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Conundrum or paradox: deconstructing the spurious case of water scarcity in the Himalayan Region through an institutional economics narrative

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Abstract

Water scarcity in mountain regions such as the Himalaya has been studied with a pre-existing notion of scarcity justified by decades of communities' suffering from physical water shortages combined by difficulties of access. The Eastern Himalayan Region (EHR) of India receives significantly high amounts of annual precipitation. Studies have nonetheless shown that this region faces a strange dissonance: an acute water scarcity in a supposedly 'water-rich' region. The main objective of this paper is to decipher various drivers of water scarcity by locating the contemporary history of water institutions within the development trajectory of the Darjeeling region, particularly Darjeeling Municipal Town in West Bengal, India. A key feature of the region's urban water governance that defines the water scarcity narrative is the multiplicity of water institutions and the intertwining of formal and informal institutions at various scales. These factors affect the availability of and basic access to domestic water by communities in various ways resulting in the creation of a preferred water bundle consisting of informal water markets over and above traditional sourcing from springs and the formal water supply from the town municipality.

Keywords: Domestic water scarcity; Eastern Himalayan Region; Mountain towns; Urban water governance; Urbanization

Introduction

Most water scarcity studies typically provide a very narrow view of the contextual reality, describing them as physical water shortages, perhaps distinguishing them as either physical, economic or

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institutional scarcity (Falkenmark & Lundqvist, 1998; Seckler *et al*., 1999; Government of West Bengal, 2012; Hoekstra & Mekonnen, 2012; Molden *et al*., 2014; Vaidya, 2015). Locally, scarcity almost always manifests through a combination of all three typologies both spatially and temporally, and is also differentiated based on social class and geographic location (Bandyopadhyay & Gyawali, 1994; Ohlsson & Turton, 1998; Anand, 2001, 2004, 2011; Wolfe & Brooks, 2003; Mehta, 2006; Mehta *et al*., 2011; Srinivasan *et al*., 2013; Badiger *et al*., 2014). Concerns related to domestic water scarcity often overlook social–institutional drivers which influence access. Translation of physical water availability into accessibility for communities depends on the current state, scale and ability of the water infrastructure to overcome seasonal changes and reduce the burden of water collection. This process requires a detailed understanding of the functioning and organization of multiple water institutions (Agrawal & Yadama, 1997; Anand, 2001, 2004; Badiger *et al*., 2014).

Institutions are rules, norms, and practices which govern decision making in a society (Kiparsky *et al*., 2013). Formal institutions are associated with the State and are present at central, provincial, regional and local levels. Informal institutions are based on social networks which emerge from the need for social safety nets triggered by the absence of State-driven initiatives (Lebel *et al*., 2005; Hillmann, 2013). The intertwining or hybridization of these institutions can be observed here in the way formal (municipality) and informal (*samaj* – a self-help group, described below – and private water suppliers) work in cognizance of each other's abilities to monopolise, dominate or complement. This intertwining and overlapping is also evident in the way households are able to create their own 'water bundles' using a combination of water sources that they can access or afford and prefer. We use the term 'water bundle' in a similar context to the 'optimal consumption bundle' (Brunnermeier, 2004) of goods in micro-economics – where a consumer (a household in our case) is able to meet the net requirement of their goods' (here, the total domestic water requirement) needs through a particular combination of different goods (various water sources); where each of them has a known rule of preference over the other and has a differential cost (monetary or non-monetary) associated with acquiring them.

Mountains are often referred to as natural 'water towers' for humanity, highlighting their importance as a prominent water source for the arid and semi-arid lowlands but with little reference to water security in the mountains themselves. The Himalaya in the Indian context are perceived as an inexhaustible freshwater source but only a small fraction of the streamflow is stored and consumed by the communities living in these mountains. Water scarcity in these mountains is largely influenced by the unique local hydrogeology, climate and social characteristics. Harnessing and storing of water in large quantities is also impossible in this seismically active mountain range. Hence, springs have historically been an important and primary source of water for a significant proportion of the population, both for rural and urbanizing communities (Khawas, 2002; Sharma *et al*., 2010; Boer *et al*., 2011; Mahamuni & Kulkarni, 2012; Tambe *et al*., 2012; Tiwari & Joshi, 2012; Mukherjee, 2013; Agarwal *et al*., 2015; Ghatani, 2015; Basumajumdar, 2016; Drew & Rai, 2016).

This paper argues that the issue of water scarcity in the region has been wrongly equated to water shortage rather than searching for and finding solutions in the economic and institutional space – so, the problem, often misconstrued as a paradox, is actually more of a conundrum. The paper will primarily look at various drivers of water governance and social organization that translate to domestic water scarcity in Darjeeling (Darjeeling Municipal Town, in the district of the same name), including the central town itself which is catered for by a centralized formal water supply, as well as the surrounding sprawl whose water comes from multiple informal sources including water tankers and directly from springs. A

description of methods and the selection of Darjeeling as a study site and its history are presented first. This is followed by a presentation of the history and current scenario of formal and informal water institutions in Darjeeling. Next, the paper draws insights into the coverage of the various institutions, their multiplicity in some cases and their intertwining in others, contributing to water scarcity at household level. Lastly, the associated risks, uncertainties and conflicts surrounding the creation of water bundles to handle the water scarcity so created are presented.

Methods

Topic-guided interviews were undertaken with key informants such as officials from the Darjeeling Municipality (DM), staff of the DM Water Works Department (WWD), and the DM's staff associated with the operation and maintenance of the water supply infrastructure. Focus group discussions and semi-structured interviews were carried out with households and targeted communities. Primary data gathering was through snowballing and purposive sampling. Secondary data were gathered from official municipal reports, archives and literature. Using the guidelines of the Asian Development Bank (ADB) (Ministry of Urban Development Government of India & Asian Development Bank, 2007), the status and performance of the DM as a water utility provider was assessed.

Geographic context

The Eastern Himalayan Region (EHR) is considered as one of the highest rainfall receiving regions in India and supposedly has the highest per capita and per hectare availability of water in the country (Sharma *et al.*, 2010). However, this region experiences acute temporal and spatial water scarcity in a paradoxically water-abundant region (Khawas, 2002; Chhetri & Tamang, 2013; Lepcha, 2013; Rasaily, 2014; Drew & Rai, 2016). The history of Darjeeling's water problems and its formal water institutions are documented in detail by Rasaily (2014; in Nepali language), a major source of the historical information cited in this paper. Darjeeling (located in the EHR) receives an average annual rainfall of around 3,500 mm, compared to the all India average of 750 mm. The EHR receives 90% of its annual rainfall during the south-west monsoon (summer), with the rest coming from the north-east monsoon (winter). A skewed temporal distribution of rainfall poses the challenge of creating sufficient surface water storage for the rest of the year from the rains of the south-west monsoon, in a terrain which is highly undulating, prone to landslides and seismically very active.

Residents of Darjeeling have faced a water crisis for decades, indicating the inefficacy of the water governance system and the apathy of formal institutions. Studies on water issues in Darjeeling have focused on these physical water systems or on the absence of adequate bulk water storage, and the inefficient and insufficient supply infrastructure (Boer *et al.*, 2011; Chhetri & Tamang, 2013; Basumajumdar, 2016; Drew & Rai, 2016; Bhutia, 2017; Tamang & Jana, 2017). Hence, the water paradox – the too much, too little syndrome – has been limited to how little water exists in storage and in aquifers for use post monsoon. In our assessment, the water scarcity and security of the region are manifested by the political economy and the development trajectory of the region which is similar to that of many mountain towns in the EHR. Studies which inaccurately describe the water crisis as a paradox imply a mismatch in low levels of water available to the communities in a region with a high amount of rainfall, missing the myriad of issues which also exist within the system of

water governance. Hence, we argue that the crisis is rather a conundrum due to the intertwined problems across institutional capacity, political unwillingness, inadequate investments, and failure of cooperation between the state and regional institutions and governance.

The cultural and political history of Darjeeling

The development of Darjeeling (Figure 1) as an urban town was driven by various factors. The major junctures in recorded history which contributed to the increasing population of this region for the past *c*. 200 years were: the creation of Darjeeling as a sanatorium for British soldiers; colonial investments in tea and cinchona plantations; and its place as a permanent armed forces recruitment centre for the British Army.

The region's ethnic identity was less recognized by the State in the post-colonial period from both cultural and political perspectives, in part leading to the re-emergence of an ethnic and cultural struggle and to identity politics, with increased vigour and social impacts. The struggle for a separate state and the consequent related unrest has been going on for more than a century (Dasgupta, 1999; Khawas, 2002; Sharma, 2014), with a recent agitation in 2017 lasting for more than 100 days.

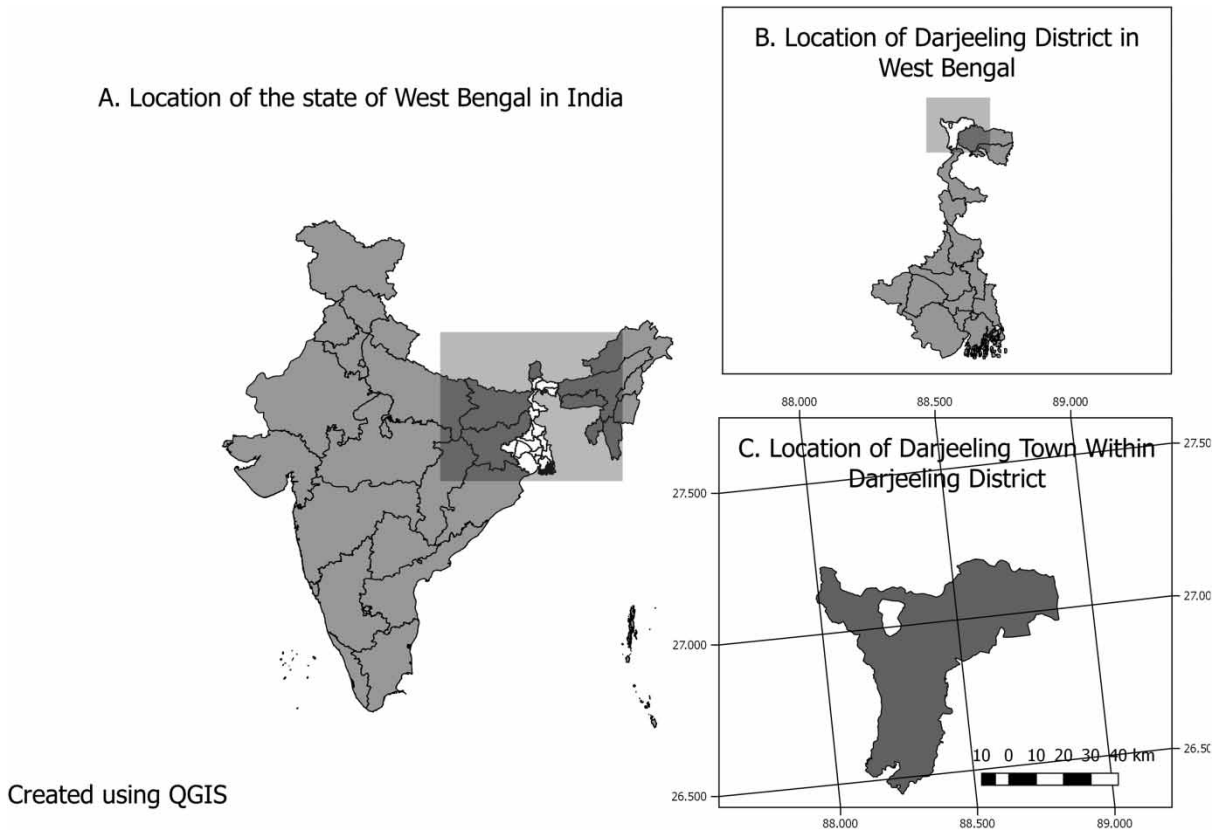

Fig. 1. Location of the DM town. (The Kalimpong district is included within the Darjeeling district boundaries, due to the unavailability of digitized new boundaries.)

Today, Darjeeling makes up roughly 11 km^2 of the entire geographical region and is the largest urban centre in the hilly regions of the states of West Bengal and Sikkim. Besides being a popular tourist attraction, it is often referred to as the 'financial, administrative and social confluence of the region' (Mell & Sturzaker, 2014). Darjeeling now falls under Gorkha Territorial Administration (GTA-2). GTA-2 is the autonomous hill council formed after the agitation that took place in 2017. It was preceded by GTA-1 (2012–2017) and the Darjeeling Gorkha Hill Council (DGHC 1988–2012) (Sharma, 2014; Wenner, 2015); the DGHC was the first autonomous hill council outside northeast India (Sonntag, 1999) and one outcome of the agitation for a separate state (1986 to 1988). Darjeeling has the dual character of being a growing urban town whilst also being located in the uplands which are quite rural in nature. The lands around Darjeeling belong to State-affiliated organizations such as the Indian military, the Forest Department, and Tea Board of India which each add to existing spatial constraints for urban expansion and development planning. With the rapid urbanization of smaller towns in the region and the increase in the urban population, Darjeeling presents an interesting case for understanding the challenges of the provisioning of basic amenities, including drinking water, given the region's distinctive geography, and social, cultural and political landscape dynamics.

Formal and informal water institutions

Due to the mixed urban–rural landscape of the towns in the EHR, numerous institutional arrangements exist alongside to meet domestic water needs. The town municipal supply (through private–individual, private–commercial or public connections) through the piped networks falls under a formal institution, managed by the DM, whilst spring-management and private water suppliers are part of informal institutions. In this section we untangle the genesis, structure and functioning of these formal (State-run) and informal (non-State) water institutions against the backdrop of the political economy of the region, throwing light on the status of water provisioning by both formal and informal institutions and how water scarcity is alleviated or reinforced through them. Table 1 lists the timeline of major projects and schemes initiated to augment domestic water supply within the Darjeeling town.

Darjeeling Municipality

Established in 1850, DM is the main civic administrative body covering 32 wards and represented by an elected board of councillors. Run by the DM, the town's water distribution system was originally designed for a stable population of around 10,000 during the 1920s. The primary water sources for this system are the twin North and South Lakes, constructed in 1910 and 1932, respectively, which lie 15 km south of Darjeeling inside the Senchal Wildlife Sanctuary and which are fed by 26 streams and springs (Government of West Bengal, 2012; Bhutia, 2017; Tamang & Jana, 2017). Water from these lakes then flows to Jorebungalow (which has five filtration units) and on to storage tanks at St Paul's and Rockville. With the exception of one household which lies above St Paul's and to which water is pumped by the municipality, the entire supply and distribution system operates under gravity through the mains and distribution network (Boer *et al.*, 2011; Rasaily, 2014; Bhutia, 2017) and all the way to individual tap connections in households, businesses, army camps and schools.

Several projects were proposed and initiated by the State to augment the town water supply. The Public Health and Engineering Department, Government of West Bengal (PHED), is responsible for the construction, operation and maintenance of both the rural water supply and bulk water supply for

Table 1. Chronology of major water supply projects initiated in Darjeeling.

Year	Event
1850	Darjeeling Municipality established
1910	North Lake constructed in Senchal Sanctuary
1920	Jorebungalow filter house constructed
1932	South Lake constructed in Senchal Sanctuary
1969–72	Rambi *Jhora* Phase-I
1993	Rambi *Jhora* Phase-II
1984	Sindhap Lake constructed in Senchal Sanctuary
1989–90	Water crisis worsened; the DM and DGHC supplied water using tankers
1991–93	Khong *Khola* proposal
1995–97	Balasun River Scheme proposal
2002	Rungdung River Scheme proposal
2004	Darjeeling residents stage protests against water crisis; PHE revives the Balasun scheme.
2005	Balasun River Scheme foundation laid
2010	Balasun River Scheme scheduled to be completed
2015	Balasun River Scheme is operational during summer when the flows to Senchal lakes diminish
2016	AMRUT (Atal Mission for Rejuvenation and Urban Transformation) scheme of Government of India sanctioned

urban areas (Government of West Bengal, 2018). The PHED worked on the Rambi *Jhora* Phase-I project from 1969 to 1972. In 1993 the Rambi *Jhora* Phase-II project proposal, under the Darjeeling Water Supply Improvement Scheme, was submitted to the then state Finance Minister, Asim Dasgupta (Ghatani, 2015). The commissioning of the project was undertaken by the PHED under the orders of the Government of West Bengal (GoWB) but was later abandoned due to a non-feasibility report prepared by the PHED (Bhutia, 2017). The *Bokshi Jhora* Water Project was another augmentation project taken up jointly by the PHED and the DM at the suggestion of the Citizens' Welfare Committee (Rasaily, 2014).

In 1984, a third reservoir in Senchal, Sindhap lake ('*dhap*' meaning 'lake' in Nepali), was constructed (Biswas, 2013; Chhetri & Tamang, 2013; Basumajumdar, 2016) at a lower altitude than the twin lakes. Due to flaws in its design and to avoid costly repairs, the reservoir is now only being used at up to 50% of its capacity. From January 1989 – May 1990 the town's water crisis worsened with several reports of violence, such as '*Khukhuri taana taan'* (the drawing of khukhuri – a kind of knife used in and around this region – by people involved in an argument). Rasaily (2014) noted that '*all records of scarcity were broken*' and the communities had to divert their spending from purchasing food to procuring water. This situation prompted the DM and DGHC to start distributing water within the town using private tankers. Between 1991 and 1993, the DGHC came up with a proposal for two new reservoirs at Khong *Khola* (Rasaily, 2014), a small perennial stream fed by a series of springs from the Senchal catchment. The proposal was glorified to such an extent that it was said that people would need to 'build swimming pools on rooftops' to store the large quantities of water it was believed would be transported to the town.

In 1995, the DM requested the DGHC to form a committee to prepare a proposal for source augmentation options and to improve the supply infrastructure. The result was a proposal to lift water from the Balasun river into the two Senchal reservoirs (Boer *et al*., 2011) at a cost of Indian Rupees (INR) 400 million (approximately USD 6 million, as on 14 May 2018). The Balasun River Scheme, under the PHE, was revised to also upgrade the pipe infrastructure at an additional INR 80 million (USD 1.2 million). Due to an insufficiency of funds, the GoWB hesitated to move forward on this project. The

DM sought funds from the World Bank with the agreement of the GoWB, but the application made no progress due to irreconcilable differences on the project design, implementation and operation between the three parties (the GoWB, World Bank and DGHC) (Chhetri & Tamang, 2013).

Under the GoWB's instruction, the DGHC then prepared the Rungdung River Scheme (Chattorpadhyay, 2005; Rasaily, 2014) but the project was stalled even before it started due to: (1) disagreements between contractors to build the road between Darjeeling and Rungdung to facilitate construction, (2) villagers' refusal to part with their land, a claim refuted by the villagers, and (3) the emergence of Gorkha Janmukti Morcha (GJM; the Gorka People's Liberation Front) and its movement for a separate state in 2007. GJM is a political entity in the region which fell out in 2007 with the Gorkha National Liberation Front, which also campaigns for the creation of a separate state *Gorkhaland* within India, out of the northern districts in West Bengal (Chettri, 2013).

In the meantime, 2004 also witnessed ground movement concerning water issues in Darjeeling. The Balasun River Project, shelved in 1995–97 due to lack of funds, was taken up by the PHED after reaching a consensus that only this project could bring resolve Darjeeling's water woes (Rasaily, 2014). The cost had increased to INR 560 million (USD 8 million) by the time work began. The foundation stone was laid in 2005 and work was to be completed by April 2010 (Rasaily, 2014; Bhutia, 2017). The project although was completed late, started operating only in 2015. Water from the Balasun river is pumped to the Senchal lakes during summer when the dry season flows from within the Senchal sanctuary decline.

During the period from 1967 to 2001, seven medium-sized and major projects were planned, of which only one, the *Bokshi Jhora* Project, was fully implemented (Ghatani, 2015). Since the time of its construction in the early 1900s, there have been no major repairs made to the supply system, except cleaning and painting jobs (Rasaily, 2014). The current infrastructure for water storage and distribution is insufficient to store the stream flow during the peak monsoon season and, as a result, half of the streams that feed these reservoirs are left free flowing and un-stored during the monsoon.

The municipal water supply runs for 60–90 minutes once a week during the dry season and 2–3 times a week during the monsoon. All formal, municipal water connections – domestic, commercial, or public standpipes – have the same frequency and duration of supply since they are connected to the same supply tank and distributaries. People with private connections receive 1,000–1,500 litres of water during each supply cycle, depending on the location, distance from the distribution line and the storage capacity of each household. Households who primarily depend on public standpipes receive far less or sometimes nothing during each supply cycle. Additionally, most public standpipes have no taps which results in massive wastage of water if the timing of supply is not known to the dependent community in advance. A local *samaj* often has to approach the DM to provide a public standpipe in their locality if one does not exist. On receiving such a request, the DM carries out feasibility checks and accordingly gives permission for construction. The cost of installation of a public standpipe is either borne by the DM or by the *samaj*, depending on negotiations and the political reach of the *samaj*. The DM apparently takes time to approve connection requests and is also said to be facing a financial crunch in recent years, and consequently the *samaj* have been bearing connection costs.

In a recent development, Darjeeling has been listed as one of the beneficiary cities of the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) scheme. AMRUT was launched by the Ministry of Housing and Urban Affairs (MoHUA), Government of India, in 2015 to provide basic amenities like water supply, sewerage facilities and urban transport for the benefit of town residents, especially for poorer sections of society (Ministry of Housing and Urban Affairs, 2017). Among the many objectives

of this Government of India scheme, AMRUT aims to provide tap water supply and sewerage connection to every household, and the Darjeeling component was sanctioned in 2016 (Chettri, 2016) and is expected to cost INR 2050 million (USD 30 million). The project is yet to achieve major milestones but citizens perceive that this project may alleviate their water stress to some extent, if not completely. However, the success of the project is also dependent on identifying and linking the new infrastructure to newer sources of water in Senchal and surrounding areas.

Community self-help groups: the Samaj

Springs are primary sources of water for a large section of the population living within Darjeeling and at least 50–60% of the population of 132,000 within the town primarily depend on them (personal interview: Assistant Engineer, 2014 and 2016). These springs and their source catchments are managed by the communities who live around them through self-help groups called '*samaj*' (literal translation: 'society').

A *samaj* is an 'inclusive social institution that organizes support for social events' and provides a platform for settling conflicts in a village (Wenner, 2015) and is quite commonly found in the Darjeeling–Sikkim Himalaya region (Boer *et al*., 2011). The first known *Gaon Samaj* (Village Society) was the *Gorkha Dukha Niwarak Sammelan* (Gorkha Community Problem Solving Convention) founded in 1932 (Boer *et al*., 2011). Originally, the primary objective of these groups was to deal with immediate and urgent community needs, such as medical and funeral expenses or other emergencies. Over time, *samaj* have been set up by communities with a similar self-help intent for various issues, including accessibility and availability of water (Drew & Rai, 2016) and recently also for the protection and management of springs. A *samaj* is formed on the basis of the location of households and for a purpose; a single household can be a member of more than one such *samaj*, depending on the primary objectives of the *samaj*, for example being a member of one *samaj* with the primary objective of maintaining a springshed (the recharge area of a spring) and another with the objective of being a micro-credit facility, or of another formed for one ethnic group.

Members of a springshed *samaj* share the responsibilities of managing the area surrounding springs, constructing reserve tanks, and also setting up rules of access collectively, and are expected to pay a monthly contribution. Each s*amaj* has a local authority and members are likely to lose their rights and privileges or even face a social boycott if rules are violated. People who have recently migrated to Darjeeling area are allowed to join the *samaj* with a probation period of a year or two (Boer *et al*., 2011). *Lal Dhiki Ekta Samaj*, *Mangalpuri Samaj*, and *Frymal Sudhar Samiti* are *samaj* within Darjeeling which carry out various self-help activities including protection of springs and their sources. S*amaj* boundaries are determined by the membership and do not overlap with the administrative boundaries of wards (the smallest formal administrative unit) within a town. In Darjeeling there are around 130 *samaj* across 32 wards (Boer *et al*., 2011).

Private water suppliers

There are four types of private water suppliers in Darjeeling and its surrounding area: water porters, hand-drawn water carts, water tanker trucks, and households who share/sell 'their' spring water or their surplus water (Chakraborty, 2018). As for informal institutions around springs, documentation of the emergence and semi-formalization of private water markets is minimal. These informal private water

supply systems play a critical role and often form a significant portion of the water sourced by marginal and vulnerable communities.

Since the 1980s, private water suppliers have played an important role in supplying domestic water at the doorstep in almost every part of Darjeeling. Among the private water suppliers, water porters and water carts supply water in smaller quantities (less than 500 litres) whilst tankers supply larger quantities (4,000–6,000 litres). Some households form a significant portion of these informal private water suppliers by charging money to other households to access 'their' springs (springs on their private land) or with whom they share their surplus storage of water (Chakraborty, 2018).

Water porters collect water from the springs, pipe leaks or breaks within the town and deliver water to people's homes on a regular basis, on demand. A 60-litre can is priced at INR 70–90 (USD 1–1.5) with a monthly supply costing between INR 1300–1500 (USD 19.5–22.5) depending on the location of the house. Hand-drawn carts, locally called '*Gorkhey jeeps*', also collect water from multiple sources including springs, and purchase from large water tankers at INR 50 (USD 0.74) for 250 litres (Chakraborty, 2018) and then supply it to households with small profit margins. A typical water tanker of 6,000 litres costs around INR 1,000–1,200 (USD 15–18) depending on the season, demand and availability. The drying up of water sources overlaps with incoming tourists during the dry season which also affects water pricing.

Water tanker operators started emerging as key players in domestic water supply in Darjeeling during the 1980s, when areas of town started experiencing acute water shortages even during the monsoon due to a lack of formal water supply infrastructure in the region (Rasaily, 2014). Water tankers were also used by DGHC and DM to alleviate the water crisis in the early 1990s (Rasaily, 2014; Chakraborty, 2018). Water tankers supply to almost everyone in town; as one supplier noted, '… *Mithai dokaan dekhi liyera paan ko patta dhuune samma …*' ('… from sweet shops to the washing of betel leaves by shopkeepers …'). Demand for water tankers is relatively lower in areas serviced by the formal municipal water supply and during monsoon; however, some parts of the town, are heavily dependent on one or more private water suppliers throughout the year. (Telephone interviews with tanker truck owners for this study were held in 2018.)

The last category of private water suppliers are households which allow access to water from 'their' springs and those who supply from their surplus storage of water. The first group own springs located on their private land. This ownership of springs allows them exclusive use as well as the ability to sell water from it for profit (Chakraborty, 2018). Some households also sell the surplus water collected and stored in their households, creating another category of private water supplier. This group of private water suppliers are a minority and not organized collectively with formal or informal institutions which guide other individual operators (private tank operators or a *samaj*) and set up rules or prices. Sharing or selling of water among this group is much more informal and their transactions are either in kind or the price is negotiated.

The status of municipal water supply in Darjeeling

Darjeeling Municipal WWD has been studied in terms of its function, staff, and support staff for operations and customers serviced (Table 2) (Ministry of Urban Development Government of India & Asian Development Bank, 2007). Here, the WWD is placed in comparison with the water utilities of 20 other Indian cities. The insufficiency of this framework to incorporate the uniqueness of utilities in mountain towns and cities is discussed below. The ADB has an exhaustive list which could not be acquired for the

Table 2. ADB indicator values for WWD.

Indicators	Indicator values considering the actual available supply	Minimum to Maximum
Water supply coverage (%)	15	15–100
Weekly water availability (hrs)	1	0.3–12
Per capita consumption (l/c/d)	29	29–203
Production/population (m^3/d/c)*	0.03	0.03–0.80
Unaccounted for water (%)**	25	13–60
Connections metered (%)	0	0–100
Revenue collection efficiency (%)	75	45–189
Staff/1,000 connections ratio	26	0.4–26
New Connection Fee (INR)	17,000 (USD 250)	100–17,000 (USD 1.5– 250)

*Considering resident static population, not including tourists and students.
**Refers to leakage and other losses in the distribution system.

DM; hence, in this study, computations have been made using the available data. (This study was part of the first author's unpublished master's thesis; see Shah, 2015).

Coverage supplied by the WWD (10–15%) is the lowest in comparison to other assessed cities (Samanta & Koner, 2016; Bhutia, 2017). The other 85% is covered by a combination of informal supplies, springs and water suppliers (personal interview: DM WWD Assistant Engineer, 2014 and 2016). Per capita water consumption is far less than the 220 LPCD (litres per capita per day) drinking water requirement for a Class I city, as according to the National Commission on Integrated Water Resources Development. Production/population is again the lowest compared to similar sized towns (production/population = [annual production volume (m^3)/365]/[number of people served]). Revenue collection efficiency is at the higher end with 75% water supplied being paid for, compared to other cities in India which have low levels of revenue efficiency. The 'staff to connections' ratio is the highest; a lower value of this ratio indicates a lack of staff to handle service provisioning and high implies the system is highly inefficient: whilst high does indicate inefficiency, difficult terrain cannot be ignored as a reason for the need for a higher staff count. The connection charge is INR 17,000 (USD 250) with additional labour and pipeline material costs. For an immediate connection, charges shoot up to INR 35,000 (USD 520) with extra labour and piping charges. An application form costs INR 100 (USD 1.50) (see: http://dm.gensoftindia.co.in/Application-Forms.aspx) and needs to be accompanied by three supporting documents: a Khatian (a record of rights for identifying land) from the Land Reforms Department; a land registration document from the court; and a mutation document from the municipality as a proof of residency (Shah, 2015). An annual water fee for a private connection is about INR 500 (USD 7.50) People have been gradually moving from public standpipes to individual private connections, despite the time, effort and money needed to obtain a private connection. Public standpipes have an increasing number of dependents who are mostly migrants without the ability to procure the required documentation; private connections are convenient and reliable. (Interviews were conducted at household level for this study in 2014).

A low ratio of production to population of the municipality affects weekly water availability which translates to low per capita municipal water availability. Another factor that affects per capita consumption or availability from the municipal source is the lack of storage at a household level. Low levels of frequency, duration, and amount of supply in addition to high financial costs for acquiring a formal water connection are some of the reasons that determine the low coverage for this water utility.

However, the ADB report (Ministry of Urban Development Government of India & Asian Development Bank, 2007) did not assess any water utility for a mountain town and thus factors specific to such regions may not have been considered. The dynamic nature of the population, consisting of a very high seasonal influx of tourists and students, is an important factor which is missing.

Governance: multiplicity and hybridity of institutions

Water, unlike a classic commodity, is a multifaceted resource which reflects on the nature of institutions that govern it and their intertwining in terms of governance and access by communities (Mehta, 2006; Kiparsky *et al*., 2013). Institutions that govern a water resource vary and so do associated property regimes. The fluidity of water creates competitive and overlapping water rights, which leads to a mix and intertwining of informal and formal arrangements (Mehta, 2006) which we refer to here as hybridity, since no single institution on its own is capable of meeting communities' demands for domestic water. In the case of Darjeeling, water is a public, private, or common property resource depending on the location, presence or absence of an institution and the nature of these institutions.

Multiplicity and intertwining of institutions makes urban water governance complex because the institutions involved have overlapping and fragmented responsibilities, jurisdictions and decision-making method silos (Anand, 2001; Hillmann, 2013; Kiparsky *et al*., 2013; Fuenfschilling & Truffer, 2016). Fragmentation of institutions can be political, issue-based, due to gaps in design and implementation of programmes, and as a result of a mismatch between biophysical and political boundaries. Darjeeling hills come under GTA-2, an autonomous hill council in addition to the national and provincial governments. Urban water in Darjeeling is managed by the DM which is an elected body and by the PHED which has appointed engineers. Political fragmentation is created here with multiple sources of funding and multiple institutions responsible for implementation of projects (Kiparsky *et al*., 2013). Issue-based fragmentation occurs because the land and water resources of Darjeeling and the surrounding areas lie with different State-affiliated organizations such as the military, Forest Department and Tea Board, which increases a physical constraint on the town and restricts access to the resources under the other organizations. The town municipality only manages the formal supply infrastructure but the areas served by springs which a large section of the town is dependent on fall outside the jurisdiction of the municipality. The multiplicity of institutions leads to an interrupted transition from planning to execution to implementation with a different institution being involved at every other step. The Balasun River Scheme is an example, with the PHED building the river-water lifting system and drawing pipelines to the supply systems of the municipality, from where the municipality has to handle the supply.

Another way of locating the multiplicity of institutions is through the infrastructure of the municipality's formal water supply system (Kiparsky *et al*., 2013), from source to taps. The water harnessing infrastructure falls under the GTA and PHE, whilst the water supply distribution system falls under the municipality (Samanta & Koner, 2016). The water supply lines pass through forested areas under the Forest Department or army cantonment areas under the Indian Army. This multiplicity of formal institutions denotes a political fragmentation through an overlap but at the same time a conflict of responsibilities among various levels of government and agencies, making complex governance structures for urban water (Kiparsky *et al*., 2013).

Formal and informal institutions handling water resources in Darjeeling and the rules with which these institutions are governed influence how they understand and handle issues of resource access,

in this case, communities' ability to access water. Emphasis on resource access is necessary because it helps individuals and communities shape their development but the institutions might enable or curb such development processes (Mell & Sturzaker, 2014).

The intertwining or hybridity occurs at the institutional level where the State-run municipality and non-State entities work together and, at times, against each other to cater for the water requirements of the communities. The low coverage, low frequency and quantities of supply make it imperative for the municipality to seek ways to fulfil the demands of households who are dependent on its distribution lines. The municipality as a formal institution interacts with the private water suppliers, especially the water tankers in times of supply deficit in their system. Vehicles used for private water supply, such as carts and tankers, have to work around the traffic police of the town, underlining the interaction of the formal and the informal. When the municipality seeks the tankers, traffic rules are relaxed accordingly. *Samaj* look after the springs which are ignored by the formal institutions, hinting at the emergence of informal institutions in the absence or negligence of a formal body. *Samaj* also approach the town municipality on behalf of their members when there is a need for public standpipes in their vicinity, and even collectively pay for the installation costs which in most cases are borne by the municipality – highlighting their importance as a conduit between communities and the State.

In the history of water investments for the DM region (Table 1), projects are primarily augmentation projects with only the Balasun River Scheme and AMRUT scheme in recent times looking to restructure an age-old distribution system. This shows the dominance of an engineering outlook with 'add more' as the only solution, without reining in an adequate knowledge of ecology or socio-economics. The stress has to be shifted towards distribution infrastructure and effective institutional functioning to enable better access, which needs support from both political and executive departments. Lack of incentives for positive performances in the public sector makes that sector more conservative and risk-averse to innovations. Absence of innovation restricts initiatives for mountain regions especially to overcome the constraints posed by the topography of the region to build sufficient, effective and less energy-intensive water distribution systems (Bandyopadhyay, 1989; Kiparsky *et al.*, 2013). As water users, communities have to work around these multiple institutions and interact with both formal and informal, to cushion the water scarcity they face. The cushion is generally in the form of a water bundle created using a combination of water sources, as noted above. The composition and proportions of a water bundle are primarily dependent on the financial resources available to a household, and its spatial proximity to the water sources. In the presence of multiple institutions, and the amount of time and resources they have to spend navigating around them, we observed that the higher the number of resources households had access to, the more secure they felt, i.e. the more varied a water bundle was, the more secure a household felt because they could have an array of resources to turn to if they had insufficient water. With the low frequency of municipal supply, if a household can afford a private supply, the frequency increases because they can ask for water to be delivered to their households. If a public spring is present in the household water bundle, a household feels more secure, regardless of the time and effort involved in fetching water from the spring (Shah, 2015).

Any external or non-local interventions tend to overlook the informal and social institutions which have emerged across the years to manage common water resources, such as *samaj*, which makes the interventions counterproductive (Bandyopadhyay & Gyawali, 1994). Problems occur at various levels pointing to the need to understand the interconnectedness of biophysical, socio-economic, political and institutional issues at each level and across various levels to enable integrated planning (Badiger *et al.*, 2014).

Conclusion

Despite being located in a volumetrically water-rich region, Darjeeling has faced water scarcity for a number of decades now. We argue that the crisis is result of a conundrum due to the interlinked problems across political unwillingness, insufficient investments, failure of cooperation between the state and regional institutions, and inadequacies in local governance including institutional capacity. Translation of physical water availability to access for communities is an important factor that alleviates or reinforces water accessibility. The multiplicity of water institutions and the way in which they are intertwined reveals the complexity of urban water governance. Creation of a household water bundle by communities through complex interactions with these institutions illustrates the difficulties they face in acquiring a basic amenity such as water.

DM is unable to meet the water requirements of the communities living in the town. Water scarcity here is cushioned to a certain extent by the presence of springs and private water suppliers, both of which fall under the ambit of informal institutions. As an exclusive dependence on municipal supply is not enough to meet basic water needs, communities create a water bundle from a combination of available sources which are in turn dependent on a variety of factors such as socio-economic status and the spatial location of households, among many others.

In a similar way to other global experiences, engineering solutions have been the order of the day, with supply augmentation the only route pursued in Darjeeling. Success rates of such augmentations have been low and have not been enough to close the gap between increasing water demands and augmented supply. Low success rates show the need to look at aspects of both harnessing and supplying water. An acknowledgement of natural, social and traditional knowledge is needed to provide better solutions and water rights and, in this case, existing systems such as springs and the array of private water suppliers should not be left out.

Various departments need to work together for a better solution to the increasing water crisis. There are an absence and reluctance on the part of the government to push for development schemes with a thorough study. Difficult terrain, lack of funds and an imbalance between urban growth and the provisioning of services might intercept any initiatives taken or render them futile after a certain period of time.

Despite getting a substantial amount of rainfall, households in Darjeeling suffer from acute water scarcity due to a myriad of governance issues. Developing buffer storage is one critical measure needed to compensate for the skewed seasonality of precipitation and to deal with high fluxes in the floating population. At present, there are quite a few initiatives aimed at alleviating the water crisis in Darjeeling. Of the many, one, under the AMRUT scheme (Chettri, 2016) and the other under the National Adaptation Fund (Department of Environment, 2016) seem to show promise in alleviating the crisis. The National Adaptation Fund also emphasizes the importance of rainwater harvesting systems. With these progressive developments, initiatives seem to be making positive headway, with the former looking at reforms in water governance (specifically at the formal water distribution system) and the latter at harnessing rainfall. The implementation of these projects might lead to the alleviation of water scarcity in Darjeeling and will additionally provide pointers for effective intervention in similar towns within the EHR.

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