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Match, don't mix: implications of institutional and technical service modalities for water governance outcomes in south Indian small towns

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Abstract

This paper seeks to contribute to the limited literature on water governance in small towns in India. For assessing water governance, we propose a broad framework encompassing adequacy and affordability, equity, sustainability and responsiveness. Analytically, the concept of 'service modality' is expanded to include not only institutional arrangements but also water resource deployment, and placed within a framework that includes multiple contextual variables as well. We use this framework to carry out an inductive analysis by comparing water service delivery and governance in four small towns across two states (Karnataka and Tamil Nadu) in southern India. Apart from differences in size, the towns differ in the institutional arrangements – from fully municipal management to a combination to complete para-statal management – and in the deployment of water resources – only ground water to a mixed supply of ground and surface water (dual sourcing). Data were gathered using a combination of household surveys, metering, records, and interviews. Dual sourcing resulted in adequate supply and optimization vis-à-vis end uses. Inter-household inequity is driven by socio-economic differences amongst households, but can be mitigated to an extent by increasing public tap density. But water resource use is not physically or financially sustainable. The responsiveness to citizen needs was significantly higher when the distribution was done by the local governments. Separation of roles, with para-statals providing bulk supply of surface water, and local governments managing the distribution of this and groundwater, may be an optimal service modality.

Keywords: Dual-sourcing; Small towns; Urban water; Water governance; Water service delivery; Water service modalities

Introduction

Urban domestic water demand is growing dramatically in developing countries because of the twin phenomena of population growth and rural–urban migration. Within the urban landscape, smaller

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towns, i.e., towns with population less than 100,000, are likely to become the centres of fastest population growth (Gupta, 2012). At the same time, such towns in developing countries face special challenges in meeting the water needs of their citizens, because of limited human and financial resources, absence of dedicated water utilities, and limited physical resources, often resulting in high dependence on groundwater (Mugabi & Njiru, 2006; Shah, 2013).

While there is a thriving literature on urban water governance in large cities of developing countries around the world, research on water supply and water governance in small towns in developing countries is of recent origin and somewhat limited in coverage and scope. Analytically, this research has highlighted the limited penetration of state-run piped water supply, especially in Africa (e.g., Adank *et al*., 2011, p. 16) and the Philippines (Tungpalan, 2009). Consequently, the focus has been on documenting and evaluating alternative modes of water service delivery, including community-managed institutions, private players, and their combinations (e.g., Cain & Mulenga, 2009; Fragano, 2001). The Indian context, and particularly that of peninsular India, differs significantly from this in that state-run water supply systems have high levels of penetration even in small towns. So the 'service modalities'[1] debate in Indian small towns is less about how to integrate public utilities with private or community players, and more about the role of and interface between different public agencies or levels of government (Krishnan, 2006; De Bercegol & Gowda, 2013)[2]. Similarly, the global literature on water supply in small towns appears to assume that lack of infrastructure and management is the problem, not physical availability of water (see, for example, the review by Mugabi & Njiru, 2006). In the Indian context, however, where population densities are very high and water much scarcer than in some other countries, this assumptions may not hold, and the choice of whether and how to use surface water (SW) or ground water (GW) is likely to be a crucial element of water management decisions at both household and municipal levels (Shah, 2014). There is an emerging literature on the conjunctive use of SW and GW by households in cities (e.g., Srinivasan, 2008), but not much attention has been paid to 'dual-sourcing' by the water supply agencies themselves.

Normatively, the literature on small town water services has tended to focus on adequacy and access, quality, affordability, and cost recovery (e.g., Caplan & Harvey, 2010). We believe that, in addition these concerns, the question of equity in distribution, physical sustainability, and the responsiveness and accountability of the public agencies involved are also important to policy makers. The literature on these dimensions, however, is much more limited. For instance, while there is literature on physical sustainability of water management systems in villages (e.g., Rautanen & White, 2013) and there is a debate about whether large cities should be importing so much water from faraway dams (e.g., Mukherjee *et al*., 2010), there is little discussion of groundwater sustainability, even in the context of small towns that are often highly groundwater dependent (Raju *et al*., 2004; Shah, 2013). Similarly, a significant literature on equity in water service delivery exists for big cities (Bakker *et al*., 2008; Anand, 2011; Subbaraman *et al*., 2013), but hardly any on similar issues in small towns.

Moreover, there appears to be a degree of disciplinary fragmentation, with sociologists focusing on equity issues and economists focusing on efficiency, preventing an integrated understanding of the multiple dimensions of concern highlighted above. Not surprisingly then, the relationship between

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[1] A term coined recently: Rusca & Schwartz (2012).

[2] One major debate about institutional arrangements in cities in India and elsewhere, viz., the question of privatization of water service delivery (McKenzie & Ray, 2009; Sangameswaran *et al*., 2008) appears to not be relevant to small towns because they are too small to attract private players (Mugabi & Njiru, 2006).

institutional arrangements, choice of resource, administrative and political cultures and the socio-economic context of households on the one hand and these multi-dimensional outcomes on the other hand remains poorly explored. Such a broader framing and interdisciplinary data are essential when policy debates do emerge, such as whether municipal supply should be handed over to a specialised para-statal agency or not (Jayaramu *et al*., 2015), whether metering is essential for cost-recovery or avoiding wastage in consumption (Kumpel *et al*., 2017), or whether importing SW is essential or not (Nadhamuni, 2012). But this broader approach has been rare in small town water research.

In a modest attempt to fill these gaps, we present here the findings from a comparative analysis of domestic water outcomes[3] in four small towns from the states of Karnataka and Tamil Nadu in southern India that vary in the role played by public agencies and in the availability of SW to supplement GW. This study was part of a larger interdisciplinary research project carried out in two river basins in southern India; the choice of small towns was therefore confined to these basins. The study seeks to contribute at two levels. Firstly, it seeks to assess the variations in the 'outcomes' of water governance across the multiple dimensions mentioned above, viz., adequacy (including affordability and quality), equity, resource and financial sustainability, and responsiveness and accountability in water governance. Secondly, the study seeks to understand how differences in socio-technical arrangements or 'service modalities'[4], specifically in the roles of the local government versus provincial para-statal agencies and in the use of GW versus SW, may influence outcomes across these multiple dimensions. Drawing upon data gathered from household surveys, interviews, physical measurement of borewell pumping rates, and secondary data, we seek to understand what might be the appropriate role for different state agencies and how different sources of water might be optimally used, while at the same time pointing to the influence of other factors outside the service modality. We adopt an inductive approach, and so the study concludes with hypotheses rather than firm assertions, some relevant to small towns and others to urban water governance as a whole.

Following from the inductive approach, the paper begins with a description of the towns studied and an overview of the service modalities they have adopted. This is followed by a section outlining the multiple dimensions of outcomes we focused on and the framework for analysis. The section on methods provides details of the indicators used for the outcomes and how data were gathered for assessing them and for exploring potential links with the factors in the framework. We then present the results along the multiple dimensions and their relationship with intermediate decisions made by the service provider. The links with service modality and other factors are discussed in the subsequent section. In conclusion, we offer some hypotheses regarding small town water governance in India for further exploration.

Study sites and service modalities

This research was part of a larger study on climate change adaptation in the water sector in two river basins: the Arkavathy River in Karnataka state and the Noyyal River in Tamil Nadu state (see www.atree.org/accuwa for more details). Both basins are similar in having a dry climate (~600–900 mm

[3] Although use of water in commercial activities was not entirely negligible in some towns, we have not included that in this paper for want of adequate data and benchmarks as to what constitutes reasonable use. So for this paper, small town water governance is equated with small town domestic water governance.

[4] We define 'service modality' broadly to include both the institutional arrangements and sources of water deployed.

annual rainfall), hard rock aquifers at that are characterised by low water yields, a largely (75–80%) urban population, and rivers that have either been depleted or polluted. Whereas the Arkavathy basin is dominated by the metropolis of Bengaluru and has only four small towns, the Noyyal basin has the two cities of Coimbatore and Tiruppur alongside 86 smaller urban settlements.

While the choice of towns was constrained by the basin boundaries in the larger research project, there were some obvious differences in institutional arrangements, water resource choices, and town sizes. We therefore chose a sample that varied in institutional arrangement, water resource deployment, and size. For this paper, we focus on the towns of Nelamangala and Ramanagara in the Arkavathy basin, and Kannampalayam and Palladam in the Noyyal basin. The basic features of these towns are given in Table 1.

The town populations range from ∼15,000 to ∼100,000, thereby also capturing the two kinds of urban local bodies (ULBs) that exist in Indian small towns: Town Panchayat/Town Municipal Council for the smaller towns and Municipality/City Municipal Council for the bigger ones. All towns have experienced high population growth rates (ranging from 20% to 47% growth in a decade), have an economy based partly on small-scale textile related operations, and have similar (∼15%) fractions of socially marginalised groups in their population.

The differences in service modalities are given in bold in Table 1. In terms of sources of water used, three of the towns use a combination of imported river[5] water and groundwater, whereas one (Nelamangala) is entirely groundwater dependent. In terms of the institutional arrangements for water service delivery: the towns in Tamil Nadu (Kannampalayam and Palladam) receive bulk supply of river water from a provincial para-statal agency, Tamil Nadu Water and Drainage Board (TWAD Board), but manage the distribution of this river water and of GW on their own. In contrast, in Karnataka, the arrangements vary across towns. Ramanagara has both bulk supply and distribution being done by the equivalent provincial[6] para-statal, viz., Karnataka Urban Water Supply and Drainage Board (KUWSDB). Nelamangala, however, manages its water supply and distribution entirely on its own. The combination of institutional arrangement and source of water gives three distinct service modalities:

- ULB alone, supplying only ground water,
- ULB and para-statal, supplying both ground and surface (river) water, and
- Para-statal alone, supplying both ground and surface water.

Note that there is limited self-supply by individual households in all the towns studied. Less than 5% of the households in all towns had private wells[7]. Private tanker use was seasonally significant in the two towns in the Arkavathy basin, yet most of the tanker supply was also by the ULB/para-statal.

There are additional nuances in the socio-technical arrangements for water service delivery that are common to the four towns. First, the main forms of water distribution are ‘public standpipes’ (street taps) and ‘in-house connections’ (see Figure 1). In periods of acute shortages, tankers may be deployed

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[5] We use the term ‘imported’ to indicate that although each of the towns is on the bank of a river, the river water that they get is from another river basin through pipelines running for 50–100 km.

[6] We use the adjective ‘provincial’ here, because in theory the ULB itself is part of the ‘state’, and it could set up a dedicated water supply agency as well. In India, however, all such agencies are set up by and answerable to the provincial (state) government (Perret *et al.*, 2014). For the rest of the paper, we refer to these agencies as ‘para-statals’.

[7] These were owned by better-off households and used as supplements to town supply, and as such do not confound our findings about inequity in town supply.

Table 1. Basic features of towns studied and key elements of their service modality (in bold).

Town	Nelamangala	Ramanagara	Kannampalayam	Palladam
District (and state) located in	Bengaluru Rural (Karnataka)	Ramanagara (Karnataka)	Coimbatore (Tamil Nadu)	Tiruppur (Tamil Nadu)
River basin	Arkavathy	Arkavathy	Noyyal	Noyyal
Population in 2011 (and change since 2001)	37,232 (+47%)	95,167 (+20%)	15,868 (+33%)	42,225 (+41%)
Key economic activities	Textiles (small scale weaving)	Silk reeling (small scale)	Textiles (spinning mills)	Textiles (power looms), Poultry
Civic status of the ULB	Town Municipal Council (TMC)	City Municipal Council (CMC)	Town Panchayat (TP)	Municipality
Water source	**GW only**	**River + GW**	**River + GW**	**River + GW**
Bulk water supply by	**Not applicable (no river water import)**	**Para-statal (KUWSDB)**	**Para-statal (TWAD Board)**	**Para-statal (TWAD Board)**
Distribution by	**ULB**	**Para-statal (KUWSDB)**	**ULB**	**ULB**
Number of municipal wells	70 borewells	200 borewells (estimated)	17 open and 19 borewells	16 open and 88 borewells
Number of public standpipes (GW)	150–200 (estimated)	430	6 hand pump + public taps	171
Number of public standpipes (river water)	0	0	89	32

Note: ULB = urban local body (elected local government). TMCs and CMCs in Karnataka are equivalent to TPs and Municipalities in Tamil Nadu, respectively.

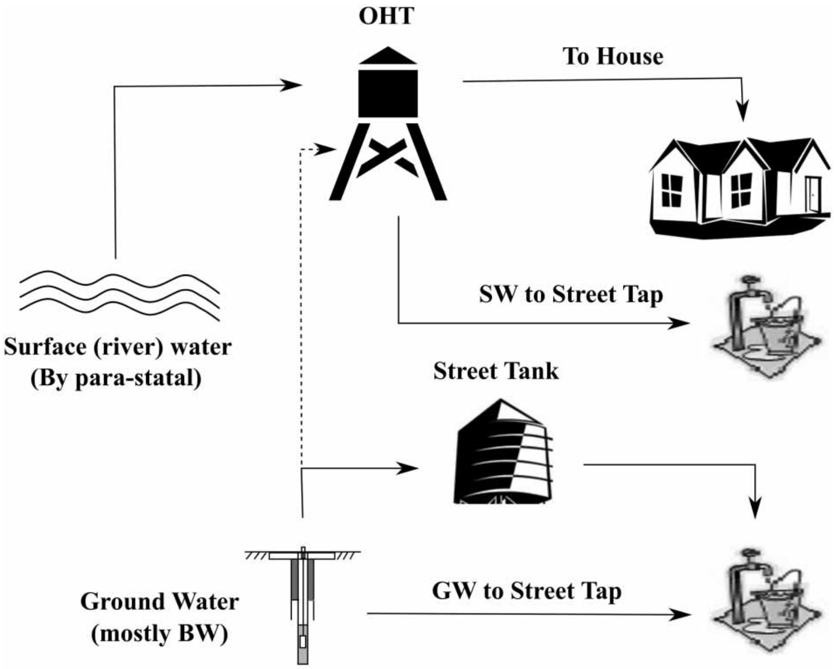

Fig. 1. Schematic diagram indicating typical public water distribution arrangements (dotted lines indicate less common pathways) (GW = ground water, BW = borewell, SW = surface water, OHT = overhead tank).

by the ULB to augment supplies. Second, in terms of frequency of distribution, in all towns, the supply is intermittent: a few hours on any given ‘supply’ day. Third, in terms of charging for water supply, the supply at the public standpipes is free of charge, whereas in-house connections are charged at a fixed (unmetered) monthly rate.

The administrative and political cultures in the two states are, however, somewhat different. Tamil Nadu inherited the administration set up by the British in erstwhile Madras Presidency, which was known to be efficiently run, whereas Karnataka state amalgamated administrations from different presidencies and princely states, and has been consistently ranked lower than Tamil Nadu in administrative efficiency (Mundle *et al*., 2016). Politically, Tamil Nadu has effectively been a two-party system, whereas Karnataka has seen more fragmentation and permutation in party politics.

Framework

In policy-making in the water sector, several normative concerns are always implicitly or explicitly present, and they determine how ‘performance’ of water service delivery or ‘outcomes’ in general are assessed. For instance, the concept of integrated water management is defined by some as ‘maximising economic and social welfare in an equitable manner without compromising the sustainability of ecosystems’ (GWP TAC, 2000); it also refers to stakeholder participation as a process goal. Similarly, the Sustainable Development Goal 6 for water highlights *inter alia* the need for sustainability, water use efficiency and stakeholder participation. Individual academic studies, being typically driven by disciplinary perspectives, tend to focus on fewer dimensions, with the result that different definitions of 'outcome' or 'performance' result in different explanations about what 'works'[8]. We therefore believe that a multi-dimensional assessment of outcomes better reflects policy and societal concerns in this sector and allows analysis to engage with them simultaneously. Drawing upon previous analyses (Joy *et al.*, 2004; Pahl-Wostl *et al.*, 2012; Lele *et al.*, 2013), we chose the following normative dimensions and indicators along which to assess outcomes related to domestic water in the small towns we studied:

1. Adequacy, quality and affordability,
2. Inter-town, inter-ward and inter-household equity,
3. Biophysical sustainability of groundwater resource and SW storage structures,
4. Financial sustainability, and
5. Responsiveness and accountability[9].

The question then is what might shape these outcomes. Our framework for answering this question is outlined in Figure 2. This framework is tailored to the south Indian small town context of largely public supply of water, and draws upon existing debates about the role of different factors in shaping water service delivery and water governance as a whole (Krishnan, 2006; Mugabi & Njiru, 2006; De Bercegol & Gowda, 2013). The framework indicates that the outcomes are likely to be the result of multiple factors, in which decisions about water tariffs, frequency of supply, or number and location of public taps, etc., would be the proximate drivers, and amongst deeper factors, the institutional arrangements (that determine which agency is responsible for what) and water resources deployed (whether only imported SW or local groundwater or both) could play a significant role. At the same time, other factors such as individual household endowments or status, resource endowments of the town and the political and administrative cultures of the region are also likely to interact with the service modality to influence outcomes. Since ours is an inductive approach, the exact nature of relationships is expected to emerge as hypotheses from the study[10].

Methods

The above outcomes were assessed using multiple indicators that were estimated through a variety of methods and data sources, with most of the data pertaining to the year 2014–15. These indicators and the methods and data sources used are summarised in Table 2.

For understanding adequacy and equity, our original intent was to estimate average town- and ward-level water delivery in litres per capita per day (LPCD) from secondary data and then to estimate inter-household variations using qualitative methods. However, field conditions complicated matters. SW supply to the whole town could be estimated from secondary data in all three cases. But estimating ward level SW supply was only possible where the service area of the public overhead tank (OHT) that was used to

[8] Such as whether private ownership of utilities matters or not (Bakker *et al.*, 2008).

[9] It may be argued that responsiveness or accountability (elements of good governance) are means to the end of adequate, equitable or sustainable water supply. We believe, however, they are somewhat independent of the other outcomes, and that in a democratic society, these are best treated as ends in themselves.

[10] Unlike in a deductive approach, where an *a priori* theory is expected to generate hypotheses about the nature of specific links.

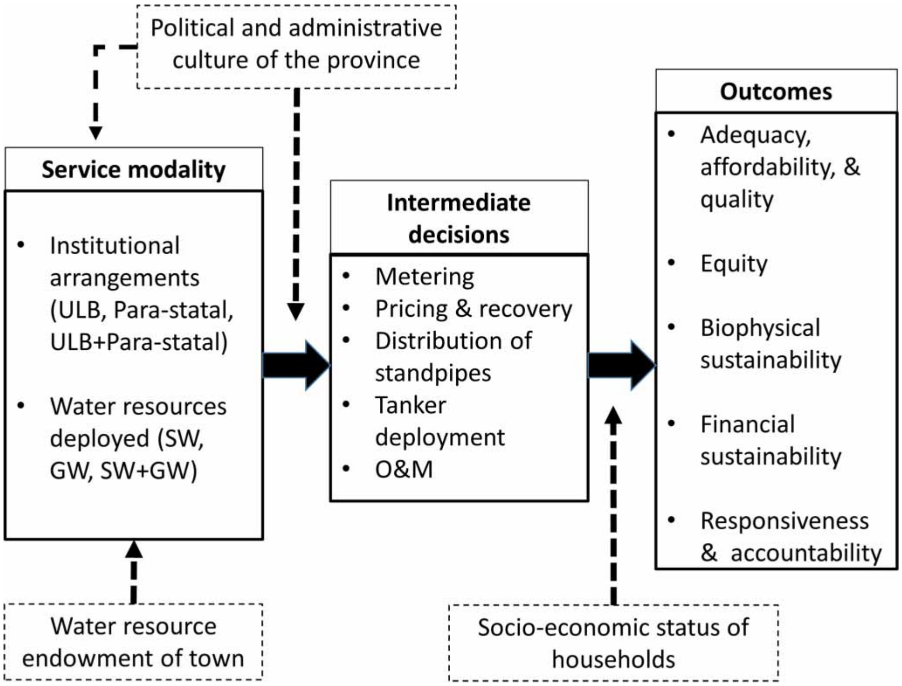

Fig. 2. Framework linking service modality and other factors to urban domestic water outcomes.

store SW matched well with ward boundaries, which was true in the Tamil Nadu towns. Estimation of the extraction of GW for public supply (see Figure 1) had never been done before, so we had to devise our own methods. For the Tamil Nadu towns, electricity consumption data were available for each of the public GW pumps (whether borewell or open well). We coupled these with pump discharge estimates by measuring discharge rates for a sample of pumps of different horsepower in each town, using either a TDS-100H ultrasonic flow meter or measuring time taken to fill the ULB's street-level tank into which the GW was being pumped. For the Karnataka towns, however, pump-wise electricity consumption data were not available from the ULB, nor did public OHT service areas correspond well with ward boundaries. Thus, only town-level estimates of public GW pumping were possible for Nelamangala and Ramanagara, by using public OHT capacities and filling frequencies obtained from linemen interviews.

To understand adequacy in the form of frequency of water supply and its seasonal variation, we used data from interviews (see below) to get at the frequency of SW and GW supply. Data on affordability came from municipal records on water tariffs, supplemented by semi-structured interviews with randomly chosen households (more than 20 in each town). These interviews also covered questions of water quality, supply frequency, and responsiveness of the administration to their complaints or concerns. In addition, semi-structured or open-ended interviews were conducted with linemen (at least five in each town), mid-level and senior ULB staff including the chief executive officers, elected town councillors (at least five in each town), and senior engineers of the para-statal agencies to understand their perceptions and constraints, and to assess their responsiveness to and involvement of citizens in planning.

For understanding inter-household variation, we focused on Nelamangala and Ramanagara. We conducted large sample surveys (N = 300 for Nelamangala and N = 600 for Ramanagara) on source-mix and water storage assets (presence/absence of sumps and private OHTs) with monitoring using water

Table 2. Methods used for obtaining data and estimating outcome variables in studied towns.

Town → Outcome ↓	Indicators used ↓	Nelamangala	Ramanagara	Kannampalayam	Palladam
Adequacy	Average water supply at town level (in LPCD)	Top-down method at ward/OHT level (OHT volume, population served, frequency of filling of OHTs)	Top-down method at town level (total river water supplied, total town population)	Top-down method: bulk SW supply from secondary data, divided by ward populations; GW supply by monitoring of pump yield, well-wise electricity bill data and population covered	Top-down method: bulk SW supply from secondary data, divided by ward populations; GW supply by monitoring of pump yield, well-wise electricity bill data and population covered
	Frequency of water supply & seasonal variation	Field interviews and observations	Field interviews and observations	Field interviews and observations	Field interviews and observations
Affordability	Rs/kL paid; time spent	Secondary data and interviews	Secondary data and interviews	Secondary data and interviews	Secondary data and interviews
Quality	Hardness & smell	Field interviews, observation	Field interviews, observation	Field interviews, observation	Field interviews, observation
Inter-town equity	Compare average water supply across towns	From adequacy estimates above	From adequacy estimates above	From adequacy estimates above	From adequacy estimates above
Inter-ward equity	Average water supply at ward level (in LPCD)	Secondary data on OHT-level supply, source mix survey (N = 300, 11 wards), field interviews	Source mix survey (N = 600, 16 wards), field interviews	Secondary data on ward-wise supply, interviews with councillors, field interviews	Secondary data on ward-wise supply, interviews with councillors, field interviews
Inter-household equity	Average supply at household level (in LPCD)	Source mix survey (for sump ownership); Volumetric metering at hh level (N = 5) + pot survey in slums	Source mix survey (for sump ownership); Volumetric metering at household level (N = 8)	Unstructured household interviews	Unstructured household interviews
Resource sustainability	Well failure rates, water table depth, condition of SW harvesting structures	Secondary data on borewell failure and new wells dug in recent years, field interviews and observations.			
Financial sustainability	% of O&M costs covered by water charges	Secondary data on income and expenses for water supply services	Secondary data on income and expenses for water supply services	Secondary data on income and expenses for water supply services	Secondary data on income and expenses for water supply services
Responsiveness and accountability	*Various: see text*	Interviews with city councillors (N = 6), ULB staff, source mix survey	Interviews with city councillors (N = 10), para-statal engineers (N = 3), source mix survey	Interviews with councillors, ULB staff, households; secondary data from ULB	Interviews with councillors, ULB staff, households; secondary data from ULB

meters for small samples. Getting households to agree to metering of their consumption and installing the necessary meters was no easy task – we eventually managed to do this only for five households in Nelamangala and eight households in Ramanagara[11]. In addition, for households that were entirely dependent on public standpipes, we conducted a simple questionnaire survey about 'pots of water collected and used for different activities' to estimate water consumption by such households in one town (Nelamangala).

Biophysical sustainability was assessed in terms of whether GW levels are steady or declining, and the ability of local SW storage structures to harvest rainfall. Data on biophysical sustainability came from interviews with linemen, secondary information on well failure and new wells dug, and our own observations.

Financial sustainability was assessed in terms of the fraction of operation and maintenance (O&M) costs that can be met from water charges received from users. Data for calculating financial sustainability came from municipal records and senior engineer/officer interviews.

Finally, the concepts of responsiveness and accountability are part of the idea of democratic governance, but are difficult to articulate and assess. We used some basic indicators. For responsiveness, we asked how well the agencies responded to citizens' day-to-day complaints, how they responded to summer shortages, and how do they respond to scarcity in the long run. In terms of accountability, we looked at the quality of record-keeping and the transparency and participation in the longer-term planning process. Data on these aspects came from the interviews with linemen, ULB and para-statal staff, and elected representatives.

Findings

We present the findings in terms of the outcome variables identified above, and the links with the 'intermediate decisions' indicated in Figure 2, in this section. The relationship with service modalities and other factors is discussed in the subsequent section.

Adequacy

As indicated in Table 2, we used three indicators to understand adequacy: average supply (in LPCD) for the town as a whole, frequency of water supply, and change in this frequency in the summer season. The estimate of average water supplied in each town (during 2014–15) is given in Figure 3, along with the supply norms as notified by the state governments for towns of those particular size: 70 lpcd for Nelamangala and Kannampalayam, 90 lpcd for Palladam and 135 lpcd for Ramanagara (Mathur *et al*., 2007).

There is of course uncertainty associated with these estimates, but it is not easy to quantify, because the systematic error (possible error in the estimation method) is likely to be much higher than the statistical error (variation across months or years). SW supply estimates come from secondary data, for which ULB staff gave an uncertainty of $\pm 5\%$. But groundwater supply estimates come from our

[11] Intermittent supply conditions required that meters be in place for at least 2 weeks to get a reasonable estimate of inflows. This made the metering-based data collection approach inherently slow. Moreover, many households that had agreed to metering, eventually removed the meters after a few days, citing 'meter reduces our inflow' as the reason. Hence the small sample size.

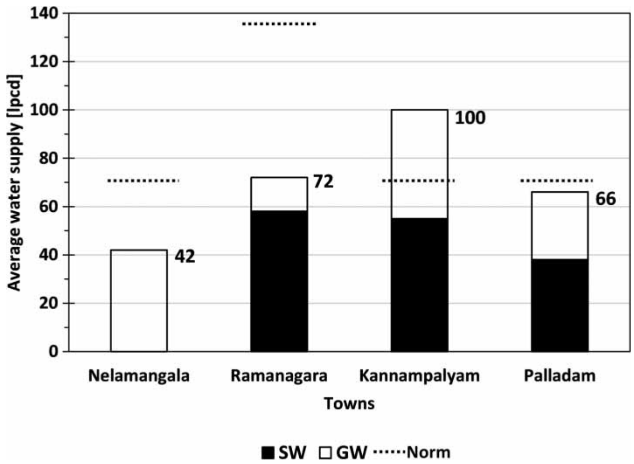

Fig. 3. Average amount of water supplied per capita in 2014–15. Numbers above the bars indicate the actual average supply. Dotted lines indicate the state's supply norm for towns of that particular size. Errors bars not estimable (see footnote 12).

one-time measurements at supply borewells and the error could as much as $\pm 20\%$. The norms should also not be applied blindly: the 135 lpcd norm is for towns with underground sewerage systems and relates to water required to move sewage, rather than water required for household needs. So it seems more appropriate to use a norm of 70–90 lpcd.

In spite of the uncertainty, and even using a modified norm, we may conclude that only Kannampalayam town meets or exceeds the official norm. Palladam and Ramanagara, however, are close to the lower end (70 lpcd) of the norm, whereas Nelamangala does not meet this norm at all. Looking at the mix of supply, it seems clear that the availability of river water is what enables higher supply levels in the three towns other than Nelamangala; groundwater alone can contribute only about 40 lpcd in such regions.

The frequency of water supply and seasonal changes in this frequency are given in Table 3. Where there is dual supply of SW and GW to each street, as in the Tamil Nadu towns, it is important to read the frequencies jointly. Keeping this in mind, we see that Nelamangala town lags behind both during normal months and in summer months, and supply frequency in Ramanagara is also not great (once in 4 days even in normal months), even though average supply in Ramanagara is comparable with that in Palladam.

The systematic 'dual-sourcing' model in the Tamil Nadu towns, wherein GW (poorer quality, because of hardness) is supplied daily or on alternate days in street taps which are spaced very close (one tap for

Table 3. Frequency of water supply during normal and summer months.

Town	Nelamangala	Ramanagara	Kannampalayam	Palladam
Supply frequency in normal months				
Surface water (SW)	Not applicable	Once in 4 days	Once in 7–10 days	Once in 5–7 days
Ground water (GW)	Once in 3 days	Not separable from SW	Daily or alternate days	Daily or alternate days
Supply frequency in summer months				
Surface water (SW)	Not applicable	Once in 8 days	Once in 10–15 days	Once in 7–10 days
Ground water (GW)	Once in 9 days	Not separable from SW	Once in 3 days	Once in 3–5 days

four dwellings or less) while SW (better quality) is supplied much less frequently, results in 'dual-use' also: households use SW for only cooking and drinking, and GW for everything else. Whereas the erratic and spatially separated model in Ramanagara, where GW supply is reserved only for areas poorly served by SW, means that no such 'dual-use' adaptation is possible.

All towns have to reduce the frequency of supply significantly during the summer, showing that although average supply during the normal months may meet the norms, significant scarcity is likely to be experienced during the lean season. The coping mechanisms adopted are also indicators of how water service delivery varies: in both the Karnataka towns, the fraction of households resorting to *occasional* (summer) purchase of water from private tankers to augment municipal water was 30–35%. But in the Tamil Nadu towns, households did not report such tanker water purchase, but relied on tanker supply by the ULB to augment supply, especially when borewells failed[12].

In terms of quality, since we relied on perception data alone, the main dimension assessed was hardness. Our interviews (not tabulated here) indicated that citizens in the Tamil Nadu towns were by and large satisfied with water quality, whereas those in the Karnataka towns were not. The reason given by the former was that they had access to better quality river water for their drinking and cooking needs. The reason for dissatisfaction in Nelamangala was obvious – they only received groundwater. Paradoxically, however, several households in Ramanagara complained that river water tended to be contaminated, and so they preferred to collect some groundwater as well. We were, however, unable to confirm the contamination or pinpoint its source.

In terms of affordability, the cost at which water is supplied varies from 0 (for public standpipes) to a fixed charge for in-house connections that ranges between 50 Rs/month (Kannampalayam), 80 Rs/month (Nelamangala), 100 Rs/month (Palladam) and 120 Rs/month (Ramanagara), which works out to Rs. 3–10/m^3 across all towns[13]. This is comparable to the price of water in other towns in India at that level of consumption (CSE, 2012).

The hidden cost for those who are dependent on public standpipes, however, is the effort involved in waiting at the standpipe and carrying pots home. One indirect measure of the difficulty faced in obtaining water from standpipes is the frequency of the standpipes. Here, the towns in Tamil Nadu had a standpipe for every four dwellings in low-income areas, whereas the frequency in Nelamangala and Ramanagara varied. Some low-income areas in Nelamangala did have standpipes at every other doorstep, but both supply and standpipe frequency in Ramanagara was much more erratic, as per our observations.

To summarise, it appears that average supply during most of the year was adequate (if one uses the lower 70 lpcd norm) in three of the four towns, but is quite inadequate in Nelamangala. And the provision of free water at the standpipes and the low (and fixed) price of water for in-house connections has kept the water affordable. The systematic dual-sourcing in the Tamil Nadu towns is able to ensure that some better quality (river) water is available to all households for drinking and cooking purposes, but this approach is not used in Ramanagara and not feasible in Nelamangala because of lack of access to river water.

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[12] The ULB in Nelamangala also supplied tanker water in summer months, but that was clearly not enough.

[13] Using an average household size of 5 and water use figures of 80–100 lpcd, because households with in-house connections consume more water.

Equity

Equity was assessed at three levels: between towns, between wards, and between households. Between towns, as Figure 3 shows, the inequity is clear: Nelamangala citizens get much less supply as compared to the other three towns. This is attributable to the unequal allocation of water that is imported from neighbouring basins. Whereas both towns in the Noyyal basin get significant (about 50%) of their supplies from imported river water[14], in the Arkavathy basin, only Ramanagara has access to such water, in spite of the fact that Nelamangala is less that 16 km away from the edge of Bengaluru metropolis, which imports 1,350 million litres per day (MLD) of river water[15]. The state of Tamil Nadu has not only constructed a number of pipelines to import river water from the Bhavani, Siruvani and Amaravathy into the Noyyal basin, but has also systematically ensured that all small towns (as well as villages en route of the pipeline) are supplied some river water from one or the other pipeline. In other words, Tamil Nadu state seems to have put in more efforts to distribute imported river water evenly across towns as compared to Karnataka state.

Our attempt to quantitatively estimate inter-ward variation within towns gave unreliable results. This is because in Nelamangala and Ramanagara towns, there was no easy mapping between OHT and ward, and there was significant inter-ward transfer in Kannampalayam and Palladam towns. What we have, therefore, are qualitative impressions based on interviews with residents, councillors and ULB staff. It was acknowledged that there were inter-ward variations. Some of these were attributed to (a) the capacities of overhead tanks not matching current population densities of the areas they service, (b) random variations in borewell yields (this variation is particularly high for deep borewells in hard rock aquifers), (c) variation in the presence of commercial users and their grabbing water meant for domestic consumers, and (d) newly added wards not having the connectivity with the OHTs in which where river water is stored. Some councillors argued that there was also systematic neglect of wards whose residents belong to socio-economically marginalised groups, but it was difficult, given our data, to tease apart this possibility from the effects of the above-mentioned ‘physical’ factors.

For understanding inter-household variation, we have systematic data only from the two Karnataka towns. These are presented in Table 4, and show that households dependent on standpipes alone may be at 40 lpcd whereas those with in-house connections and sumps may be at 47–60 lpcd in Nelamangala but above 75 lpcd in Ramanagara. Although the monitoring data comes from very small samples and therefore with large uncertainties, they match the results from more rigorous studies elsewhere (Kumpel *et al*., 2017) which show a strong correlation between the extent of in-house storage and lpcd[16]. In other words, under intermittent supply, the wealth of a household broadly influences its ownership of storage assets such as sumps and this in turn significantly influences the ability to consume water. But it also appears that the presence of a sump makes a big difference to consumption only when there is relatively higher water supply, as in Ramanagara, as against when supply itself is poor, as in Nelamangala. So the major driver of inter-household variation is the ability to afford an in-house connection and a sump (the socio-economic factor at the bottom of Figure 1), perhaps compounded by the supply situation.

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[14] ‘Import’ here referring to cross-basin transfers.

[15] And this pattern is true for the larger population of small towns in both basins.

[16] Note that Kumpel *et al*. measured all in-house storage, whereas we only noted presence/absence of a sump (not barrels or buckets), so ours is a much coarser estimate of in-house storage.

Table 4. Variation in connectivity, sump ownership and consumption.

Variable	Nelamangala	Ramanagara
% of households that are fully standpipe dependent (and their estimated consumption – pot survey)	14% (~40 lpcd)	10%
% of households with in-house connections (and their estimated consumption – monitoring)	86%	90% (~53 lpcd)
% of households with in-house connections and sumps (and their estimated consumption – monitoring)	77% (47–60 lpcd)	45% (75–120 lpcd)

Note: Connectivity and sump ownership data are from the large-sample source mix surveys (N = 300 and N = 600 for N and R respectively) and consumption estimates are from household-level monitoring (N = 5 and N = 8 respectively) for households with in-house connections, and 'pots collected' survey (N = 41) for fully standpipe dependent households.

Biophysical sustainability

Biophysical sustainability can be examined in terms of the trends in GW levels and the status of SW harvesting structures. All towns depend on GW to some extent. The sustainability of this resource is therefore crucial to sustaining water supply in these towns. The two basins in which the towns are located are undoubtedly facing groundwater depletion due to agricultural pumping (Lele *et al.*, 2013; Srinivasan *et al.*, 2014). It is therefore not surprising that the linesmen in all the towns reported that groundwater levels are dropping.

But the groundwater situation is not identical across all towns (see Table 5). The towns facing most groundwater sustainability issues are Nelamangala and Palladam. In terms of actual failure of borewells, Palladam had 13 borewells (8% of the total) failing in 2014–15. Although Nelamangala ULB staff could not give the exact number of borewell failures, they dug 12 new borewells that year, of which four did not yield any water. Typical borewell depths there were 750 ft (225 m), and the taluka (sub-district) itself has been notified as over-exploited by the Central GW Authority[17]. On the other hand, Kannampalayam and Ramanagara did not report any borewell failures as such, although linemen there did report declining groundwater levels.

This variation in groundwater depletion can be explained by a combination of geography and extraction patterns. Nelamangala is the heaviest user of groundwater and it is located in the upper reaches of the Arkavathy basin, which has seen severe groundwater depletion due to agricultural use and the consequent drying of the river (Srinivasan *et al.*, 2015). Ramanagara uses limited amounts of groundwater,

Table 5. Borewell failures in 2014–15.

Town	Nelamangala	Ramanagara	Kannampalayam	Palladam
Number of municipal borewells that failed in 2014–15 (% of total BWs in town)	12 replacement borewells dug (4 unsuccessful); total borewells 70	0 (0%)	0 (0%)	13 (8%)

Note: Nelamangala ULB staff could not give data on how many borewells had failed.

[17] http://www.cgwb.gov.in/CGWA/documents/CGWA%20Notifiaction%20dated%2027-11-2012.pdf.

and is located in the middle reach of the Arkavathy, where the river flows intermittently. In the Noyyal basin, Kannampalayam is next to the Noyyal River and immediately downstream of Coimbatore city, which releases more than 300 million litres per day of sewage into the river (Srinivasan *et al*., 2014). Not surprisingly, the water table in Kannampalayam is shallow, with a number of functioning open wells. Palladam is, however ~11 km from the river, almost at the edge of the surface watershed, and (as seen in Figure 3) extracts much more groundwater than Kannampalayam.

The biophysical sustainability of imported river water is not an issue as such. SW is a flow resource, and as long as the rivers from where the water is imported flow, the water will be available to the towns through the bulk supply system. But the sustainability of local SW harvesting structures is relevant. Here, we see that SW harvesting and storage structures, i.e., erstwhile irrigation tanks that each town is endowed with, are in complete disrepair. Kannampalayam is not using its tank to harvest local rainwater runoff, but to collect effluents released by Coimbatore city for groundwater recharge. And the tanks in Nelamangala and Palladam towns are completely filled with sewage, rubble or solid waste (see, for example, Figure 4), whereas Ramanagara's tank is dry. This is particularly paradoxical, given that the import of river water is from a distance of over ~100 km.

Financial sustainability

The minimum criterion for financial sustainability is that O&M costs are covered by the water charges (Jayaramu *et al*., 2015). Accordingly, we compared O&M costs with income from water charges for all the towns. The details are given in Table 6. It is clear that, in spite of uncertainties, Palladam town is breaking even but the other three ULBs are not even close to breaking even on O&M costs – their income from water charges ranges from 11% to 28% of these costs. And data from previous years (not presented here) show that this has consistently been the case.

Fig. 4. Status of Palladam tank.

Table 6. Annual expenditure and income related to water supply (in 10^5 Rupees unless mentioned otherwise).

Town		Nelamangala	Ramanagara	Kannampalayam	Palladam
Expenditure	River water charges	0	(Included below)	7.4	28.8
	Electricity	53.5	129.1	19.4	30.8
	Maintenance	68.0	89.5	72.8	19.3
	Salaries of staff	*Not available separately*	*Partly included in maintenance*	00.4	18.4
	Total	**121.5**	**218.6**	**100.0**	**97.3**
Income from water charges (all consumers)		**13.7**	**47.1**	**28.7**	**99.2**
Efficiency of water charges recovery		**~70%**	**~20%**	**97%**	**90%**
O&M cost of water supply Rs/m^3		33	19	15	6.9
Income per m^3		2.7	1.8	2.2	7
Budgetary deficit		**89%**	**78%**	**71%**	**nil**
Year of data		2012–13	2014–15	2012–13	2012–13

Notes: 1. Numbers pertain to the most recent year for which data were provided from the ULB/para-statal.
2. Income figures for Ramanagara are estimated assuming a 20% recovery rate, as informed by the engineer.
3. Expenditure on salaries of ULB staff who assist the para-statal in water distribution in Ramanagara were not available. Nor were electricity costs of pumping borewell water included. So actual costs in Ramanagara are significantly higher than estimates given here.
4. Salary costs in Kannampalayam are low because many contract staff salaries are included under maintenance.
5. 1 Indian Rupee ≈ 0.015 US$ during the study period.

There are multiple reasons for this outcome. First and foremost, water charge recovery is very poor in the Karnataka towns, ranging from 20% (Ramanagara) to 70% (Nelamangala), whereas it was above 90% in the Tamil Nadu towns. Second, the cost of water is higher for towns dependent on deep groundwater: in Nelamangala because it is entirely dependent upon pumping from deep (>600 ft) and low-yielding borewells, the cost is Rs 33/m^3 because of high electricity and pump maintenance costs. Whereas the cost of river water supply ranges from Rs 9/m^3 in the case of the Noyyal basin to Rs 15/m^3 in Ramanagara[18]. Third, a detailed examination of the maintenance costs showed that Kannampalayam's maintenance costs are high not just because of the salaries they include but also an inexplicably high expenditure on pump maintenance, which officials were not able to explain (and which suggests a mismanagement of funds).

How do these towns meet this continuous deficit? They use development grants provided by the state government under fiscal resource sharing policies towards covering these deficits, thereby reducing their regular development spending. Indiscriminate spending of 'drought relief funds' on digging new borewells to appease citizens rather than addressing the problem of groundwater sustainability in the long-term is another example of short-sighted policies.

The case of Palladam, however, shows that it is not impossible to meet O&M costs from water charges. Palladam has the lowest O&M costs (6.9 Rs/m^3) and the highest income from water charges (7 Rs/m^3). Discussions with their staff and comparison across towns suggest that in addition to a

[18] TWAD Board charges only Rs 4.5/m^3 to the small towns in Tamil Nadu, but their officials informed us that their actual O&M cost for bulk water supply is around 9 Rs/m^3. So when comparing cost of water across towns, we have taken the full cost of river water as 9 Rs/m^3, but when examining income-expenditure, we have used the lower billed amount.

tight control on maintenance costs, and a strong focus on water charge recovery, they have the highest tariff for in-house connections (Rs. 100/month as against Rs. 50–60/month in other towns) and similarly higher tariffs for commercial and industrial consumers. The last measure is certainly a crucial component of financial sustainability.

Responsiveness and accountability

We assessed responsiveness and accountability on four parameters, and summary ‘grades’ for each town are given in Table 7. The basis for these grades is as follows.

In terms of how the water supplying agency responded to day-to-day citizen complaints, the ULBs in Tamil Nadu had complaint books, which were actually in use, and interviews with citizens revealed that they had a satisfactory experience in terms of grievance redressal. Citizens had phone numbers of linemen, ULB staff and elected officials, which they did not hesitate to use, and which brought quick redressal. In the Karnataka towns, citizens in Nelamangala said that they call the councillor in case of distress and s/he communicates with the ULB staff to resolve the issue. In Ramanagara, however, citizens found the para-statal staff not very responsive, and councillors were unable to redress grievances quickly because the distribution was handled by the state-level para-statal, in which ultimate accountability was to their own head office in Bengaluru. At the same time, in Nelamangala, citizens reported having to pay some ‘additional amounts’ (tips or bribes) to the linemen to get water released during times of scarcity – clearly frontline staff taking unfair advantage of the high level of water scarcity in that town. Whereas in Ramanagara, the frontline staff were colluding with customers to provide additional ‘illegal’ connections (for which no monthly charges were being paid).

In terms of responding to summer-time scarcity, we found that both the ULBs in Tamil Nadu were more responsive and organized: they deployed their own tankers and moved water from functioning borewells to supply the service area of failed borewells. On the other hand, in Nelamangala, while the ULB did provide water through tankers during the summer, they did this in fairly irresponsible ways. Councillors blocked the executive officer’s attempts to purchase a tanker for the ULB, and also blocked attempts to share water across wards; they preferred to spend scarce ULB funds on purchasing water from private tankers for augmenting the supply – reportedly due to their having a vested interest in those private tanker companies. They also spent special state funds made available for ‘drought relief’ on digging new borewells, rather than on measures to address groundwater sustainability in the long run. One councillor, however, used personal funds to dig a borewell and lay ‘alternate’ line of standpipes in his constituency. In Ramanagara, the para-statal passed on the responsibility of tanker supply during distress months to the ULB, which agreed to take on these costs because of the political sensitivity of the water issue.

Table 7. Broad assessment of responsiveness and accountability.

Indicator	Nelamangala	Ramanagara	Kannampalayam	Palladam
Response to day-to-day grievances	Fair	Poor	Good	Good
Response to summer shortages	Fair, but short-sighted	Poor, erratic	Good	Good
Record-keeping quality	Fair	Poor	Good	Good
Councillor involvement in long-term planning	Limited	None	Limited	Limited

As a basic form of accountability, we found that the quality of record-keeping in the four towns varied significantly. The two towns in Tamil Nadu maintained and provided detailed records on bulk water purchase, monthly electricity bills, water connections and charges collected, borewell pump details and electricity meters, etc. This also reflected in high levels of water charges recovery. Whereas both towns in Karnataka did a poor job of record-keeping – they did not have lists of households with in-house connections, electricity bills for municipal borewells could not be traced or did not match meter numbers at the borewell, borewell-wise pump details were not available, nor were details of water being pumped to each OHT. And this poor record-keeping reflected in poor water charges recovery. Even between the two towns in Karnataka, the record-keeping was surprisingly poorer in the para-statal-managed town (Ramanagara) than that in the ULB-managed system (Nelamangala) – the para-statal provided meagre data, and kept changing their estimate every few months.

In mid- to long-term planning, such as whether or not to give new connections, proposing new construction of OHTs and seeking funds from the state government for various projects, one sees the involvement of executive staff in the towns which have ULB-managed distribution. Elected officials are hardly involved, except perhaps the chairpersons of the ULBs. In the case of Ramanagara, where the water supply and distribution are managed by the para-statal, the planning process was completely opaque and engineer-controlled, and there was no mechanism for input from elected officials at all. The elected officials were, however, involved in decisions about setting water charges and about where to dig borewells when state funds became available.

Discussion

In the previous section, we have identified the broad patterns in the outcome variables and the intermediate decisions (proximate causes) that might have resulted in these variations. Here, we discuss how these might relate to the deeper causes, including the service modality in its institutional and technical dimensions, and the other factors in our framework.

First, overall water scarcity is explained by a combination of the biophysical endowment and the service modality. The biophysical endowment and socio-economic context of the towns clearly sets the baseline for this scarcity. All towns are growing rapidly, but are located in regions limited and declining surface and groundwater availability[19]. Groundwater alone cannot suffice, and is not the preferred source because of quality concerns. SW is essential, and access to it enables towns to at least come close to societal norms of average supply. At the same time, the socio-technical mode of managing these two sources is important. By embracing a dual-source policy and supplying river water and groundwater in parallel, the Tamil Nadu towns are able to ensure that higher quality water goes for higher quality end-uses and therefore spread the higher quality water more evenly. Households adapt to this systematic dual-sourcing, storing SW and GW separately and using them for different activities, thereby optimising the resource vis-à-vis end-uses. Simply augmenting overall supply by installing GW-based supply in some locations, as is the case in Ramanagara, does not help.

Is there a link between the systematic adoption of dual-sourcing and the institutional arrangement? We believe there is: the separation of roles between TWAD board (bulk supply of river water) and

[19] Kannampalayam's shallow groundwater is the result of sewage discharges from upstream Coimbatore city.

the ULB (distribution) also means that a uniquely engineering mindset that understands SW as the sole and proper water to be distributed, does not dominate at the distribution end. The objective remains supplying water, not just river water. We have observed this phenomenon in the metropolis of Bengaluru as well – the para-statal agency, being composed exclusively of engineers, only believes in supplying river water, and refuses to integrate groundwater into its paradigm of water supply. Even when it inherits public borewells as a result of an expansion in its jurisdiction to erstwhile small towns, it sees them as temporary arrangements until river water supply pipelines are put in place. Not surprisingly, private well ownership in cities such as Bengaluru is around 30% (Malghan *et al*., 2016) but has remained below 5% in the small towns we studied in Tamal Nardu[20].

Second, inequality across households in water consumption is of course primarily a result of pre-existing economic class differences – a households' ability to afford the initial cost of an in-house connection and, in the context of intermittent supply, to store water for several days is crucial in getting access to more water. The question is how the governance system responds to these pre-existing differences. All towns have responded to socio-economic inequality through the concept of free supply at public standpipes, and increasing the density of such standpipes in the poorer neighbourhoods – but the town with the para-statal has done the poorest job here. And its separation of surface and groundwater supply regions has meant that poorer households also get only water of greater hardness.

Third, a fairly clear relationship does seem to emerge between the institutional arrangement and responsiveness and accountability in service delivery. Where ULBs do the distribution, there is greater responsiveness to day-to-day grievances, and also some local involvement or at least transparency about longer-term decision-making. This is not surprising, given that para-statal is only accountable to the state government, not the ULBs. But some of the differences between the three ULB-managed towns, however, appear to be related to the differences in the political and bureaucratic cultures of the two states: the better quality of record-keeping in the Tamil Nadu towns[21] for one, and the more competitive but less conflictual functioning of the councillors for another.

Fourth, the inter-town inequities cannot be explained by the factors in the framework: they seem to be driven by higher-level processes regarding allocation of water across towns and sectors, which are different in the two states. In Tamil Nadu, there appears to be an 'empowered committee' at the state level that takes decisions regarding all bulk supply projects[22], and there seems to have been a conscious decision that bulk supply must be shared across all towns and also with villages en route from the source to the town. In Karnataka, there seems to be no institutionalised mechanism. A Karnataka State Urban Water Council was mooted under a World Bank-aided project (Sustainable Development Department, 2011), but never created (K. P. Krishnan, personal communication).

Fifth, again, neither differences in service modalities nor in the political or administrative culture appear to affect the resource sustainability outcomes: groundwater depletion is ubiquitous, as is neglect of local water bodies. Admittedly, the groundwater depletion in these towns is driven not just by their own extraction, but also by over-extraction by surrounding farmers over decades. Pollution of local water bodies may be

[20] Unfortunately, it is not clear that the ULBs realize the benefits of dual-sourcing or of taking an integrated perspective. Kannampalayam and Palladam towns recently decided to not give any more in-house connections (because of limited supply of river water), but this will only drive new household into private borewell drilling, and easily lead to a Bengaluru-like situation where groundwater regulation then becomes impossible.

[21] Also corroborated by other small towns studied in the larger research project.

[22] http://www.twadboard.gov.in/twad/administrative_sanction.aspx.

caused by the inability of small towns to invest in sewerage, but given the neglect of sewerage infrastructure even in large cities such as Bengaluru (Jamwal *et al*., 2014), the problem may be of mindset than just the lack of funds or technology. Interestingly, Kannampalayam town has tried to use the effluents from Coimbatore city to recharge its groundwater table by diverting and storing some of those flows in their SW tank (originally an irrigation reservoir). While the public health consequences of using untreated/poorly treated city effluents for groundwater recharge are likely to be negative, the effort indicates some awareness of the groundwater situation and a willingness to attempt recharge in some form (and perhaps a level of desperation).

Similarly, different modalities surprisingly do not seem to affect financial sustainability. One would have expected a para-statal to be 'stricter' in recovering its O&M costs, because it is not beholden to local electoral politics. But either by systematically under-charging for river water (as the TWAD board does) or neglecting to recover full O&M costs (as KUWSDB does), the para-statals seem to be driven by the perceived importance of local water supply in state-level electoral politics, as does the continued subsidy to towns to cover O&M costs from development funds. And of course ULB's are reluctant to raise water charges, because the councillors see their electoral fortunes dependent on low rates. But as Palladam's case shows, it is not politically impossible to raise water charges and ensure water charge recovery to a level that meets at least the O&M costs. It also suggests that metering may not be crucial to achieving financial sustainability, if basic costs and recoveries are managed well, a conclusion in line with the findings of Kumpel *et al.* (2017).

Conclusions

We began this study by pointing out that the research on small town water governance in India was very sparse, but that, unlike, say, small towns in many African countries, those in India are by and large characterised by nearly full coverage by government agencies and are above the absolute minimum of 25 lpcd. Consequently, the debate is not about how to interface public, private and community efforts, but about how to make these government agencies (or their combinations) more effective. And since the minimum threshold has been crossed, the concerns in policy-making should go beyond sheer adequacy and access to questions of equity, physical and financial sustainability, and responsiveness. By taking such a multi-dimensional approach to assessing outcomes, and by defining service modality in broad terms, we have managed to provide a more holistic picture of small town water governance in southern India. Our study perhaps provides the first (even if approximate) estimates of the contribution of groundwater to public supply, and also possibly a first-time comparison of multi-dimension outcomes across different institutional and socio-technical arrangements. The small town universe is vast and heterogeneous, even just in India, and so generalisations are risky. What we offer through this exploratory study that used an inductive approach are not exact policy prescriptions but rather hypotheses that require further testing.

An easy way to encapsulate the policy-relevant hypotheses that emerge from our analysis, across the two components of 'service modality', is the idea of 'match–don't-mix'. That is to say, a separation and matching of roles and responsibilities as well as of resources, rather than muddling or mixing them, is desirable. First, regarding institutional arrangements, and following Mugabi & Njiru (2006) in thinking at multiple levels:

- In terms of roles of different agencies, it appears that bulk supply of SW is best done by an engineering-oriented provincial para-statal agency or government department, whereas local groundwater supply and distribution of all water is best handled by a wing of the local elected government. The latter can provide more equitable and responsive water service delivery, whereas the former is set up for deployment of regional water resources (a point also made by Krishnan, 2006)[23]. This is not to say that ULB-led water management is a panacea – being answerable to users makes ULBs reluctant to raise water tariffs even to levels that would cover O&M costs, and rent-seeking by elected officials and their patronage politics (Nadhamuni, 2012) may be worse than the non-responsiveness of para-statal engineers. But closing the fiscal loop on ULBs (see below) rather than usurping their functions would be the way forward. This would also require ULBs to build their technical capabilities and staffing, something that has been recommended repeatedly in India (Rai & Singh, 2008; Perret *et al*., 2014).

- Inter-town allocation of SW has crucial implications for meeting adequacy norms in individual small towns, and therefore requires much more 'due process' at the state level to ensure fair allocation. The debate is not whether imports of SW is essential or not (as Mukherjee *et al*., 2010 seem to suggest), but about how to fairly allocate what will be an increasingly scarce, expensive and contested resource.
- The state (provincial) governments have an important role to play, but they need to keep away from meddling in lower-level functions such as staff deployment or pushing para-statals into water distribution and engage more systematically with higher-level functions. These functions include not only allocating river water fairly and transparently across towns and villages, but also replacing state financial grants with more devolution of taxation powers to make ULBs more self-financially sufficient, and building ULB capacities to address questions of groundwater sustainability and wastewater treatment and reuse.

Second, with respect to the socio-technical dimension of service modality:

- Consciously adopting a dual-source (groundwater plus SW) approach allows the matching of end-use needs to quality of water, and provides more equitable access to higher quality water, in addition to augmenting overall availability. Ironically, although this approach is being practised in many of Tamil Nadu's small towns, it is not clear whether it has in fact been institutionalised[24]. The idea that 'GW is an inferior resource, to be used as a last resort' or only until river water pipelines are completed originates in a surface water-oriented water engineering community. But in fact, GW provides an important supplement and buffer and also acts as a barometer of the state of local resources[25]. Dual-sourcing (as a part of integrated water management) needs to be institutionalised, and it is more likely to happen within ULBs than within engineering-oriented para-statals. This may involve more investments (dual piping) and complexity in operations, but will make supply more sustainable and use more efficient (by matching sources to end-uses).
- At the same time, efforts will be required to regenerate and augment local resources, through rooftop and lake-based rainwater harvesting, and wastewater treatment and reuse. But this will require shifting away from the illusion that continuous expansion of cross-basin or long-distance SW transfers is possible, and similarly continuous expenditure of public funds on simply drilling new borewells or buying private tanker water for summer supply is possible.

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[23] Indeed, there is a growing feeling that even large cities should bring para-statals under municipal control (Ravindra, 2010).

[24] The latest projects initiated in Coimbatore city involve increasing imports of river water to meet needs in newly added areas, rather than spreading existing imported water equitably across the whole town (Durba Biswas, pers. comm.).

[25] 'Wells talk to people' (S. Vishwanath, quoted in Sitlhou, 2013).

In a rapidly urbanizing countries such as India, with villages turning into small towns and existing small towns growing quickly, local urban governments are always playing catch up, struggling to provide just basic service delivery. Provincial governments are tempted to deploy engineering para-statals to quickly 'solve' problems, often citing the lack of technical capability or under-staffing in the ULBs (De Bercegol & Gowda, 2013; Atkins *et al*., 2014). Towns are caught between the reality of GW dependence and their aspirations for complete SW supply that large metropolises seemingly have achieved, aspirations promoted by engineers who only understand SW supply. But these towns have the advantage of being earlier on the curve, and need not repeat the mistakes made by large metropolises. Expanding the goals of both policy and research to think in terms of multi-dimensional water governance rather than delivery of an average quantum of water, and bringing a socio-technical-cum-institutional idea of service modality, along with other factors, to the research could support this process towards more sustainable and equitable development.

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