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Water management systems of two towns in the Eastern Himalaya: case studies of Singtam in Sikkim and Kalimpong in West Bengal states of India

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Abstract

This study examines the water supply systems, their sociopolitical dynamics, and the future of water management in two Indian towns in the Eastern Himalaya, Kalimpong in West Bengal and Singtam in Sikkim. The research was centred around issues of demand and supply, water scarcity and stress, equity, water governance, and the sustainable conservation and management of water resources in a climate change context. Methodologically based on surveys, focus group discussions, and key informants' interviews, this study finds that spring sources are drying alarmingly in Singtam, even as demand is increasing dramatically due to a floating population that is more than the number of local inhabitants. The town suffers from the lack of an adequate reservoir facility and the frequent damage of water supply pipes during the monsoon. Kalimpong faces acute water shortages all year round. The political tug of war between the state government agencies and the local government around the management and supply of water, declining water discharge in spring sources, the lack of water infrastructure for repair, maintenance, and supply, and the glaring inequity between the higher, middle, and lower income groups are the immediate issues around water in Kalimpong. The spring sources that supply drinking water to Kalimpong and Singtam need immediate conservation measures to arrest the declining state of discharge. Micro-planning at the local level, reviving drying springs, and the adoption of appropriate soil and water conservation practices on a watershed basis are all important ways forward. The development of water security plans and their strict enforcement through multi-institutional collaboration can contribute to improved water governance and socioecological restoration for sustainable water resources management.

Keywords: Dhara Vikas; Drying springs; Governance; Kalimpong; Micro-planning; Singtam; Water management; Water supply system

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1. Introduction

The countries of the Hindu Kush Himalaya (HKH) region are increasingly facing challenges in meeting their demand for water, food, and energy due to rapid socioeconomic development, population growth, and urbanization (Mukherji *et al.*, 2015). The region faces severe seasonal water shortages due to high variability in rainfall, a problem likely to be exacerbated by climate change (Vaidya, 2015). The variability in rainfall patterns, seismicity, early snowmelt due to climate change, the geological composition of aquifers in the HKH region, and unpredictable, prolonged dry periods have resulted in declining trends in water discharge in springs, rivers, and rivulets (MoWR, 2012; Gupta & Kulkarni, 2018). As a consequence, water shortages have become increasingly prevalent in cities and towns of the region, such as Kathmandu and Pokhara in Nepal; Darjeeling, Kohima, Mussoorie, and Shimla in India; Lhasa in China; Thimphu in Bhutan; and Kabul in Afghanistan (Synder, 2014). In the Sikkim Himalayan region more specifically, towns and cities are growing with unprecedented developmental and population pressure, a situation aggravated by climate change impacts. However, a scientific understanding of the socioecological situation is still lacking.

In order to fill this gap, two Indian towns, namely Kalimpong in West Bengal and Singtam in Sikkim, were chosen for a preliminary study focusing on governance and water supply systems, management, and benefit-sharing. This paper is an exploratory study of urban water supply in the two towns. It aims to expose gaps, identify potential areas of future study for the better management of water supply systems and benefit-sharing, and underlines the need for the conservation of water sources.

1.1. Historical context

This study on water and livelihoods in two Himalayan towns, in Sikkim and West Bengal, respectively, traces its narrative to the history of the region before it was defined and mapped as Sikkim and West Bengal. An understanding of this timeline is significant for a larger perspective on the changes that the region has seen – natural, anthropogenic, and sociopolitical. Basically, the challenges of water management in Singtam and Kalimpong are not a sudden outcome, but a product of many gradual changes that led to its current state of water shortage, occurring against the backdrop of climate change and increasing, unplanned urbanization. For want of space, we can touch on this history very briefly.

Historically, in terms of cultural assimilation, the Lepchas are the original inhabitants of the Darjeeling hills (which includes Kalimpong) and Sikkim. They were followed by the Limboos and later the Bhutias. The Nepalis were already settled in the western bank of the River Teesta after they conquered the land under the leadership of Prithvinarayan Shah during 1774 and later extended agriculture in the region (Pradhan, 1991). Later, during the 1960s and 1970s, the Marwari business community started settling in Sikkim and Kalimpong, along the old Silk Route, in order to trade with Tibet (Jha, 1985).

The annexation of Kalimpong by the British in the late 19th century resulted in the initiation of trade with Tibet through Jelep-la and Nathu-la (Hackett, 2008). Similarly, the merger of Sikkim into the Indian union in 1975 (Datta-Ray, 1984) resulted in several cultural and political shifts. Both of these geopolitical changes resulted in the emergence of different governance and political practices. As the 22nd state of India, Sikkim witnessed economic and sociocultural developments, political awareness and consciousness, administrative reforms, and active participation of the people through their representatives in the state legislative assembly. Kalimpong, ruled in succession by the Sikkimese and Bhutanese kingdoms, and the British East India Company during the 18th and 19th centuries, became a part of

West Bengal state after Indian independence in 1947 as a subdivision of Darjeeling district, and subsequently a full-fledged district in February 2017. It is currently ruled by Gorkha Territorial Administration (GTA) under the West Bengal Government. This would have an impact on both the hill towns: Kalimpong and Singtam, now located in the states of Sikkim and West Bengal, respectively, in independent India.

During the 1990s and in 2000s, as many as 27 hydropower projects in the Teesta River and long-distance tunnels running under the mountains were planned that brought up sociocultural and socioecological issues in the sacred landscapes including the perturbation of pristine environments leading to degradation of local water sources (EPDGOS, 2015). With the increasing infrastructure development for hydropower projects, the Teesta River basin has been seriously impacted by loss of political rights, loss of indigenous religion and cultural identity, landlessness, loss of livelihoods, biodiversity loss, and environment degradation due to hydropower projects (Kerry, 2008; Huber & Joshi, 2015; Lepcha, 2018; Sharma & Pandey, 2018).

1.2. Water governance, policies, and challenges

Gupta and Kulkarni (2018), in a report for the National Institution for Transforming India (NITI) Aayog, stated that nearly half the perennial springs in the Himalayan region have dried up or become seasonal in nature, due to natural dynamism, erratic rainfall, seismic activity, and ecological degradation associated with land use change for infrastructural development impacting mountain aquifer systems. When considering the case of Sikkim Himalaya, traditional and natural wetlands and water bodies such as village ponds, *dhara/pandhera* (springs), *kuwa* (shallow wells), *khola/kholsa* (small rivers or rivulets arising from a spring), and *devithan* (water sources, abode of local deities) have all been badly degraded over the last few decades (Sharma *et al*., 2012; Tambe *et al*., 2011, 2012). Consequently, thousands of Himalayan villages and several towns are currently facing acute water shortages for drinking and other domestic or agricultural purposes. These structures ought to be restored, maintained, and used properly and these water bodies should not be allowed to be encroached upon for any other land use (MoWR, 2012).

The National Watershed Development Project for Rainfed Areas (NWDPRA), the Integrated Watershed Development Programme (IWDP), and soil conservation schemes in the catchments of river basins and flood-prone rivers are programmes extended by different ministries of the Government of India. India's first National Water Policy (NWP) was adopted in 1987 and revised in 2002 and 2012 (MoWR, 2002; Kumar, 2017). However, it has not categorically addressed the declining state of water sources meant to cater to the needs of mountain cities and towns and the increasing demand for water. In 2014, the Government of India adopted the National Mission for Sustaining the Himalayan Ecosystem (NMSHE), as one of the key elements of India's National Action Plan on Climate Change (NAPCC) (DST, n.d.). It is expected that marginalized and vulnerable communities in the Indian Himalayan region, which straddles 12 states, will be the beneficiaries of the mission, as it seeks to safeguard people from the impacts of climate change through evidence-based policy formulation and enhanced research and capacity.

At the individual state level, the contrast in policy is stark. Sikkim, with a stable government and not much political discord, has successfully undertaken springshed management with the first systematic and landmark initiative, *Dhara Vikas*, led by the Rural Management and Development Department (RMDD) and its collaborators. As a robust climate adaptation strategy for drought-prone areas in

Sikkim, *Dhara Vikas* (meaning, springshed development), an innovative programme was adopted in 2008 to revive and maintain drying springs, which is helping to alleviate the problem of rural water scarcity by reducing surface run-off of rainwater and allowing more water to percolate down to recharge underground aquifers, which, in turn, ensures increased discharge from springs (Tambe *et al*., 2011, 2012; Sharma *et al*., 2012). This scheme has been replicated and undertaken in the form of pilot projects of varying scales across Indian mountain states such as Himachal Pradesh, Nagaland, and Uttarakhand (Seidler *et al*., 2016; Gupta & Kulkarni 2018). However, such an initiative is yet to come about in the adjoining Kalimpong district, despite its proximity to Sikkim. The reason for this lack is the political atmosphere: Kalimpong and Darjeeling Hills have been witnessing political agitations since pre-independence, based on ethnic identity, and over time this has morphed into the demand for Gorkhaland for the minority Nepali Gorkha community, demanding separation from West Bengal (Ganguly, 2005). The movement has seen outbreaks of violence, particularly since the early 1980s, and as a consequence there has been lack of coordinated initiatives towards water management by the West Bengal government and the GTA. In contrast to the coordination and collaboration between agencies on water governance in Sikkim, one study conducted in the adjacent Chibo–Pashyor area of Kalimpong has concluded that the key reasons for poor water resource governance and management were lack of coordination, convergence and engagement of local administration (PHED and the municipality) in the construction, distribution, management and monitoring of water resources, poor local-level awareness about various government schemes and programmes on water supply and systems, outdated and defunct infrastructure for overall distribution and capturing of excess run-off, and lack of properly designed schemes and projects involving community participation (Sharma *et al*., 2019).

1.3. Climate change and reduced rainfall

According to Sikkim's *Socioeconomic Census 2005–06*, nearly 65,000 (80%) of the 80,000 rural households in the state depend on springs as a source of drinking water (Government of Sikkim, n.d.). However, these springs now face a new hazard. Though degradation of catchments has been identified as the main cause for the drying up of springs in the 20th century, climate change is now emerging as the new threat (Tambe *et al*., 2012). In the mid-hills and low-hills, the precipitation varies from 1,000 mm annually in the subtropical agro-climatic zone to around 3,500 mm in the temperate zone. The Sikkim Himalayan region is blessed with high rainfall (annual average, 3,000 mm) but an overwhelmingly high proportion of it falls during the summer monsoon season. Sikkim has witnessed unprecedented, long spells of dryness in recent years, with 1986, 1988, 1989, 2006, and 2009 being classified as drought years. These years received 13–21% of lower rainfall than the 30-year average (1981–2010). This rainfall deficit has had adverse effects on drinking water supply, irrigation in the rabi season, the production of vegetables, oranges, and other fruit crops, and Sikkim's economy in general (Rahman *et al*., 2012).

In the Kalimpong and Darjeeling regions, the maximum temperature showed a decreasing trend, whereas the minimum temperature showed an increasing trend. The mean temperature showed an increasing trend over the years. The annual rainfall slightly increased over the years. The extreme weather events (mainly rainfall fluctuation) increased more in recent years (after 1980) (Benerjee *et al*., 2015). Droughts, landslides, flash floods, long dry spells, drying springs and water sources, extended summer temperatures, and increased incidences of pests and diseases in crops are some of the climate change indicators (WBSAPCC, 2010; Sharma *et al*., 2019).

2. Study sites

Two Himalayan towns, Singtam in Sikkim and Kalimpong in West Bengal, were selected for a comparative study and to present the case of each town when it comes to shaping water resources management, demand and supply, water scarcity and stress, equity, water governance, and sociopolitical dynamics and contextual factors (such as climate, demography, historic evolutions, etc.) in a climate change context.

2.1. Singtam, East Sikkim

Singtam Nagar Panchayat (municipality) is in East Sikkim district and is located (27°9′0″N, 88°22′48″E) at 423 masl spread across a 0.18 sq. km area along the banks of the Teesta River and Rani Khola (Figure 1). The annual average rainfall varies between 1,500 and 1,800 mm, with the highest precipitation being in June to September. The municipality is divided into six wards (Figure 2), and has 1,144 households with a total population of 5,868 (2011 census). Of these, 3,097 are males and 2,771 females (MHA, 2011). However, its population has increased dramatically over the last 7 years. As per the Singtam District Hospital's Community Need Assessment Survey conducted during March 2018, the total headcount in Singtam municipality and Golitar was 25,665, with a floating population of more than 6,000 persons, which is rising each year. Golitar, on the left bank of the Rani Khola and Teesta Rivers, includes a population of around 5,000 that includes temporary rental occupants and East Point School campus residents. On the right flank of the Teesta River lies Manpari Busty

Fig. 1. Satellite image of Singtam. *Source*: Google Earth.

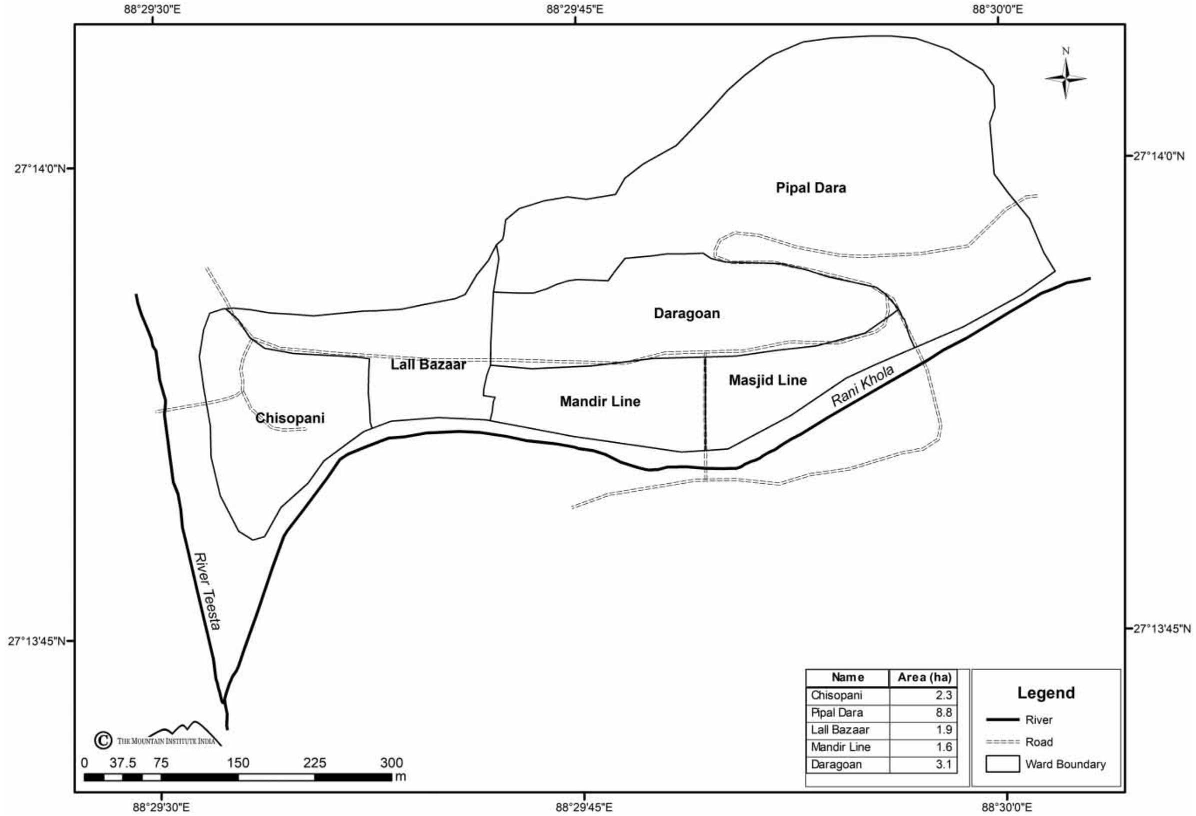


Fig. 2. Singtam town municipality and wards. *Source*: IndiKosh (2018b).

(Adarsh Gaon), inhabited by around 75 resident households and little more than 150 rental families. Both Golitar and Adarsh Gaon, an extension of Singtam, are dependent on Singtam Municipality for day-to-day requirements and services.

As many as 75% of the population of Singtam are engaged in business, or employed in government or in private companies. Approximately 55% of the males and merely 14% of its female population are currently working. Around 53% of the total male population are full-time workers and 2% are part-time workers. In contrast, merely 13% of the female population are full-time workers and 2% are part-time workers (IndiKosh, 2018a).

2.2. Kalimpong, West Bengal

About 40 kilometres (km) away from Singtam is the town of Kalimpong (1,400 masl) in West Bengal. Kalimpong municipality (27°4′25.17″N, 88°28′37.92″E) is located between two hills – the Deolo and Durpin (Figure 3). The municipality covers an area of 9.17 sq km, has 23 wards (Figure 4) with a population of 49,403 (2011 census) (ODM, n.d.). It has grown by nearly 15% over the last decade. Around 51% of the male and merely 16% of the female population work. About 47% of the total male population are full-time workers and 4% are part-time workers. About 14% of the total female population are main workers and 3% are marginal workers (IndiKosh, 2018b)[1]. The annual average rainfall of the city is 2,200 mm, with the highest precipitation being in May to October.

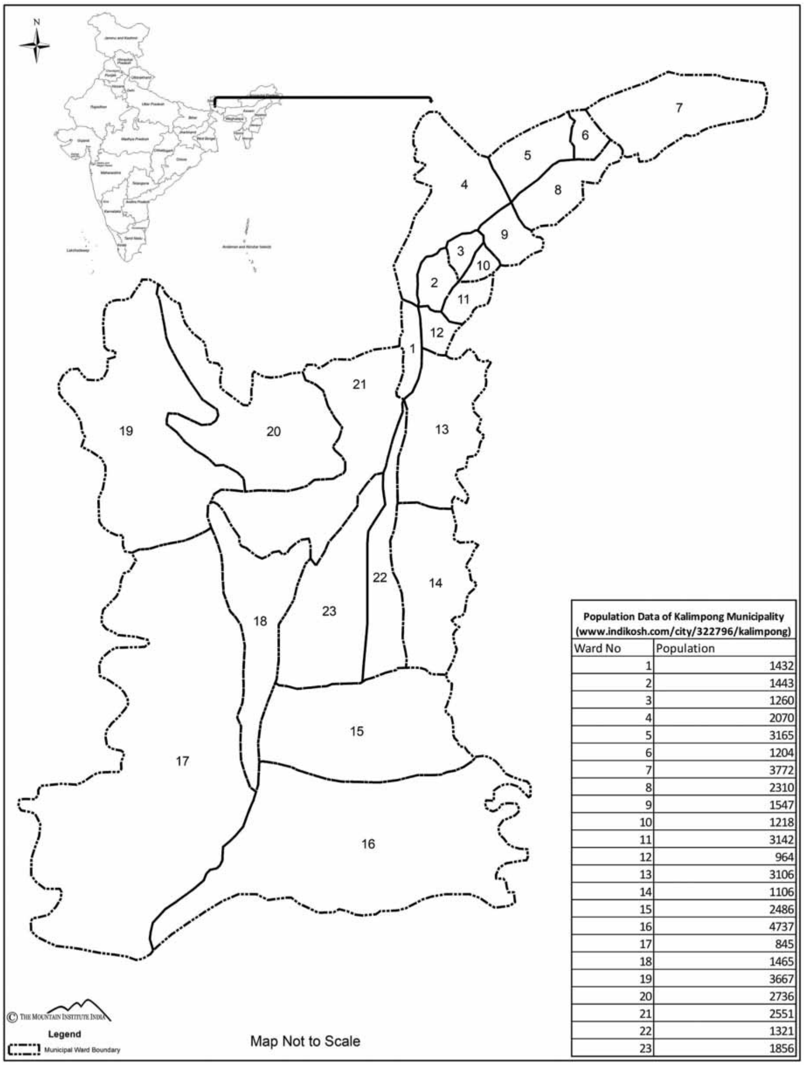
3. Methodology

The data collected for this study were derived through qualitative and quantitative methodologies using participatory rural appraisal techniques such as focus group discussions (FGDs), key informant interviews (KIIs), and field observations. We used semi-structured and open-ended questions and conducted 18 KIIs and 7 FGDs (5 mixed and 2 female groups) in Singtam, and 23 KIIs and 12 FGDs (7 mixed and 5 female groups) in Kalimpong. As many as 276 households from 23 wards of Kalimpong and 35 households in 6 wards of Singtam were interviewed during January–December 2017 using a structured questionnaire. Data were recorded online using the AKVO Flow Android mobile application system, a data collection and monitoring tool that works in field situations, to gather reliable and geographically referenced data. The wards in Kalimpong are scattered and thus a higher number of representatives were interviewed from different locations of the town and adjacent villages within the municipality so as to reduce data bias. While in Singtam, the wards are smaller and closely located to each other with similar situations. Most of the general issues were covered in KIIs and FGDs and thus, proportionately, a lower number of the household surveys were conducted in Singtam.

The respondents' households comprised culturally similar ethnic and resident business communities (Nepali[2] 37%, Bhutia (see note 2) 19%, Lepchas (see note 2) 13%, Behari[3] 14, Marwadi (see note 3) 17%), age groups, had attained different education levels (Figure 5), and different income categories (Table 1). Around 15% of the respondents were between 60 and 80 years of age, 35% between 40 and

Fig. 3. Satellite image of Kalimpong. *Source*: Google Earth.

[1] Typically, those who get work for more than 6 months in a year are 'main' workers; those who work for less than six months are 'marginal' workers.
[2] Nepali, Bhutia, and Lepcha are indigenous communities.
[3] Behari and Marwari are business communities.



Ward No	Population
1	1432
2	1443
3	1260
4	2070
5	3165
6	1204
7	3772
8	2310
9	1547
10	1218
11	3142
12	964
13	3106
14	1106
15	2486
16	4737
17	845
18	1465
19	3667
20	2736
21	2551
22	1321
23	1856

Fig. 4. Kalimpong town municipality and wards.

60 years of age, and 50% were between 20 and 40 years of age. Thirty-two per cent of the respondents in Singtam were women and 56% in Kalimpong. Around 80% of the respondents belonged to households with houses they owned, while the remaining 20% were in rented apartments in both the towns. Similar and contrasting elements/aspects of water source management, transportation, distribution and supply to households, and governance for Singtam and Kalimpong are given in Table 2.

We used the inductive coding style with symbols applied to sections of text in order to easily categorize those that are related to research questions, themes, concepts, and which were easy to retrieve and organize. During and after coding, we looked for connections between codes and began with descriptive themes; we also looked for sub-categories, relationships, cause-effect, etc. and finally developed a matrix of codes and themes, and analysed the information. To ensure

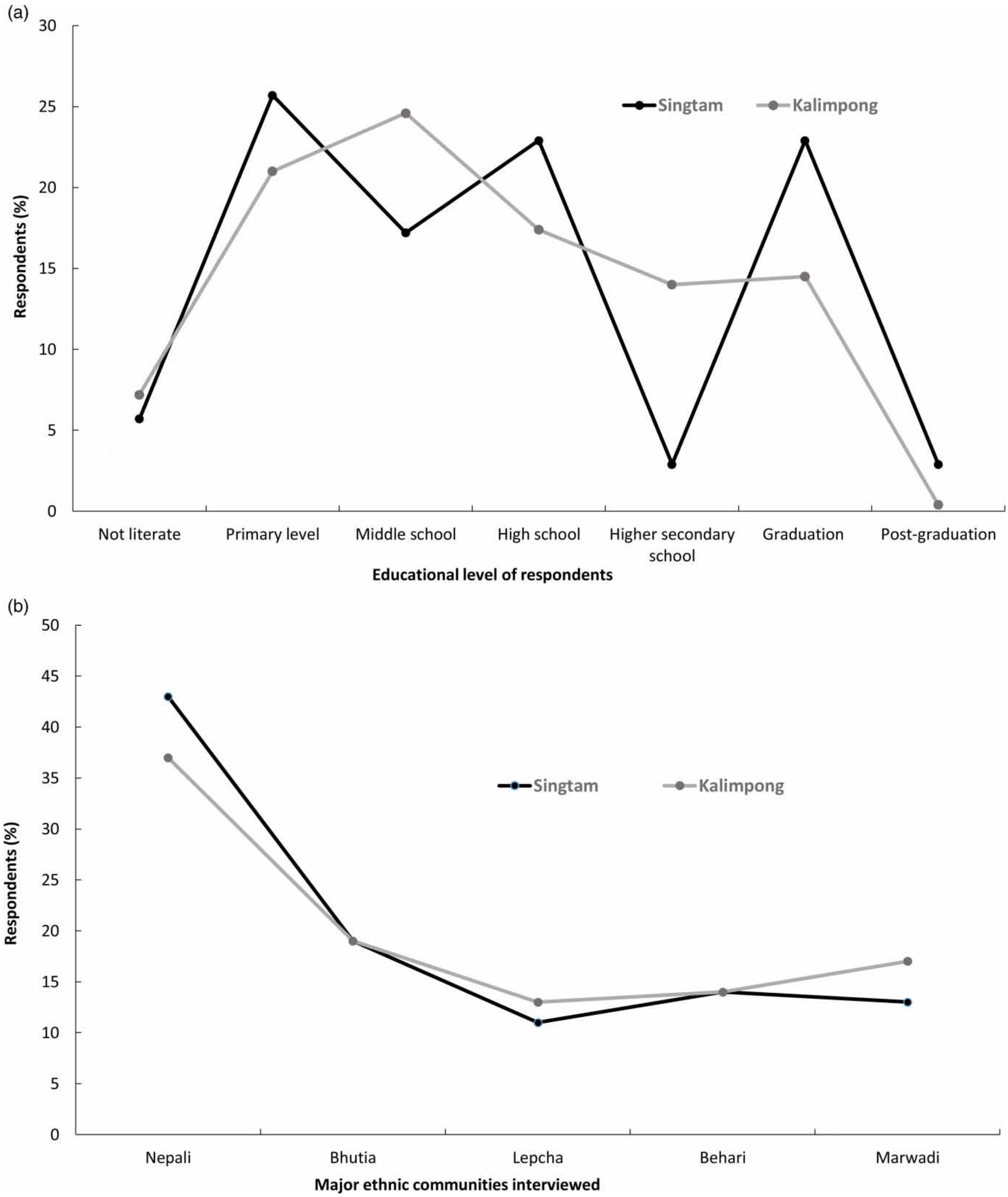


Fig. 5. (a) Educational levels of respondents in Singtam and Kalimpong. (b) Per cent respondents belonging to different ethnic and other communities in Singtam and Kalimpong.

Table 1. Monthly income levels of respondent households in Singtam and Kalimpong.

	Income categories (INR)						
Municipalities	> 10,000	10,001–15,000	15,001–30,000	30,001–50,000	50,001–100,000	> 100,000	Don't know
Singtam (%)	20.01	35.22	27.40	11.23	3.6	2.54	–
Kalimpong (%)	18.11	38.11	25.11	10.63	4.33	1.90	1.81

reliability, qualitative data were cross-checked during the FGDs, and some of them were discussed informally with the KIIs. The participants of KIIs were members of nagar panchayats, businessmen, hotel and restaurant owners, PHED and municipal officials, pipe fitters, water vendors, household owners, and those on rentals.

4. Water supply, distribution system and management

4.1. Drinking water sources, distribution, health, and other challenges

4.1.1. Singtam. The water distribution system in Singtam falls under the Public Health Engineering Department (PHED), Government of Sikkim. According to PHED, a total of 0.8 million gallons per day (mgd) is supplied to the town, including to the Singtam District Hospital, the police, the fire station, government offices, and public and private schools. The per capita water consumption in Singtam is only 39 litres per day (lpd), which is below the national average of 70 lpd. The total demand currently is 1.5 mgd.

The PHED transports water from Sang-chu Khola at the Martam–Nazitam gram panchayat unit (GPU), which is about 7 km away from Singtam. PHED authorities have constructed three water storage tanks, each with a 0.12 million gallon capacity, above the main town at Chisopani around 1 km away, and provide a direct connection to roughly 83% of the households. However, about 90% of the respondents' households and 70% of the KII respondents reported irregularity in water supply, receiving turbid and muddy water during the monsoon, and insufficient supply in winters. Therefore, apart from the main Sang-chu Khola source, 85% of the households also derive water from springs and streams from five other locations, most of which are located 1–3 km away from Singtam (Table 3). FGDs revealed that spring sources are tapped by the town's older residents, who have brought the water supply through pipes into their homes. A majority of the newer residents (labourers and officials of hydropower projects and pharmaceutical companies) are also dependent on the PHED supply.

Our field survey also discovered that besides PHED supply, other springs, namely, Kali Khola, Andheri Khola, Simana Khola, and Seti Khola, which are located around 1–5 km away, are significant sources of water for Singtam, Golitar, and Adarsh Gaon catering to around 1,360 families. These spring sources are 'private lines' and are poly-piped for private household consumption on payment. FGDs also disclosed that due to a warming climate and prolonged dry periods in recent years, springs have been drying. Thus, people have been shifting their source of water and looking for alternative springs. Seti Khola, located in Lower Namphing, is a major source of water for around 102 households (Figure 6(a)). In Golitar, 13 households have been drawing water from bore-wells as an alternative measure (Figure 6(b)).

PHED officials reported that they are looking for an alternative water source for Singtam that can fulfil the current total demand of 1.5 mgd. Until 2010, PHED brought water from Ghattey Khola located in Bhirkuna which dried up due to recurring prolonged dry periods coupled with anthropogenic impacts, and hence the department was forced to shift to Nazitam for a new water source.

Table 2. Similarities and contrasting features of the selected towns on drinking water management and governance.

Particulars	Kalimpong	Singtam
Similar elements/aspects		
Location of the municipalities	A hilltop town dependent on springs, spring-fed rivers and rivulets for domestic water, for hospitals, hotels/restaurants, government offices, Indian Army and others	Town located at the bank river Teesta and Ranikhola, dependent on springs, spring-fed rivers and rivulets for domestic water, for hospitals, hotels/restaurants, government offices and others
Water sources	Sources of water are around 86 km away at Neora Forest village	Sources of water are around 7 km away, at Sang-chu, in Martam-Nazitam area
Agencies involved in water supply	The source at Neora forest is under the State government – Neora office The water is then brought in through pipelines to the reservoir at Deolo. The water distribution is then under Gorkha Territorial Administration (GTA) and Kalimpong municipality and is implemented through Public Health Engineering Department (PHED)	PHED with nagar panchayat are responsible for water distribution and supply
Contrasting elements/aspects		
Number of wards and area	Larger municipal area with adjacent semi-urban villages within the municipalities	Small town area, urbanized wards
Water distributions	Water source, connection from the source to the reservoir, and maintenance etc. are carried out by state government department. PHED under GTA is responsible for water distribution and supply. So differences in coordination in the convergence between agencies	Only PHED is responsible for water distribution and supply. The state government allocated funds for repair, maintenance and source development. PHED utilizes the fund in close coordination with nagar panchayat (elected representatives of town)
Water supply during scarcity and crises	Tankers form an alternative economy and water source for those who can buy water. Walking to nearby springs is an alternative for many. Small-scale rainwater harvesting is also carried out in many households	Around 60% household have privately owned pipes connected to natural springs in addition to PHED supply. For those do not have alternative arrangements, PHED would supply through tankers, and immediately repair and maintain distribution system
Water demand	Water demand is high as the population is a little over 50,000. The Kalimpong is comparatively dry area and receives less rainfall. Springs are drying, and the discharge is declining	The demand is still less for around 25,000 people. There are other water sources to tap water as an alternative to meet the increasing demand
Governance on water management	Political instability, frequent strikes, two different government authorities (GTA and the State Government) with differences in resource mobilization and maintenance, distribution and supply of water, etc. water infrastructure set up at the time of British rule for a smaller population. No significant change in water infrastructure for about 30 years now	Stable government for the last 25 years, PHED department looking after water distribution and supply in close coordination with the Nagar Panchayats. As the resident, as well as floating population, is increasing, the government PHED is looking for an alternative water sources to meet the future water demand

4.1.2. Kalimpong municipality. The water source for Kalimpong municipality is the Neora forest, which is 86 km away from Kalimpong. Water brought from there is stored in a reservoir at Deolo and then supplied to the town. The responsibility for delivering water from the reservoir to the

Table 3. Water sources and supply systems for Singtam.

Water source	Public/private	Number of supply pipes	Number of dependent households	Status of spring source, and effects
Kali Khola, Sirwani–Chisopani GPU	Privately owned poly-pipes	80	400	Water sources at Chisopani are drying, and as a result farmers have stopped wet paddy cultivation
Andheri Khola, West Pendam GPU	Privately owned poly-pipes	30	150	Spring catchments of the Andheri Khola have been disturbed; springs drying due to prolonged dry periods
Simana Khola, Sumin Linchey GPU/West Pendam GPU	Privately owned poly-pipes	60	300	Simana Khola originates from the Sumin Forest area, and the water sources are intact due to its wider catchment area of >500 hectares
Seti Khola, Namphing GPU	Privately owned poly-pipes	102	510	The sources of Seti Khola have been disturbed due to road-building, mudslides, and is drying rapidly
Groundwater	Bore-wells	13	78	Not known
Nazitam, Martam Khola, Martam–Nazitam GPU	Steel pipes laid by the PHED	2	1,000	The water discharge at Nazitam is gradually declining due to prolonged dry periods during November–April

Source: Authors' survey.

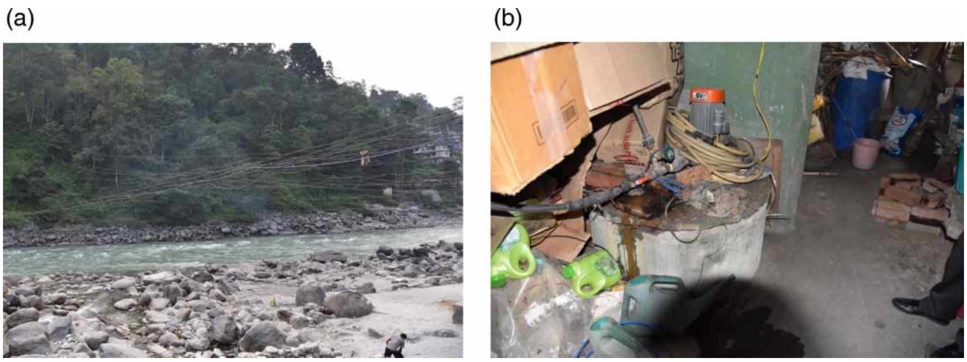


Fig. 6. (a) Poly-pipes privately connected across the Teesta by residents of Singtam, drawing water from Lower Namphing. (b) Bore-well at East Point Secondary School, Golitar.

households in the 23 wards lies with the PHED, under the local government (the GTA), and the Neora Water Supply and Maintenance Division (NWSMD) at the state level. The PHED works with the Kalimpong municipality to facilitate the water distribution. As per the KIIs, water was brought to Kalimpong from 1991 onwards from the Neora River. This source required a large capital investment, which was met by the Government of West Bengal, with the help of the Indian Army. As a result, the Neora water was distributed between the Indian Army and the civilian population of Kalimpong.

According to the NWSMD, the Kalimpong municipality has a water demand of 2.3 mgd. Of this, Neora provides 1.6 mgd, 0.8 million gallons of which is distributed to the civilian population and 0.7 million to the Indian Army, and the remaining 0.1 million gallons to villages en route to the

Deolo reservoir. The remaining 0.7 mgd used to be drawn from Thuckchok Relli. However, according to the NWSMD, and as stated in KIIs by around 95% respondents, the water level has been depleted over the course of about 5 years and the supply has fallen to about 0.4 mgd.

As per records available from the PHED office in Kalimpong, NWSMD supplies no more than 0.35 mgd for a population of over 50,000 or about 31.5 litres per person per day. This has resulted in a severe water crisis, as the current demand for water is about 1.5 mgd. Moreover, 40,000 gallons per day are to be given to the sub-divisional hospital. During the dry season, the water received from Neora Khola is only 0.35 mgd. This created a hue and cry as PHED could only supply water once in 3 days, and during the dry season once in over 5 days. Some residents collect water from natural springs, while most buy water from the markets, brought on tankers, which in turn bring water from springs from far-off places (Figure 7(a) and 7(b)). Based on KIIs with concerned officials, the differences in numbers pertaining to the volume of water supplied from the source as narrated by the two departments reveal the differences in data that exist between the two departments and a lack of good coordination.

4.2. Demand–supply gap

A basic issue that arises regarding the discussion of the demand–supply gap is the nature of the narrative about the water supplied to the households, market, and institutions. This is because the quantity of water supplied is often dependent on networking and the purchasing power of the households. It is usually difficult to derive an honest estimate in such cases, as people are conscious of what is legal and what can be problematic.

The water consumption patterns of households in Singtam and Kalimpong and their respective water sources are given in Table 4. Daily water consumption per household in both towns as per the household survey is presented in Figure 8. The majority of households require 201–500 litres of water per day. When we triangulated the information extracted from KIIs, FGDs, and household surveys, the data on water storage and consumption mismatched, as many have illegal connections, and more than one municipal water pipeline.

KIIs revealed that 82.9% of the households in Singtam are dependent on the municipal supply; however, they do not get water in their taps throughout the day during the dry season (January–May). While household respondents reported that many receive water every alternate day, for some households, it comes every 2–3 days, for 20–30 minutes each time. About 55% of the households receive PHED

(a) (b)

Fig. 7. (a) Water distributed by tankers at Kalimpong. (b) Supply pipes to Kalimpong, PHED's and privately owned.

Table 4. Uses of water in Singtam and Kalimpong (%).

	Singtam nagar panchayat			Kalimpong municipality		
Water source	Drinking/cooking	Washing	Bathing	Drinking/cooking	Washing	Bathing
Municipal supply	50.4	50	50	49.32	67.32	76.55
Rivers	1.1	3.6	4.3	3.87	6.38	5.32
Curtailed water[a]	0.7	1.1	1.1	0.92	2.43	0.89
Springs/dhara	47.5	44.9	45.6	39.23	21.45	11.78
Water tankers	0.3	0.4	00	6.75	2.51	5.56

[a]Curtailed water: Reserved water fetched from distant springs or neighbours.
Source: Authors' survey.

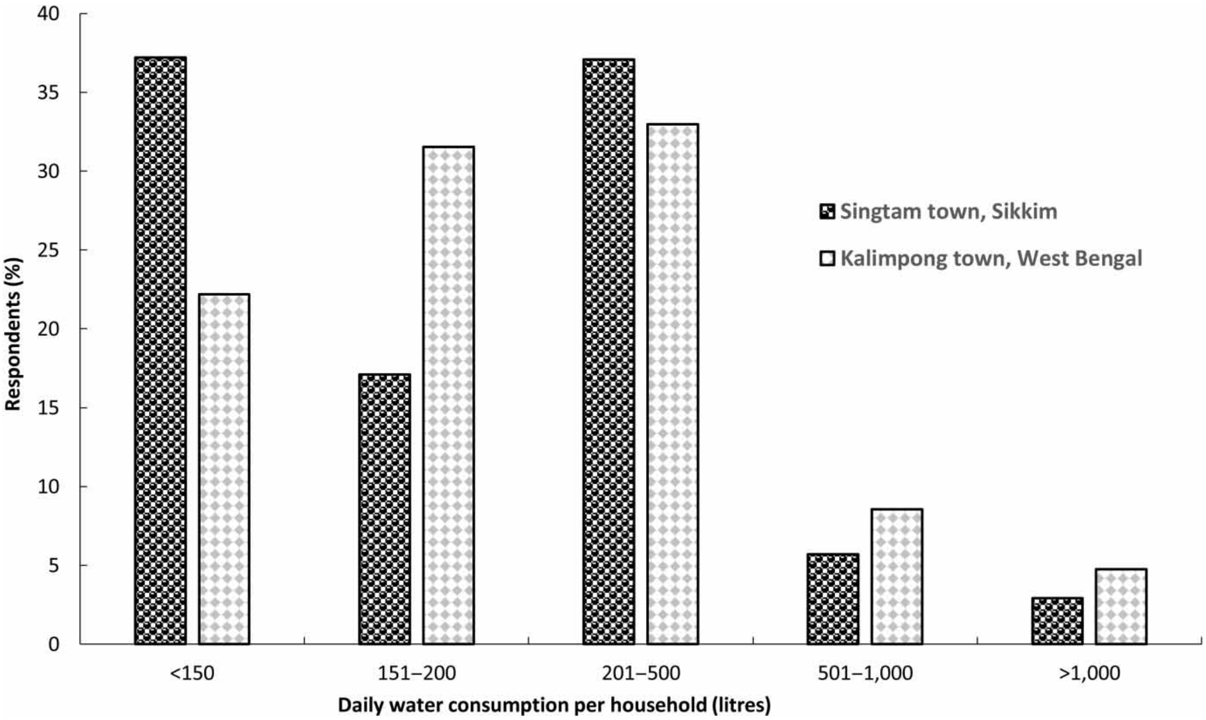


Fig. 8. Daily water consumption per household (litres). *Source*: Authors' survey.

water once in 3 days and even less frequently during the dry season. Consequently, around 70% of these households have to depend on alternative water sources, with the water brought through poly-pipes from different spring sources to their houses. Another 18% of the households, without PHED connections, are fully dependent on spring water transported through poly-pipes. This has been the situation in Singtam in recent years, though the water distribution system is being improved.

There is no system of water collection from a common public tap in Singtam; households either have PHED connections or get water through poly-pipes, or both. As reflected in FGDs, as an alternative solution for better-off households at Golitar 13 private bore-wells have been constructed for their domestic use. The Manipal Institute of Technology at Majhitar has installed around six bore-wells, while the majority of pharmaceutical companies in Sikkim have been drawing water through bore-wells. The Singtam Fruit Preservation factory has constructed two bore-wells and bottles mineral water.

Around 91% of the household respondents reflected that some homes have two municipal pipes, or get water for longer hours in comparison with other households in addition to a poly-pipe connected to springs. Seventy-four per cent of KIIs and 95% household respondents disclosed that almost all hotels, restaurants, and elite households have more than one PHED connection, apart from water brought from springs on poly-pipes. In terms of the frequency of water supply, it varies across the seasons and between households. Interestingly, KII informants were adamant about disclosing such a situation.

There is a growing water crisis – a result of the growing population, climatic changes, erratic rainfall, and earthquakes that damage spring supply infrastructure – in Singtam. Furthermore, the Ramphu–Singtam–Dikckhu highway area is dotted with 12 pharmaceutical companies, 3 hydropower projects, and other factories and industries. A majority of their working population resides in Singtam. Therefore, the water crisis in Singtam is going to increase manifold. Water scarcity is definitely a concern for 60% of the residents, with their water supply fluctuating sharply, from getting the PHED supply daily, to receiving it once in 2–3 days or even more infrequently during the dry season.

The respondents in the KIIs, FGDs, and household surveys reflected that Kalimpong, being a larger town than Singtam and set against political assertion/instability and unrest, has become a place where the people's need for water has been sidelined in the discourse around a larger community assertion of identity politics. Partly due to this, water supply has become problematic and households are forced to take up other alternative options (Figure 9). What is ideally stated to be the system of water distribution

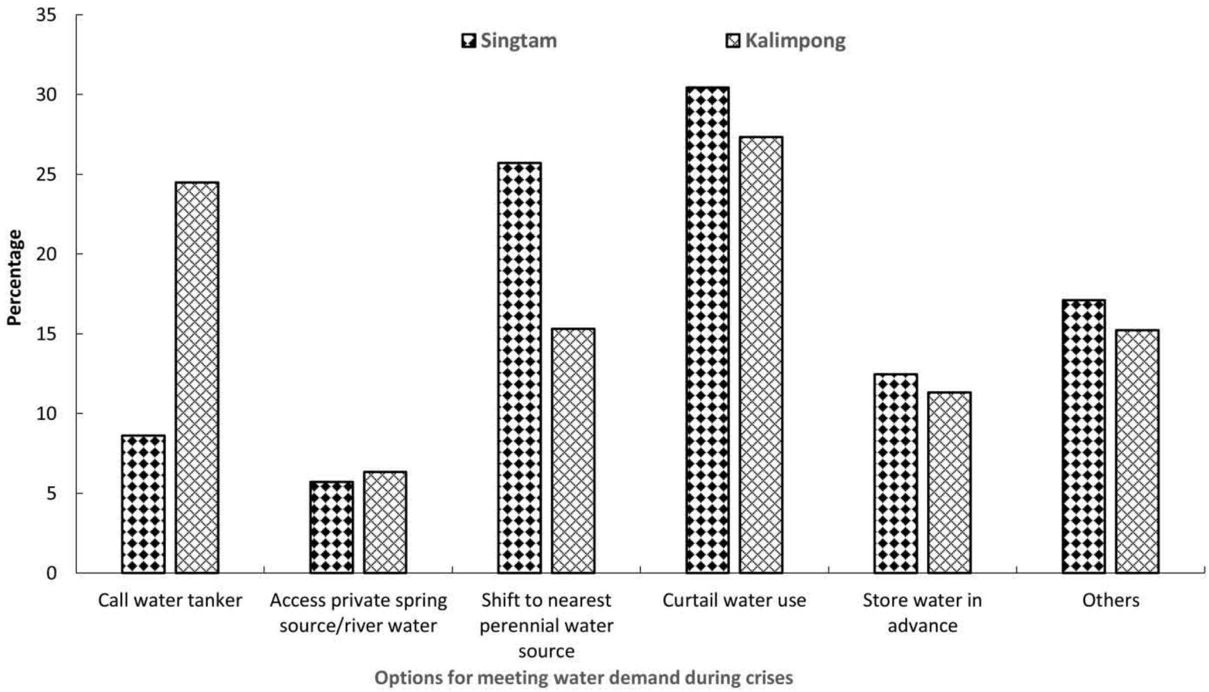


Fig. 9. Responses during water crises. *Source*: Authors' survey.

at the top levels of governance is not what trickles down to the household level, as was evident during the course of this research with FGDs and KIIs.

In the discourse around water distribution and supply in Kalimpong, different stakeholders present varied narratives, as was expected. The responses from the PHED and NWSMD officials were analysed and they stated that adequate water is supplied by them from the source to the water reservoir. A civil society group comprising concerned citizens also reiterated this view of adequate water being supplied to the municipality. However, all the household respondents reported that with outdated infrastructure and unplanned constructions, the PHED could not distribute water proportionately to all the locations and populations.

During FGDs and informal conversations during household surveys, people raised issues mainly related to poor governance and mismanaged water distribution. The main reasons household respondents of both the towns mentioned were lack of conservation, resulting in degradation due to development pressure (28%); increased demand for and overexploitation of sources (26.5%); land use change in spring catchments (24.5%); decreased rainfall and increased number of dry months (17%); and poor and inefficient water infrastructure (4%) (Table 5).

When we interacted with an elderly woman at Kalimpong about the current situation of water, she said ‘in olden days we had several spring sources nearby with sufficient water discharge, we had lush green forests all around and had uniform rainfall year round. These days population has remarkably increased, forests have been lost, climate is altered and water in the springs have also disappeared. Bad time is approaching.’

Kalimpong municipality comprises urban and peri-urban ward distribution. Households at peri-urban wards located away from the main roads restated the lack of municipal water connection. This is because pipelines have been cut due to poor infrastructure and the lack of planning processes. Additionally, like in Singtam, hotels, restaurants, and higher income households pay more money to get access to more water, thereby creating an imbalance and greater water shortages for people from marginalized groups and locations.

Households at Kalimpong also informed us that water supply is only around 30–40 litres per person per day, less than the per capita norm of 135 litres per day as set by the municipality. During critical moments of water scarcity, households manage to meet their water requirements through water tankers, private spring sources/river water, fetching water physically from distant springs, storing water in advance, or shifting to other perennial springs.

4.3. Health impacts due to poor water quality

According to Singtam’s residents, water supplied by PHED is mostly *ledo* (muddy) and *dhamilo* (turbid) during the monsoon, when they face problems of scarcity and poor water quality. The Singtam

Table 5. Responses on rising scarcity of water.

Indicators of water scarcity	Singtam	Kalimpong
Decrease in rainfall; increase in the number of dry months	20	14
Increased demand, overexploitation of spring sources	26	27
Poor and improper water infrastructure	5	3
Land use changes in spring catchments	24	25
Lack of conservation; degradation due to development pressure	25	31

District Hospital officials reflected that the presence of contaminants in the water has been affecting people's health adversely, including gastrointestinal illness, diarrhoea and vomiting, cholera, and dengue. The situation is yet to improve, as there is no functional water treatment plant for the storage tanks installed at Chisopani. They added that around 4,857 patients visited the hospital with diarrhoea during January–September 2018 (average 500 patients per month), confirming that water supply to the town is contaminated throughout the year. Cases of typhoid and contamination of coliform bacteria were found in the water in and around Singtam.

From our interaction with health officials, we know that water quality in Kalimpong too declines in the monsoon, and people face all the illnesses mentioned above, and also dysentery and the flu. Coliform bacteria were found in several sources of drinking water in Kalimpong. According to the Health Officer of the Civil Hospital at Kalimpong, the authorities had declared the water from these sources as unsafe for drinking, but acceptable for washing and other domestic purposes (Ravidas, 2012). The contaminated water in Kalimpong has increased the number of patients with bacterial infections such as typhoid, paratyphoid, cholera, bacillary dysentery, and amoebic dysentery.

4.4. Issues and challenges of water management

KII respondents argued that the key challenge Singtam faces is its floating population that is fast increasing due to the rapid industrialization along the Ramphu–Singtam–Dikchu stretch in the Teesta River basin and, therefore, water demand is going to increase manifold. Heavy traffic congestion, increasing air, water, and noise pollution, the incidence of waterborne diseases, and lack of proper management of sewerage are issues that need immediate attention. According to the KII, FGD, and household respondents, Singtam is soon going to face water shortages due to a planned road construction approved by the Sikkim government in the Lower Namphing forest, which supplies water to more than 110 households in the town, and hence it is anticipated that its supply will cease. The current water sources at Nazitam-Namphing were reported to be in a declining trend.

In the case of Kalimpong, KII respondents said that the current water supply system was designed and built around 65–80 years ago, and is incapable of catering to the needs of the increasing population of the present-day Kalimpong. Pipelines and storage tanks are not repaired periodically, and thus the feeder and supply pipes are rusted, twisted, and too weak to hold sufficient water. The water sources lack conservation and protection of their catchments. A modern metering system has not yet been established so as to maintain optimum water use efficiency and accountability and to avoid the illegal tapping that occurs at several places. There is a lack of regulation over water consumption. The town also lacks adequate water harvesting systems.

5. Governance, local bodies, and political priorities

5.1. Parallel governance vs. uniform governance

The FGD participants and KII respondents recounted that *andolan* (political unrest/movement) over the demand for Gorkhaland gained momentum again under a new political party, Gorkha Jan Mukti Morcha, and led to the formation of the Gorkhaland Territorial Administration (GTA) in 2012 in Darjeeling. The GTA has administrative, executive, and financial powers (but no legislative powers, which are vested in the Government of West Bengal). The system of parallel governance, i.e. control and authority over the same resource by both GTA and Kalimpong municipality, has resulted in a constant power struggle and mismanagement of the water supply system in Kalimpong. The constant conflict between the state government and GTA pushes issues and agendas of development and change into the background, and control and power take precedence. Transporting water from the source to the reservoir falls under the ambit of the state government. Subsequently, the distribution of water from the reservoir and to the different wards in Kalimpong falls under the PHED, which works with the local municipality. FGDs and KII revealed that this division of responsibility leads to miscommunication, with the two bodies often working in isolation, rather than in convergence. The two departments also blame each other for the shortage of water supply and scarcity. Comparably, household respondents argued that it is the local residents who suffer, as they do not know who is accountable for their grievances. Several areas do not have municipal water pipes, such as wards 15 and 17. Respondents and participants in FGDs said this was because of the *andolan* in the late 1980s, which, they say, led to the destruction of some of the water infrastructure, which was lost or sold by the agitating youth at the time.

KII respondents contemplated that in the situation of political unrest and growing unemployment in Kalimpong, the water shortage has also generated employment for many, as tank water suppliers, plumbers, and drivers. There exists a formal water market registered as the Kalimpong Water Supply Drivers' Welfare Association, which 'is operated, often in monopolistic ways, by water vendors and taxi drivers who work under the patronage of local political leaders' (Joshi, 2014). The supply of water has become less about citizens' daily needs but generates a new terrain of political tussle and control over it.

Comparatively, contrast is the system of governance in Singtam. The water distribution and supply systems have a decentralized approach involving the PHED and the Singtam Nagar Panchayat as per the FGDs and KIIs. Singtam is an example of uniform governance (close coordination and convergence), which operates from the government level (the PHED) to the local municipal level. Thus, the system of governance in Singtam ensured accountability, which in turn translated into more equitable water distribution, relatively regular water supply, and conflict management.

However, Singtam also has water issues; governance here is focused mainly on water supply, but it also needs to focus on policies that will cope and deal with the growing urban population, the drying of springs, and the occurrence of disasters such as landslides and earthquakes, which adversely affect water connections. Remarkably, there is a new system of private water supply, for meeting increasing demand at the households, largely unregulated poly-pipe water suppliers who are outsiders and do not own water sources. They are paid for hanging poly-pipes from the spring source to the households and monitoring the supply.

The water governance in the towns of Kalimpong and Singtam in Sikkim and West Bengal state of India shows complex socioecological dynamics with examples of cross-scalar policy challenges which particularly impact with increased environmental vulnerabilities. The policy responses failed to tackle escalating environmental and developmental challenges. It is, therefore, important to integrate approaches to address these challenges, emphasizing an emancipatory multi-scalar politics that has the potential to open up sustainable pathways in the context of dynamic social and ecological changes in the Himalayas (Satyal *et al.*, 2017).

6. Socioeconomic backgrounds and correlation with water distribution

6.1. Whose issue is it anyway?

Issues of access, water shortage, its distribution, and concerns surrounding it are directly related to the socioeconomic background of households. The purchasing power of households, or lack thereof, is central to water shortages and the water economy. The officially unmentioned water economy in the region often came up in FGDs, KIIs, and even in informal discussions. This was especially evident in Kalimpong. However, a study (Joshi, 2014) also states that access to water is 'highly differentiated and not only financial', but also influenced by a host of other intersecting disadvantages based on 'class, caste, ethnicity, and personal fortune in terms of marriage, life partners, and children'. Another major dynamic in the access to water is politics. Given the volatile political situation, local politicians have established strongholds in certain pockets and among certain groups of people, which influences the access to, and control of, resources.

Singtam is a compact urban town spread over a small area. People in Singtam mostly operate local businesses – shops, small restaurants, and canteens – or work in pharmaceutical factories and hydropower projects established along the Teesta River. A few of the migrants coming into the city are from rural areas of Sikkim. There are also an alarmingly increasing number of migrants from outside Sikkim, mostly from the plains of West Bengal, Bihar, and Uttar Pradesh.

6.2. Adaptation and coping

6.2.1. The growing water economy in Kalimpong and Singtam. During interviews and in FGDs, people said that those with high purchasing power in Kalimpong buy more than one pipeline with municipality water, and thus there is unregulated selling of water pipelines. Many residents spoke of a growing water economy, benefitting certain groups of people. It is said to work at all levels, from water tankers to local PHED sources. Many respondents blamed the inefficiency of the local government and specifically the role of plumbers working under the department. Buying a PHED line, it was said, costs roughly INR 20,000 or more. One such connection can supply water for about 20–30 minutes, daily during the monsoon, and once or twice a week during the dry seasons. However, several households had access to PHED water throughout the year, even during the dry season, as many households were capable of buying multiple PHED connections. Hence, although water shortage is a huge issue, the impacts of this shortage are felt by different households differently. During times of water shortage in Kalimpong, the most convenient option is calling for a tanker. Around 1,000 litres of water, the minimum amount of water that can be bought from tankers, costs INR 280–350. Even households that are unable to afford the tankers themselves access them by distributing the costs, and the water, among two or more households. Of the households surveyed, 36.6% admitted to calling for water tankers. However, it must be borne in mind that the households surveyed were largely from lower income groups, who are far more dependent on spring sources. Alternative sources, if any, may be available only to those with economic, social, and political resources. This leaves a high proportion of lower income households, migrants, and the slum population at a disadvantage. The fact that water can be bought by many is the primary reason why pressure has not been applied to political parties, governments, and policy-makers to implement sustainable solutions.

In Singtam, payment for water to private vendors and to the PHED started 5 years ago, although a metering system is yet to be introduced. Besides the special connection lines (with a continuous flow of water) provided to the district hospital and the fire brigade, some elite households have been given special lines, resulting in an unequal distribution of water by PHED. Those households with private poly-pipes pay around INR 1,000–1,500 per month per poly-pipe, depending on the distance and amount of water at the source. Unfortunately, and interestingly, the payment goes to illegal water vendors, mostly unskilled fitters from Islampur and other areas of West Bengal, who tap water from the forests and monitor supply to households.

This capacity of the better-off and dominant social groups to purchase extra water via PHED lines or tankers not only leaves a large section of the lower income population more vulnerable, but it also puts future generations at the risk of absolute water shortages.

6.2.2. Catering to the floating population. There is an increasing floating population (approximately 8,000–10,000 people) in Kalimpong, which is due to tourism and other businesses. Kalimpong derives much of its revenue from tourism. An important change in Kalimpong over the last 5–7 years has been the rise in homestays, new hotels, and restaurants attracting a new generation of tourists. The homestays are located in peri-urban areas as most of them are styled as local cottages and have spring sources of their own. Hotels and restaurants here cannot legally have PHED water connections as they are only meant for household residents. The representative from the hotels said that running a successful hotel in Kalimpong required about 10,000–12,000 litres of water every day, which is impossible to get out of a PHED line. Many of the hotels and restaurants located in the town deploy their own trucks to transport water for the sole purpose of running the establishment. Their owners are obliged to buy trucks, jeeps, petrol, and employ drivers and helpers. On average, about INR 0.63 million are spent a year by the hoteliers in Kalimpong municipality on getting water. The issue of the right to water becomes an issue of purchasing power.

Singtam has a floating population of over 6,000–7,000 persons per year, which is rapidly increasing, with 2,000–3,000 vehicles plying every day. Singtam is not a tourist destination, but a hub for industries, pharmaceutical companies, educational institutions, automobile workshops, factories, and hydropower projects established close by, all of which bring in a significant working population. People migrate here from all four districts of Sikkim, and even from neighbouring states, in search of employment. It also functions as a trading junction for Sikkim and is a business gateway for agricultural produce such as large cardamom, vegetables, and other cash crops. So the population in Singtam has always been ‘floating’ in nature and there is an increasing demand for water.

7. Lessons from Singtam

7.1. Micro-planning

Both Kalimpong and Singtam have to plan for their growing populations, ensure regular water supply systems from reliable sources, and carry out revival measures for the drying springs. But because of its small size, a uniform government, and active policies, Singtam can provide lessons to Kalimpong and other Himalayan towns on several counts. Solutions adopted locally can contribute towards meeting immediate water demands. Water shortage, though a critical issue, is not faced equitably by all households.

Hence, planning solutions should be done at the micro level, in order to ensure the inclusion of the major issues and shortcomings of the existing water system. Planning and policies passed at the state level based on urban planning may not be applicable or appropriate at the local level in hill towns. An example of this is the lack of communication between the state authorities and the GTA regarding Kalimpong.

Kalimpong's 23 wards face different issues regarding access to water. Some wards lack PHED pipelines, whereas some are more dependent on springs; all this needs to be taken into account. Singtam, being a smaller municipality with six compact wards, follows a more efficient form of water governance. Not just because of its smaller size, but also the proximity of the municipality to both local institutions and the state capital, Gangtok. Local representatives have access to higher levels of government. Micro-planning is, however, required to address the increasing migration and the growth of slums, which are the most vulnerable to water scarcity and policy marginalization.

7.2. Dhara Vikas and adaptive options to revive drying springs

The RMDD, Government of Sikkim, with its partners since 2008, TMI India, Advanced Centre for Water Resources Development and Management, Pune (ACWADAM), People's Science Institute, Dehradun, and WWF India developed an atlas of approximately 700 springs, and initiated *Dhara Vikas* in the dry areas of South and West district of Sikkim for reviving drying springs. The programme has provided a number of learning experiences that can be replicated in the other parts of the Himalaya. An important aspect of *Dhara Vikas* is that local communities are involved at the village level in convergence with the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA). Sharma *et al.* (2019) conducted a study in the Chibbo-Pashyor watershed (905–1,325 m) in Kalimpong for identifying drying springs for revival. A total of 12 out of 54 springs were identified for long-term monitoring; roughly 439 households in Chibbo-Pashyor villages depend on them (Sharma *et al.*, 2019).

8. Conclusion and ways forward

This study has focused on issues of demand and supply, water scarcity and stress, equity, water governance, and the sustainable conservation and management of water resources in a climate change context in two towns in the Eastern Himalaya, Singtam and Kalimpong. It finds that spring sources are drying in Singtam, and Kalimpong faces acute water shortages through the year. Springs, streams, and rivulets have provided water to these two towns for centuries. However, they are being gravely impacted by new stressors in the form of climate change and other anthropogenic pressures. These towns are also having to cope with a rising floating population of tourists and industrial workers.

The revival of traditional sources of water is extremely important for the sustainable conservation of water resources in the Himalayan context. In the recent past, the NITI Aayog, the NWP, and the NMSHE have all emphasized springshed development for the conservation and revival of declining springs. However, the benefits of these missions are yet to materialize on the ground in the Sikkim Himalayan region. The National Rural Drinking Water Programme Guidelines 2013 has mentioned that, by 2022, every rural person in the country would have access to 70 lpcd within their household premises or at a horizontal or vertical distance of not more than 50 m from their home. One hopes that this would benefit Kalimpong and Singtam.

The adoption of appropriate soil and water conservation practices on a watershed basis (*in situ* conservation, adopting soil conservation practices like contour bunding, terracing, construction of check dams, gully control structures, providing farm ponds, and digging trenches to collect rainwater and utilize it for supplemental irrigation) is considered to be the only way to control soil erosion and improve the environment in the catchments of the springs through successful springshed management activities. Over the past 10–15 years, safe and uninterrupted drinking water supply has become hard to find in Kalimpong due to the poor performance of water supply schemes, whereas the water supply and sanitation situation is continuously degrading even in Singtam. If governments at all levels seriously wish to counteract the plight of the urban populations and prepare for existing water-related vulnerabilities due to climate uncertainties, they will need to invest vigorously in expanding services to reduce the isolation of these towns from the main developmental agenda of the central government and the respective states. There is a need to promote coordination and cooperation among the concerned agencies, with targeted investments. The development of water security plans and their strict enforcement through multi-institutional collaboration can contribute to improved water governance and socioecological restoration for sustainable water resources management. Planning should be contextual, and a system of micro-planning is required in Kalimpong, Singtam, and other hill towns throughout the Himalaya.

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