rates varying from 75/- to 200/- per KL. There is always nervousness in the tanker operator's mind as well as the consumer's mind about the longevity of the water source, the capability

of new communities to pay more for the water and consequent reduction in access to ground water for older communities. This leads to the following behaviours:

1. Tanker Operators are territorial. Once they tie up with a community/institution for water supply they do not allow for the community to look for other vendors. Mechanisms used include threatening the other tanker water suppliers and/or the community itself.
2. Tanker operators price their services not merely based on their "production and delivery cost" of water but on competitive demand.
3. As a consumer response to this - so as to ensure that the tanker water prices do not vary greatly - the RWAs (Resident Welfare Associations) have organized themselves and call for a meeting with the tanker operators once a year to negotiate a price that can be common across all buyers. While there is no official sanctity to this meeting, the discussions here are largely adhered to.
4. Non regular buyers of tanker water (eg: individual home owners) who normally reach out to tanker operators only in summers or times of acute water shortage have to pay upto Rs 2000/- for 6KL of water (>300 Rs/KL).
5. Tanker operators who do bulk supply prefer if the number of tankers that are ordered for by a community does not change on a daily basis. This is so that they can plan their operations better.
6. During the monsoons apartments that have implemented RWH are left with sumps full of harvested rain as well as several tankers waiting to supply water. This sometimes leads to some unpleasant communications. However, many a time the tanker operators also graciously acknowledge how easy and sensible it is to harvest rain rather than bring in water in tankers.

Competitive digging and competing uses

The authors engage with urban communities to help manage their water in socially and environmentally responsible ways – such as implementing rainwater harvesting or waste-water reuse. In the course of these engagements over the last decade they have observed

1. A pattern emerges when revisiting the same community over time. In many communities which are completely dependent on groundwater over a decade new borewells are drilled as some of the earlier borewell sources have gone dry. Further these new borewells are deeper than the earlier borewells. There is a tendency to "dig deeper" in search of water security. The borewell drilling business makes more money if borewells are deep. The borewell digging service teams are an informal source of information and understanding of groundwater for many communities. This behavior is typically happening in the context of poor understanding of local aquifer systems.
2. Communities are wary, sometimes even unfriendly with new communities that emerge in the same area (digging new borewells) as the new development is construed as reduced water availability for existing borewells. Of course this tension may not always be explicit and is expressed really in private conversations.
3. There is new found interest in hydrofracturing amongst borewell owners. Hydrofracturing includes "camera inspection" which fills in information gaps that may exist about existing borewells. Borewell owners are particularly interested in hydrofracturing as a technique to increase yields of borewells often without the knowledge that it may result in increased yield but at the cost of neighboring borewells. Adequate knowledge about aquifers and how groundwater works may help to influence such behaviours.

4. Businesses / industrial houses have been observed to buy small patches of land in high groundwater yielding areas only to secure supplies of water. Capital availability allows business houses to resort to investments of these sorts.
5. Many urban residential communities in Bengaluru are in conflict with their real estate developers over water security. The real estate developer often "mines" the groundwater during the construction process and markets the development misinforming potential clients about availability of water. The developer then leaves occupying residential communities with infrastructure but no resource. This kind of conflict is particularly obvious when the real estate developer operates the infrastructure in a "multi-land use" project. In such projects, large tracts of land are developed into a combination of residential communities and commercial establishments such as software campuses, hotels and shopping malls. The occupation of these multi-use projects also happens in phases when significant parts of the project are still under construction. The developer supplies water to all parts of the real estate development controlling the ground- water sources but determining water allocations across residential, construction and commercial uses of water. In such developments the real estate developer often flexes his political muscles to ensure formal water supply from city's institutions even if that geographical area currently is not served by the institution. The authoring organisation is working with one such community where it was discovered the entire shallow aquifer is not utilized and the development is depending on a combination of borewells, water tankers and some piped water supply from the BWSSB (albeit that the proportion of supply from BWSSB is smaller than tanker water supply). An engagement is ongoing with the community to invest in recharge into and withdrawal from the shallow aquifer through open wells – the community getting a "buy-in" from the real estate developer will be critical to this engagement.

Narratives of Competition mitigating responses: Potential and hope for cooperation

Even in the midst of such a competitive groundwater context the city sees responses that can be construed as competition mitigating – perhaps even cooperation. Many of the competition mitigating responses stem from being dependent on tanker water markets or private borewells – both of which are characterized by a sense of water-insecurity. Water tanker markets also have high water pricing (100 Rs / KL and more). Even for urban communities with private borewells, this represents an important opportunity cost of water in the backdrop of drying borewells. This context is also combined with some regulatory measures taken by both the BWSSB and the KSPCB. BWSSB mandates Rainwater harvesting for all forms of land-use including and beyond the 30 * 40ft plot size (though this is applicable only when BWSSB supplies water to the premises, this has become a reference for water harvesting conversations in other parts of the city). The KSPCB has a "zero" liquid discharge norm that mandates layouts, apartments and commercial/business establishments to treat and reuse waste-water completely. While these regulations play an important role, their enforcement and mechanisms to monitor are far from effective. The groundwater regulations by the Karnataka Groundwater Act 2011 however are hardly known or understood by watsan service consumers. The combination of this sense of water-insecurity, pricing signals by the water tanker markets and regulatory (albeit weakly enforced) measures has spawned an interesting array of responses by consumers in their endeavor to manage their water and sanitation services. Some representative narratives of these are as follows.

1. *Communitising borewells and investments in recharge*

Recognizing the futility and waste of money in competitive digging of too many groundwater withdrawal structures, many communities respond by "communitizing" groundwater withdrawal. Communities share a set of common withdrawal structure with a community institution – typically – a resident welfare association managing withdrawal and distribution of water. Further many communities, institutions and businesses invest in artificial groundwater recharge. Of course the consideration of whether recharged groundwater can be captured by their withdrawal structures is a part of the conversation and negotiation in the run up to decisions on these investments. These investments can also be de-risked based on the limited hydrogeological understanding that these players may have – for example, a community has invested significantly in recharge but has located recharge structures within its property boundary in such a way that it minimizes possible capture of recharged water by neighboring withdrawal structures (which are often commercial). These forms de-risking predicates itself on imperfect and more often than not poor knowledge of aquifers. However, an increasing number of communities are investing in recharge conscious that groundwater is a public commons and with the active knowledge that the recharged ground water may only be partially captured or never be captured by their withdrawal structures. This is a reflection of a growing understanding and acknowledgement of groundwater as a "common property resource".

2. *Demand management: Metering, Transparency and Tariffs*

In the struggle to manage community water supply, resident welfare association or estate managers face multiple problems. Scarcity of water, high cost of tanker water and iniquitous consumption of water within the community are some of them. One of the solutions that has evolved to manage internal competition for community water is retrofitting consumption meters and making transparent within the community water consumption of individual households. A sophisticated meter market that makes retrofitting easier and easier – with software technology to integrate and manage data – has developed. Communities that have invested and undertaken metering have observed that the mere act of metering and making consumption known results in upto 20% drop in demand. Further communities are beginning to impose tariffs that are designed to recover & control costs and discourage wastage of water. Demand management therefore is also a response to increasing competition for groundwater. And this response is good for the city and has a net competition mitigating influence. Communities are beginning to become conscientious about their demand.

3. *Investing in waste-water reuse – displacing use of freshwater*

In this same struggle, communities, institutions and businesses have invested in retrofitting reuse of waste-water. For example, a business that claims to be running around 10 MLD of Private Sewage treatment capacity (as on 2013) in Bengaluru revolves around a model that takes over a dysfunctional sewage treatment plant, refurbishes it and promises to sell back the treated waste water at much lower than tanker water rates to the community for lower value end-uses. These kinds of businesses are effectively displacing use of fresh groundwater and developing a market not only in the context of the increasing competition and cost for groundwater, but also in the context of some growing consciousness of some urban elite to be environmentally sensitive.

All of these above solutions – metering, rainwater harvesting & groundwater recharge, resue of waste-water is now entering the lexicon of some of the marketing language of real-estate: Though it is still only the beginning, they are advertised as features in green-field projects. This is indicative of a maturing market for these kinds solutions.

Narratives of cooperation to protect public commons: Protecting lakes

Apart from the above "implicit" or "market driven" responses that mitigate competition, Bengaluru city also sees explicit forms of citizen cooperation to protect public commons. Nowhere is this clearer than the current citizens' movements to protect Bengaluru's lakes/tanks. Citizens have come together to, mobilize neighborhoods, garner resources from corporate social responsibility, develop solutions, move the judicial systems and make institutions of governance accountable and engage with them to revive lakes and restore rule of law to protect them. They have come forward to forge public private partnerships to maintain and manage them. This collective response from citizens is also creating different debates within the city on what the re-imagination of lakes/tanks in the city should be – what is the role of lake in contemporary Bengaluru? – should they be soures of recharge, places of recreation, the city's bio-diversity spaces, wetlands for waste-water management or urban flood mitigating systems? What are the tradeoffs and how many functions can each lake or a network of them together perform? These are questions the city is now asking. These citizen movements have made researchers, academic institutions and professionals from different sectors also become interested in and get engagement with this movement.

The case of Kaikondrahalli Lake in the aforementioned Yamalur watershed is one such example. And in this discourse of lake revival and protection, the explicit linkage between lakes and groundwater is beginning to be acknowledged. Another example is of the Jakkur Lake - which receives 10 Million Litres of treated waste-water from a public sewage treatment plant (run by the BWSSB), further treats the water through a designed wetland system and helps in keeping the lake full and helps in recharging groundwater locally, thus converting waste water into valuable fresh water "at a systems level".

While the lake is understood as public commons, the acknowledgement of the linkages between lakes and groundwater – and of groundwater as a public common - is beginning to influence the city's consciousness. This new understanding needs to be strengthened with appropriate science that reinforces the values of public good, sharing and cooperation.

Conclusion: Learning from what's already happening

The latter narratives of cooperation represent a very important opportunity for Bengaluru to re-imagine its water future and the role of groundwater in it. In these narratives perhaps lie some answers to how water should be managed in Bengaluru – above all these narratives bear within them clues on how to make people a part of the solutions to Bengaluru's water problems. Broadly, these narratives tell us that some of the critical aspects of a water governance strategy are the following:

a) People can display demand management responses in supply constrained and insecure contexts when they are manage their own water sourcing. When the utility's piped network extends into these areas therefore, very careful consideration needs to be given on how to ensure value is added by the formal utility without rendering this capacity irrelevant.

b) Tariff and regulatory environments should be designed so as also to incentivize: demand management responses by the people and private investments in public good (such as recharge & reuse of waste-water). These incentives can be both economic and non-economic.
c) An encouraging environment for businesses that provide "ecological watsan services" – such as water metering/sub-metering, rainwater harvesting, recharge, waste-water reuse etc.
d) Investment in and collaborations for developing the relevant new skills and knowledgeable human resources within the sector.
e) A "communications and campaigning" element which focuses not only on dissemination of information and "demystified" water science, but also focuses on inculcating values and a culture of water stewardship.
f) Institutionalizing of mechanisms for continuous conversations and knowledge sharing between citizenry and governance.

There are of course multiple challenges to actually translate these strategic elements into policies, regulations and investments. The pricing of water – which *should ideally reflect its true costs beyond a certain universal lifeline* (right to life) use of water – is one major challenge as it hits the hurdle of a "political unwillingness" to charge – this has a very big implication for the "larger market" and economic signals that stimulate "good behavior" with respect to water management in general. The other major challenge stems from the fact that institutions governing the different water aspects of water issues are fragmented – so coordinating a regulatory and policy response into a single integrated response that can achieve good groundwater governance specifically and water governance in general.

In conclusion, the activists, researchers, water managers and citizens seeking a more water secure and water responsible Bengaluru have to persist and persevere with strengthening the above heartening narratives of cooperation and stewardship – and taking these narratives to the larger public and the institutions of governance.