



Problems and Challenges on Urban Water Management in Darjeeling Hill Town

Suvechha Ghatani^{1*}

¹*Department of Geography, Sikkim University, Gangtok, India.*

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/ARJASS/2021/v13i230209

Editor(s):

(1) Dr. G. N. Tanjina Hasnat, Patuakhali Science and Technology University, Bangladesh.

Reviewers:

(1) Yuri Sotero Bomfim Fraga, University of Brasília (UnB), Brazil.

(2) Ina Suryani, Universiti Malaysia Perlis, Malaysia.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/64589>

Original Research Article

Received 20 November 2020

Accepted 26 January 2021

Published 11 February 2021

ABSTRACT

Provision of basic services such as portable water and sanitation are vital for health and wellbeing of the society. The growing intensity of use of water in urban environment due to increasing urbanization and rapidly growing population has posed significant challenges for efficient water supply and conservation in many developing countries. Darjeeling town alike most of these developing countries struggle for the improved access of water for urban population. The urban dwellers in Darjeeling Town struggles for the improved access of water due to increasing urban population. The daily uncertainty and anxiety over the access to water has been a common sight to the people in urban Darjeeling hills. The rapidly growing urban population associated with the increasing demand for water has led to striking challenges in the management practice of water resources. Consequently, a huge imbalance has generated between the demand and supply of water in the town. The present study therefore attempts to explore the existing situation of water resources and discuss the issues and challenges around the management of water resources in the urban landscape of Darjeeling hills. The study revealed that the gradual introduction of developmental activities, faulty construction plans relating to water, political intrusion, poor governance system and lack of public awareness are some of the prominent factors for insufficient water supply and creating a situation of scarcity in Darjeeling.

Keywords: *Darjeeling Himalaya; urban water resource; water scarcity.*

*Corresponding author: Email: gsuvecha@yahoo.com;

1. INTRODUCTION

Water is the basic element that plays a significant role in our everyday life. All the dimensions of security in life like food and economic securities largely depend on water resources. Thus, the crucial importance of water in every aspect of the world makes it an essential component for international, national and local security. Still, a large number of human beings lack access to clean and safe drinking water. The problem of water shortage is predominantly experienced in the cities and towns due to rapid urbanization, especially in the developing countries as more and more people are trying to live in urban areas than in rural areas. Therefore, there has been a constant problem regarding the availability of safe drinking water to the onslaught inhabitants in urban areas. The share of the urban population in India has risen from 27.81 percent in 2001 to 31.16 percent in 2011 [1], which has led to the striking challenge in the management practice of water resources. Consequently, many local governments fail to provide their people with such basic needs of life, and access to clean and safe water relative to human demand has become one of the serious challenges faced by the people in the present times.

The Himalayas in the Indian context are perceived as an inexhaustible freshwater source. They are often referred to as natural 'water towers', highlighting their importance as a prominent water source for the arid and semi-arid lowlands, however, with little reference to water security in the mountains themselves. Only a small fraction of the streamflow is stored and consumed by the communities living in these mountains [2]. There are issues of springs drying up in many parts of the mountain due to lack of adequate recycling owing to changing rainfall patterns and catchment degradation. On the other hand, the increasing demand for water with the increasing population has added stress on water resources. The hill town of Darjeeling has no exception in this matter. Further, the hill towns of Darjeeling have a continuous floating population consisting of tourists visiting the place due to its scenic natural significance and pleasant climatic condition. This further increases the demand for water [3,4]. The increasing gap between the demand and supply of water for human consumption due to the rapidly increasing urban population has become a serious issue in Darjeeling. Everyday uncertainty and anxiety over access to safe and clean water is the common sight to the people in urban Darjeeling

hills. Besides, the subsequent failure of the planned effort made by the municipal water supply infrastructures and the government's inability to provide sufficient water to this hill station has made the problem more complex.

The study therefore has the following objectives:

- i. To assess the public water supply provision in Darjeeling town.
- ii. To identify the existing problems related to inadequate water supply in Darjeeling Town.

2. DARJEELING TOWN: AN OVERVIEW

The Himalayan town of Darjeeling is situated on the lower part of Darjeeling–Jalapahar ridge in the Siwalik Himalaya, located between 26° 31" and 27°31" North latitude and 87°59" and 88°53" East Longitude [5]. The region is located at an average elevation of 6,982 ft. (2128 m) in the Darjeeling district (Gorkhaland Territorial Administration region)¹ of West Bengal state. The name Darjeeling came from the Tibetan word where "dorje" meaning thunderbolt and "ling" is a space or land; hence Darjeeling means the land of thunderbolt. Due to its scenic natural beauty with snow-clad mountains, tea gardens and pleasant climatic conditions, Darjeeling is popularly known as the "Queen of hills".

Darjeeling Municipal Town represents one of the oldest municipalities in India, established by the British in 1850. The town covers an area of 10.75 sq. km. comprises 32 municipal wards with a total population of 1,20,414 people [1]. The town is also an administrative headquarters of the district and is the largest among all the hill towns situated in the district. The town receives an average annual rainfall of about 309.3 cm ranging amongst the highest in India. The average temperature in the town ranges between 16°C – 17°C during summer months and 5°C to 6°C during winter season. Further, the growth and development of hill town of Darjeeling was different from that of plains counterpart as these towns were predominantly built up by the British as sanitarium to relieve the British rulers from the heat of plains, predominantly selected for their own comfort and needs whereas the cities of plains have multi-functional values.

¹ Gorkha Territorial Administration is a semi-autonomous administrative body formed on August 2012 for Darjeeling hills of West Bengal State. It was replaced by Darjeeling Gorkha Hill Council formed in 1988 that administered Darjeeling hills for 23 years.

3. MATERIALS AND METHODS

The participation in everyday living in the Darjeeling being indigenous triggered the curiosity to investigate the unsolved issues of the water scarcity in Darjeeling hill towns. The paper attempts to comprehend the public water supply in Darjeeling town and identify some of the prominent problems faced while making urban water resource management in Darjeeling Municipal town. Primary and Secondary data sources were used to generate information for the study.

The primary data was collected through different ways. Based on the objectives of the study the household survey was conducted using a structured schedule in order to obtain individuals views and people's perception of water use and the management of water resources. An in-depth interview was conducted with the officials of Darjeeling Municipality, Waterworks Department Darjeeling Municipality and Public Health Engineering Department (PHED). They are chiefly associated with the operation and maintenance of water supply in the town. Therefore, discussion with the authorities associated with water supply and the perception of the residents provided a space to use qualitative as well as descriptive

method in the study. Moreover, to understand the role of institutions regarding the issues related to water crisis, direct observation was made by staying in the different locations in the area. The secondary data for the study was collected from the published and unpublished government documents such as annual reports of Darjeeling Municipality, reports of Public Health Engineering Department, Forest Department, District Statistical Handbooks 2010, 2011 and District Census Handbooks 2011. Further, additional information regarding the water resources of the region was also collected through different academic literatures, newspaper reports, etc.

4. WATER RESOURCES IN DARJEELING

Springs and streams are the major sources of drinking water in Darjeeling hills. The region of Darjeeling Himalaya is mainly characterized by high hills and deep valleys, and due to the higher relief and steeper gradient of the area, groundwater comes out as seepages and springs whenever the land surface intersects the local groundwater table [6]. Therefore, the region of Darjeeling has a good number of perennial and semi-perennial water bodies in the form of hilly springs. Hence, the water supply in the town

Location of Study Area

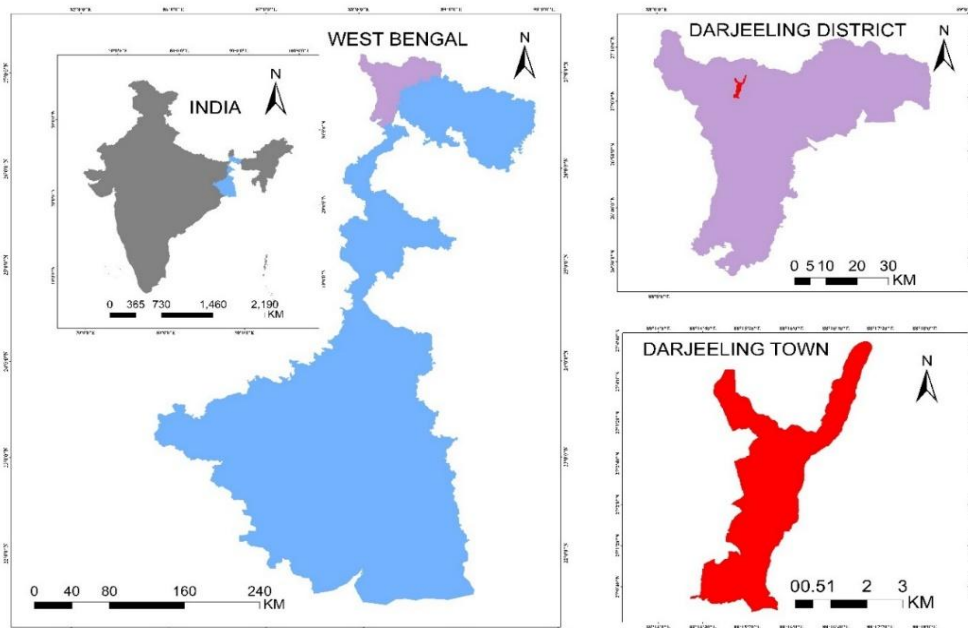


Fig. 1. Study area

largely depends upon these natural springs. Darjeeling hill is also mainly characterized as a high rainfall area with the region receiving an average annual rainfall of approximately 309.2 cm [7] which is the highest amongst the rates of annual rainfall in India. Therefore, natural precipitation is the primary source through which these springs are recharged. It is important to note that the rainy season is the predominant season in Darjeeling which occurs twice a year, once after the summer from mid-May to late-October and another in the winter which lasts from early-November to early-April [2]. July is the wettest month with the maximum number of rainy days.

Some of the major sources that facilitates drinking water supply in Darjeeling town are discussed below:

4.1 Sinchel Catchment Area

Springs and rivulets in the Sinchel range located at about 10.5 km southeast of Darjeeling town is the major source of water in the town. Hence, Sinchel wildlife sanctuary, located at an elevation of 7,000 to 8,000 ft (2134 to 2438 meter) above sea level, is the chief water harvesting area for the Municipal Water Supply (MWS) in Darjeeling. This sanctuary covers an area of 3,860 hectares, out of which the catchment area covers 1,060 hectares [8]. At present, 26 numbers of springs emerge from the northern and the southern part of Sinchel range. Water from these springs are collected in an arrestor tank and fed to the masonry conduit line (which is about 8 km in length) that brings water on gravity to the storage reservoir, namely North Sinchel lake and South Sinchel lake. These two lakes are of vital importance for municipal water supply in the town. The North Sinchel lake was constructed in 1910 and is located at an altitude of 7,444.50 ft above sea level. The lake has a capacity of holding 20 million gallons of water. The South Sinchel lake was constructed in 1932 with has a capacity of holding 13.5 million gallons of water [9]. These lakes were constructed during the colonial period to provide water to the small number of population (about 10,000 people) that thrived in the region during that period of time.

4.2 Sindhap Lake

It is another important source that provides water to the town. This lake was constructed by the Public Health Engineering Department (PHED) in the year 1978 to cope with the problem of water shortage in the town. Water in this lake is

pumped from Bangla Khola and Khong Khola, located in the close proximity of the lake and also from the springs located in the vicinity of the lake. It helps to provide additional water to the twin Sinchel lake during the dry period when the volume of water in the lake decreases. Therefore, this lake is usually operated only during the dry season. Sindhap lake is also located in the Sinchel range which has the capacity of holding 15 million gallons of water, but due to the poor quality of reservoir and several leakages, Sindhap lake fails to provide a satisfactory result. As per the municipality report, the lake in the present time can store only 50 percent of the water of its actual capacity.

4.3 Khong Khola

This is a small perennial river located near the town of Darjeeling. During the dry season, when the yields of springs are not sufficient to fill up the lakes to meet the demand of the people in the town, water is often pumped from Khong Khola to the Sinchel lake. According to the Municipality Report [8], about 75,000 gallons of water is pumped per day from the Khong Khola to Sinchel Lake mainly during the dry period.

4.4 Rambi Catchment Area

Apart from the three lakes located in the Sinchel catchment area, water from the Rambi catchment area is the other important source through which water is supplied to the town. It is located about 20 km away from the town. Rambi catchment area consists of streams like Rambi Khola, Kalikhola and other eleven natural springs through which water is provided to the town during dry seasons. About 70 to 80 gallons of water is pumped per day to the town from this area [8]. Thus, the Rambi catchment area is known as the other major lifeline after Sinchel for the people of Darjeeling that helps with additional water supply to the people.

4.5 Natural Springs located within the Municipal Area

Apart from the formal water supplied by the municipality through the pipe supply system, natural springs located within the town are the other major sources of water. There are more than 65 numbers of natural springs available within the Darjeeling municipal area. Although these perennial springs are located within the municipal boundaries yet, they do not fall within the purview of the municipality. Most of these springs are maintained and managed by the local

communities, i.e., *Samaj* located within the close boundary of springs. Further, the religious and social group also plays an important role in the management of these springs. These natural springs at an average serves about 20,000 gallons of water per day [8]. Some of the springs located within the municipal area are listed in Table 1.

5. EXISTING WATER SUPPLY AND DISTRIBUTION NETWORK SYSTEM

The existing water supply system of Darjeeling town was commissioned during the colonial period (1910-1915) and is entirely dependent upon the natural springs from the catchment area of Sinchel forest and wildlife sanctuary. At present, 26 natural springs from the Sinchel range serves as the major source of municipal water supply in the town. Water from these springs (26 in number) is tapped and collected in an arrestor tank that drains water through the masonry conduit line extending around 8 km. covering all the springs. According to the municipality report, the average discharge of water through the open conduit during the dry season is 14,000 gallons per hour, i.e., 3.36 lakh gallon per day and during the non-lean period, the average discharge through the open conduit is 80,000 gallons per hour or 9.2 lakh gallons per day [9].

Water from these conduit lines then flows down to the open reservoirs (Sinchel lake). The entire system of water supply from the collection, transmission, and distribution is done through gravity due to the high altitude and steep slope of the land. There are three storage lakes: North

lake (storage capacity of 20 MG); South lake (storage capacity of 13.5 MG); and Sindhap lake (Storage Capacity of 15 MG). However, due to seepage and leakage, the third lake (Sinchel lake) can hold only 50 percent of water of its actual capacity.

From these storage reservoirs, water is then directly discharged to the filter house located at Jorebonglow for purification, where filtration of water is done through five pressure filters, each having the capacity to filter 16,000 gallons of water per hour [9]. From the filter house, water is fed into St. Paul's and the Rockville tank through the main pipelines that have the capacity of holding 56,651 gallons and 58,012 gallons of water respectively [9]. From these reservoirs, water is then distributed over the town either directly through the reservoirs or through the subsidiary tanks distributed at different places of the town.

The existing water distribution system was originally constructed during the colonial period to meet the demand of about 10,000 population living in the town during that period. However, the population of the town at present time has increased to 1,20,414 in 2011 and with the beginning of tourist season the total population will be added by another 25 to 30 thousand of floating population, for which water must be provided. However, the town till today depends upon the two reservoirs and the old distribution system constructed for 10,000 people. According to the Darjeeling municipality record, the demand for water is 15 lakh gallons, but water availability for the public is just 5 lakh gallons. Hence, there is a wide gap between the demand and supply of water in the town [9].

Table 1. Location of some of the natural springs within Darjeeling municipal area

Sl. No	Spring	Elevation	Sl. No	Spring	Elevation
1	Bhote Dhara	1897m	14	Lal Dikhi	2035 m
2	Haridas Hatta	1947m	15	Giri Dhara	2006 m
3	Muldara	1911m	16	Police Dhara	1869 m
4	Jail Dhara	1908m	17	Dhara Gown	2055 m
5	Vineeta Gram Dhara	2157m	18	Naag Dhara	1918 m
6	Pul Dhara	1973m	19	Krishna Villa Dhara	2091 m
7	Nayabasti Dhara	1798m	20	Nimki Dara Dhara	2046 m
8	Victoria Falls Dhara	1984m	21	Rani Hitti	1977 m
9	Khalashidhura Dhara	2151m	22	Ghum Dhara	2246 m
10	Sunar Busty Dhara	2157m	23	Lebong Dhara	1800 m
11	Navin Gram Dhara	1911m	24	Jwarbusty Dhara	2064 m
12	Redrose Dhara	2081m	25	Rani Hitti 2	1984m
13.	Kholi Ghar	1911 m	26	Merry Villa Dhara	2091m

Source: Compilation from the field survey

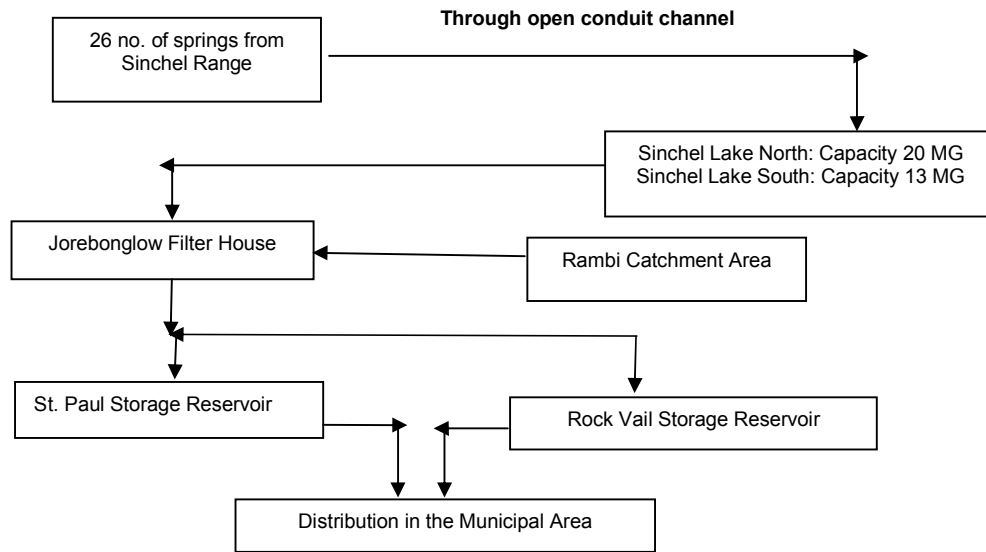


Fig. 2. Water distribution network of Darjeeling municipal town

Source: Constructed by author based on data acquired from, Darjeeling Municipality Report (2012)

Table 2. Calculation of average water demand and supply in the town

Parameters	Gallons/day
Total water storage capacity of reservoir (N. Sinchel lake, S. Sinchel Lake, Sindhap lake)	4.75 million gallons
Water production per day	8,50,000 gallons/day
Wastage (25 percent)	2,12,500 gallons/day
Net water available	6,37,500 gallons/day
Fixed supply (Army, Hospital, St. Paul School)	11,000 gallons/day
Water available for public	5,27500 gallons/day
Total demand of water	1,860,0000 gallons/day
Total water available	5,27500 gallons/day
Total deficit	13,32,500 gallons/day

Source: Darjeeling municipality annual report (2012)

6. RESULTS AND DISCUSSION

6.1 Challenges on Water Resource Management in Darjeeling Town

Despite the prominent natural endowment of the region and having its location on the high average rainfall region with an abundant number of springs, the availability of freshwater is in short supply in Darjeeling town. Irregular and insufficient access to water is one of the persistent challenges faced by the residents in the town. Insufficient and unreliable supply of water by the Municipality Water Supply Infrastructure in the town have compelled the people to look into the alternative sources so as to ensure that there is enough water at least for drinking purpose. Hence, buying of water from the private vendors have been the common

practice of people in the town. Due to high paucity of water, selling of water has become a profitable business in the town today. Water vendors are commonly seen in the area operating without any legal framework and this water business has provided employment opportunities to many unemployed youths of the town as this has become one of the easiest modes of earning.

Some of the prominent factors responsible for the scarcity of water in the towns are discussed below:

6.1.1 Rapid population growth

Darjeeling has experienced unprecedented growth in population and extensive urbanization of the town. The trend of urban concentration in

the town reveals that the population of the town has increased from 19,005 in 1911 to 57,603 in 1981 and 1, 20,414 in 2011 and the growth rate of population in the town had increased from 12.30 percent in 1991 to 34 percent in 1981 and 49.9 percent in 2001. Apart from the natural increase in population, rural to urban migration has encouraged an increase in the population of the town and there is a growing gap between the demand and supply of water. Thus, the physical and demographic growth of the town has posed a challenge for sustained water supply to the residents. This has also led to severe challenges upon the municipal water supply system to accommodate with efficient water supply service. As a result, people in Darjeeling experiences severe water problems even during the rainy season.

6.1.2 Old distribution system

About 95 percent of the distribution pipelines and valves in the town were laid during the colonial period (1910-15). Very little maintenance work has been taken up since then. However, most of the repair and restoration work has been done on a temporary basis only. The network has not been maintained properly from the time of installation, excluding some patchwork projects only, as a result, the large volume of water is wasted from the leakages of pipelines adversely affecting water supply. In some places, the cases are also seen where the broken pipes get mixed with the damaged sewerage lines running through the town, leading to severe contamination of water.

6.1.3 Illegal tapping of water

In addition to the old distribution system, which lowers the actual production of water supply, illegal tapping of water has further reduced and degraded the amount of water supply. It is the bitter truth of Darjeeling town that most of the

connecting pipelines are seen to be vandalized at various places from where the water is illegally tapped. Valves are often seen to be broken due to illegal tapping, mainly during the nighttime.

6.1.4 Shortage of storage tanks and reservoirs

Darjeeling has umpteen number of water resource in the form of springs and streams located within the town and its immediate surroundings, but due to an insufficient number of storage reservoirs, a large volume of water is wasted every day. According to the municipal report, 26 springs are tapped in the Sinchel catchment area for public water supply. However, during the rainy season, the collection of water from 8 springs becomes sufficient to fill up the existing reservoirs and the rest of the water has to be drained off into the nearby *Jhoras* due to the limited capacity of reservoirs. Similarly, there are several numbers of springs located within the town, but the absence of storage facility leads to heavy loss of water. Further, the absence of a water treatment facility is the other major factor adding up to water scarcity in Darjeeling. A large volume of wastewater runs through sewerage pipes, *Jhoras*, roadside drains every day, recycle and reuse of such water would have been helpful in checking the situation of scarcity, but the absence of facilities like recycling and reuse of wastewater has resulted in contamination of water and wastage of water in the long run.

6.1.5 Deforestation

The absence of proper planning such as land use planning or town planning has inspired unplanned growth of the town with haphazard constructions. This has encouraged illegal felling of trees in the region. The inflow of water from the springs of the Sinchel range has been gradually decreasing at an alarming rate due to

Table 3. Storage and distribution reservoirs in Darjeeling

Sl. No.	Storage reservoir	Capacity (in million gallon)
1	North Sinchel lake	20
2	South Sinchel lake	13.5
3	Sindhap lake	15
	Total	48.5
Distribution tank		Capacity (in gallon)
1	St. Paul Storage tank	2,35,812
2	Rock Vail tank	56,651
3	Rock Vail Masonry tank	58,012

Source: Darjeeling municipality office, 2014

the massive felling of trees in and around the sources. (Rasaily, 2014) [6] in relation to this stated, out of 3,860 hectares of the total area, approximately 770 hectares (18 percent) of the area was completely deforested in 1984 and it was further increased to about 50 percent by 1986. The degradation of Sinchel natural resources has a great impact on water harvesting capacity and water supply to Darjeeling. The rapid deforestation has led to the denudation of the hills and resulting to decrease in conduit discharge. This has become one of the serious reasons for the shortage of water in Darjeeling today.

In spite of the region being located in a volumetrically water-rich region, the authorities are finding it difficult to harness these resources so as to make them adequate for the people to drink. Some of the challenges pertaining to the efficient management of the available water resource in the town are discussed in the next section.

- **Limited institutional capacity:** The shortage of skilled manpower is one of the critical issues faced by the Darjeeling municipality. This is, in fact, one of the major limiting factors for attaining the desired service provision in the town. In addition to its inadequate equipment facilities and insufficient materials have added more problems in the proper management of water. Further, the municipality also suffers from a lack of long-term vision, strategy, and proper action plan to facilitate an efficient management system. These are some of the major constraints rendering proper management of water resources at the municipal level.
- **Inadequate budget:** Delivery of water supply requires a high level of investment. The existing amount generated by the municipality is not sufficient to meet the required demand; thus, lack of sufficient funding has limited the quantity and quality of water supplied at the municipal level in Darjeeling. It is mainly due to lack of adequate funds; several leakages are observed within the pipelines and left unchecked even when the scarcity is acute. Lack of effective funding has seriously hampered the management system. Further several projects concerning water management have been left incomplete in the town due to the

insufficiency of funds. Similarly, chlorination of drinking water in the filter house has been stopped in recent time, and filtration of water is done simply by adding bleaching powder, which is not adequate for proper filtration of water.

- **Absence of community participation in decision-making:** The decision-making process in terms of water management at the municipal level in Darjeeling is typically centralized and bureaucratic in nature. The participation of local people in the decision-making process relating to water management is almost absent or non-existent. Public participation in decision making is restricted until electing the representatives of ward councilors. The decisions are generally made by the people who own the majority in election; hence, the public opinion and suggestions are usually not entertained. This is the other major challenge relating to the proper management of water resources.

7. SUGGESTIONS FOR BETTER MANAGEMENT OF WATER RESOURCE DARJEELING TOWN

Recognizing water as a vital necessity for life, its management and conservation plays a crucial role in enabling the sustainable urban environment. Following interim suggestions may be considered productive for efficient and sustainable management of water in Darjeeling:

- There is a need for repair and renovation work for the improvement of an old and complicated water distribution system to make a uniform supply system.
- A large volume of water is wasted through drains, *Jhoras* and springs due to lack of proper harvesting system. Encouragement of rainwater harvesting and wastewater treatment plants would lead to proper conservation of water.
- In the case of Darjeeling, the development of plans and policies has always been in favor of those who own the power; hence, the management strategy implemented for water resources will not be sustainable as sustainable management of water resources depends upon the interest and participation of the citizen in a system. However, the involvement of the community and community-based organizations in the decision-making

process will help to bring the issues into people's hands and make them aware of the issues. This will help to make the system transparent and efficient.

- Development of a proper long-term plan keeping in view the rational utilization, protection, conservation and management of water resources based on community needs and enforcement of strict laws against illegal connection and misuse of water.
- The presence of responsive bureaucracy is of vital importance. However, in many cases, the plans and decisions made by the previous boards are often not followed or completely quashed with the changing political situation. Thus, bureaucrats ought to play an active role in ensuring that the previous projects and plans are not abandoned or affected by the prevailing political situation.
- It is essential to organize an awareness program in every ward by the municipality to educate the mass about the causes of degradation, depletion, and pollution of water resources and resultant threat and inspire the society about the importance of preservation, restoration, and rational use of their source.

8. CONCLUSION

From the above discussion, it can be analyzed that the region of Darjeeling has umpteen water resource in the form of rivers, streams and natural springs located within the town and its immediate surroundings. However, in spite of being located in such a volumetrically water-rich region, the town experiences acute water scarcity. The water resources in the Darjeeling has been severely stressed due to numerous detrimental anthropogenic activities that has disrupted the natural water recharging system and resulted in drying-up water sources. Further, the absence of proper management has added the problem to the situation of water scarcity, due to which a huge imbalance has generated between the demand and supply of water in the town. With the passage of time, the entire structure of the town has been changed with high raised buildings and haphazard construction of towns. Hence, the age-old distribution system has failed to cater to the demand of the rising population of the town. Further, lack of public awareness is also the other crucial reason leading to water scarcity in Darjeeling; for instance, most of the connecting pipes along the

roads are sometimes seen to be convincingly vandalized, from where people illegally tap water, not realizing that this will ultimately lead to more water scarcity. The pipes are sometimes left cut or broken for a long time without anyone caring to join them again, due to which large gallons of water gets wasted, causing a further shortage in the long run. Furthermore, we also noticed water overflowing from the water tanks of the houses. Therefore, scientific and long-term proper planning is needed for proper management and maintenance of the available water resource in the region.

ACKNOWLEDGEMENT

We thank the anonymous reviewers for their positive comments which improve the content of the manuscript; additionally Prof. E. N. Chifu is appreciated for continuous mentorship and extensive discussion on the subject.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Census of India; 2011. Available:http://www.censusindia.gov.in/2011-common/census_2011.html.
2. Shah R, Badiger S. Conundrum or paradox: deconstructing the spurious case of water scarcity in the Himalayan region through an institutional economics narrative, Water Policy Corrected Proof. 2018;1-16.
3. Mell IC, Sturzaker, J. Sustainable urban development in tightly constrained areas: a case study of Darjeeling, India. International Journal of Urban Sustainable Development. 2014;6(1):65-88.
4. Tamang Pravesh, Jana SK. Water scarcity in the hill town of Darjeeling: Effects on women's health. Intercontinental Journal of Human Resource Research Review. 2017;5(7):113-120.
5. Dozey ECA. Concise History of Darjeeling district since 1835. Siliguri: NL Publishers; 2011.
6. Guha RK, Kujur AR. Roof top rainwater conservation in Darjeeling town an option to mitigate the crisis of water supply-A case study of Raj Bhawan Darjeeling West Bengal. Bhu-Jal News Quarterly journal. 2009;24(1):85-90.

7. Drew G, Rai, PR. Water management in post-colonial Darjeeling: the promise and limits of decentralized resource provision. Asian Studies Review. 2016;40(3):321-339.
8. Rasaily DS. Darjeeling Paharka Nagarpalika Kshetra ko Vikash Ra Khane Pani Ko Itihas Sanchipta Ma, San.New Delhi. 2014;1835-2012
9. Waterworks Department, Darjeeling Municipality. A report on water supply system of Darjeeling Municipal Area, India: Darjeeling Municipality; 2012.

© 2021 Ghatani; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/64589>