Water Poverty in Kalimpong District of West Bengal: A comparative study of urban and rural areas

A Dissertation Submitted

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Submitted By

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DECLARATION

I, **Nimesh Diyali**, hereby declare that the research work embodied in the dissertation titled **"Water Poverty in Kalimpong District of West Bengal: A comparative study of urban and rural areas"** submitted to Sikkim University for the award degree of Master of Philosophy, is my original work and it has not been submitted earlier to this or any other University for any degree.

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CERTIFICATE

This is to certify that the dissertation titled **"Water Poverty in Kalimpong District of West Bengal: A comparative study of urban and rural areas"** submitted to Sikkim University for the partial fulfilment of the degree of **Master of Philosophy** in the **Department of Economics**, embodies the result of *bonafide* research work carried out by **Nimesh Diyali** under our guidance and supervision. No part of the thesis has been submitted for any other degree, diploma, associateship and fellowship.

All the assistance and the help received during the course of investigation have been duly acknowledge by him.

We recommend that the dissertation be placed before the examiner(s) for evaluation.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES/CHARTS

LIST OF MAPS

ABBERVIATIONS

CDB	Community Development Blocks
BDO	Block Development Officers
GP	Gram Panchayats
ST	Scheduled Tribes
SC	Scheduled Caste
OBC	Other Backward Classes
FC	Forward Caste
ICDS	Integrated Child Development Service
SHG	Self Help Groups
PHE	Public Health Engineering
DGHC	Darjeeling Gorkha Hill Council
GTA	Gorkhaland Territorial Administration
M	Municipality
RWS	Rural Water Supply
NGO	Non-Governmental Organization
CPR	Common Property Resource
PPR	Private Property Resource
RMDD	Rural Management & Development Department
WWD	Water Works Department
Mg	Million gallons
CI pipes	Cast Iron pipes
DPR	Detailed Project Report
lpd	Liters per person per day
WPI	Water Poverty Index
WPI_i^{AM}	Water Poverty Index for area 'i' using simple Weighted Arithmetic Mean Method
WPI_i^{GM}	Water Poverty Index for area 'i' using simple Weighted Geometric Mean Method
HDI	Human Development Index
HDII	Human Development Indices and Indicators
HS	Higher Secondary

CHAPTER 1

INTRODUCTION

1.1. Introduction to Water Issues in the recent period

The environment is an all-encompassing concept that incorporates both living and non-living elements of planet earth. Human activity in general and economic activity, in particular, has a decisive impact on the environment.

Water is becoming more widely recognized as one of the most important and seriously stressed resources, and there is a lot of emphasis on worldwide stress on water and the poorest people's water needs. The United Nations World Summit on Sustainable Development was held in Johannesburg in September 2002, was probably the most recent international event to draw attention to these issues. Reaffirmation of the Millennium Development goals by the United Nations was one of the critical outcomes of that meeting, particularly goal number 7, "Ensure environmental sustainability," for which one indicator was the number of people who do not have access to clean drinking water. However, goal number 1 of Millennium Development goals is also essential to "Eradicate extreme poverty and hunger" as water is the fundamental basis of life and poverty cannot be eradicated without access to water (Sullivan et al., 2003).

As water is an extremely important commodity for survival of living species including humans and plants. Hence use value of water is very high. But its exchange value tends to be low. It does demonstrate the Water Diamond paradox. People often view that packed bottled water is safe and clean rather than piped water; hence, bottled water has an exchange value since safe or clean water is scarce, so scarcity value is paid. The availability of water and its quality is also an essential factor in determining its exchange value.

Water is the most vital economic input for most economic activities. Hence, to understand water's importance, World Water Day is observed on March 22 every year by the United Nations. Each country has to adopt the WASH (Clean Water, Sanitation and Hygiene) policies to manage freshwater resources. According to the Sustainable Development Goals (SDG), 17 targets are set to change our environment for all countries to concentrate on water problems. SDG target No. 6 talks about clean water and sanitation as the first six goals, including poverty eradication, zero hunger, nutritional health and well-being, better education, gender equity, and safe water and sanitation, are really relevant and inextricably connected.

In our constitution, Article 246's seventh schedule consists of three lists of subject matters: (i) Union List, (ii) Concurrent List, and (iii) State List. Entry 17 in State List talks about water, irrigation, and canal, water development and storage are a state subject. There are different tribunals set up in India after 1956. Inter-State River Water Disputes (ISRWD) was set up in 1956 to handle river water dispute issues because India's cities are running out of water. In cities like Chennai, there was acute water scarcity where there was no drinking water for people. Such shortage of water raises questions on the issue of water governance? Especially rural areas of India have lots of water problems than urban areas, so there is an urgent need for water management policies. According to NITI Aayog's 2018 report, groundwater shortage is expected in 21 cities by 2020, so cities have to plan water resource management strategies through institutional accountability. Central Water Commission and Indian Space Research Organization (ISRO) said India is in a "water-stressed condition," which means per capita water availability decreases due to rapid urbanization.

Water in hill regions is becoming increasingly scarce. The problem is becoming worse as water demand increases and population expansion, urbanization, and household use increase. It is therefore essential to understand whether individuals or households have access to sufficient water for survival. Questions about equitable water distribution because water is necessary as water is increasingly getting scarce today than before. Many individuals or households still suffer from a lack of access leading to water-based inequalities. Public ownership increases access to all compared to private tanker-based water supply, which only caters to wealthy households backed by ample purchasing power. Market-based allocation will further exclude poor and resource-less individuals increasing water inequalities. Also, since water resources like springs are publicly owned, individuals or households tend to overuse them. This shows the growing dilemma we face as our water demand outstrips supply.

Moreover, water scarcity has various physical, economic, managerial, institutional, and political (Mollinga, 2003). Sen (1983) said that poverty is when people cannot meet at least one basic need in life.

Similarly, water poverty is a situation where people are unable to meet their basic water needs. So water poverty is more inclusive, and border analysis of water scarcity includes not only physical water scarcity but also socio-economic factors and demographic factors of water scarcity in a multidimensional sense

1.2. Review of Literature

The fact that people don't have water today is a result of the past decision. Due to the increasing realization of water poverty, water conservation has become an essential issue for sustainable development. As a result, policymakers are paying more attention to water challenges in water-poor regions today. Several studies have been done on this issue, and the results of some of these studies are summarized below:

1.2.1. Concept of Sustainable Development

Gleick (1998) talks on the sustainable and equitable allocation of water for adequate water supply management to secure future generations' interests, and political support for sustained development is much needed.

Brien (2002) sustainable development is the integration of the environment, society, and economy, maintaining a balance between them. The sustainable development concept is applicable across all disciplines.

1.2.2. Impact of Socio – Economic Factors on Willingness to Pay (WTP) for Water

Anand (2001) shows that the higher the incomes, the more expenditure on improving water quality tends to be high and that health expenditure on the water is not considered. Roy (2004) focused on improving the water quality in the city of Kolkata and how much the people in the city were willing to bear to improve the quality of the water through a willingness to pay for an economic valuation concept. It was observed that socioeconomic factors significantly impacted WTP and WTP, which was not related to family size. Sattar (2008) estimated willingness to pay for a safe drinking water supply. Collected primary data from Hyderabad City (Pakistan) for study purposes. Results showed that female education had more effect than male education. Education has a greater impact on the willingness to pay among the many variables taken. Lohano (2014) found that poor water infrastructure due to low revenue from water bills is the cause for inadequate access to clean drinking water. Improved water supplies contribute to higher service costs; willingness to pay is seen through a contingent valuation process. High WTP was observed, and household income played a significant role. Jung et al. (2015) used the Contingent Valuation Method (CVM) to achieve the willingness to pay for renewable energy and recognize its worth. They found that education has a negative impact on willingness to pay.

WTP is pricing, but pricing may favour the rich. It does not consider water access to people who don't have enough income leading to the unjust distribution of water resources. So WTP does not address distribution side questions. So it raises questions on the viability and desirability of market-based solutions on the issue of water problems.

Drummond (2001) observes that willingness to pay (WTP) depends on the way the questionnaire is prepared, where Escudero (2009) views the WTP as restricted only to some studies and people who are affected who usually state high WTP. Often hypothetical WTP and actual WTP do not match. Also, WTP results are not comparable within regions, so that no comparison studies can be done. It is also challenging to find WTP for services rendered.

1.2.3. Water Resources and Community Participation

According to Hardin (1968), population rise may lead to severe problems in the future. How can common resources be distributed due to their scarcity? Either sell it to private hands, owned publically, sell them through auctions and stand in queues to get it. Water conservation could be encouraged through a tax system.

Widstrand's (1989) study focuses on managing the available water resources, i.e., demand-side management. The author points out that population growth is the reason for water scarcity. Growing population and limited water create the problem of proper management. Rijsberman (2004) focuses on physical water shortage (supply side), or water is available but not used in a better way (demand side). Water scarcity may be due to no proper water service, or also, people might not have the financial support to get it. Due to urbanization and industrialization, people lack access to safe and affordable water use. Also, there still exist regions which are "economically water stress" where no investment in water infrastructure were made to meet people's water needs, often there are conflicts due to water scarcity between users on the allocation of limited water, so there must be demand-side management rather than supply-side management. Lohano (2014) also argues that the lack of access to safe drinking water in Karachi City, Pakistan, is due to an increase in population, increasing demand for water. Similarly, Sherpa (2017) points out that the water shortage in Darjeeling is due to population growth and also to faulty human practices that overburden water resources.

Streeten (1994) talks about why human development should occur as human development is end, while economic growth is a means of achieving that end. Human development is increasing labour productivity. As human development takes place, population growth is being monitored. Human development is beneficial to the physical environment.

1.2.4. Water Resource Management: Institutional role

Anand (2001) examined the scarcity problem in Chennai and how individuals and institutions look at scarcity. He finds that government decisions to improve the water situation depend on several factors, mainly election motive, projects, capture power. Zehnder (2003) views water pricing in irrigation alone does not promote its conservation. Other institutional actions are necessary for the preservation of water in agriculture. Cairncross (2003) highlights that water supply utility is a natural monopoly. If water supplies are privatized poor would badly suffer as a result of their low incomes such that water services can be looked after by the government as in the USA. Dhanju (2012) suggests a hybrid water management system where the state controls and supplies water and different institutions for efficient functioning, which was possible decentralization of power. Badiger (2018) notices plenty of rainfall in the eastern Himalayan areas, so there is no scarcity issue. The scarcity problem is due to the lack of proper management by water institutions, so this is the case of institutional failure. Chakraborty (2018) concluded that in Darjeeling, due to management problems in institutions, water mafia (informal water sector) and many illegal immigrants from Nepal who bring water to cope with water shortages have arisen, so that both formal and informal institutions can work together. Agrawal (2019) observed that since water is scarce in Uttrakhand and is only available via springs, efforts to be made by water institutions to transfer water from surplus springs to deficit springs by gravitational force can continue for irrigation and horticulture purposes.

Sharma (2020) finds bad water governance in Kalimpong due to lack of engagement of residents, not community engagement. However, Singtam has initiated a spring management programme, "*Dhara* Vikas", in 2008. Pradhan (2020) examined water insecurity in the Kathmandu Valley and concluded that cooperation between local communities was essential in placing pressure on local authorities to resolve water insecurity.

Whereas, Cairncross (2003) claim that water institutions poor management is a myth where the growth and development of water services rely on governance at both the national and local levels.

1.2.5. Time allocation and Water access

According to Vickery (1997), households vary in their time, services and wealth from their assets, especially women-headed families who spend maximum time in non – market activities. Gustafsson (2003) women are the key players in water management, should frame policies to focus on women as "active participants" rather than "passive participants".

Memis (2010) considers inequality between households in terms of their time resources as unpaid services in some developing countries include water and fuel processing activities, for which market alternatives do not usually exist or can be identified. Elfarouk (2014) to make women aware of and increase their roles in water management. Jones (2016) points out that community members are more concerned with their natural resources than any other outsider, so there is a need for community participation where gender is a significant consideration for involvement.

1.2.6. Water Poverty & Water Poverty Index

Chettri (2018) views that improper water management has led to commercialization and privatization of water resources leading to unequal water distribution. Commercialization of water resources has forced urban poor to wait for a long time in the queue to collect water from sources which has given rise to water poverty. Chakraborty (2018) finds that the water problem strongly connects to school dropout rates and the late arrival of children in schools and colleges. Sullivan (2001) finds that development is not successful because of water issues in many areas where the demand for water and the supply of water are out of balance to meet basic human needs, leading to a lack of time to get water from faraway places women. The water available for consumption must also be connected to physical and socioeconomic conditions to recognize water scarcity for which the water poverty index (WPI) is designed. Lawrence (2002) uses WPI to show water situation, water shortages and how socioeconomic factors impact water supply in 140 countries and finds a relatively positive association between WPI and the Human Development Index (HDI), where HDI accounts for 65% of WPI variations and a strong correlation between access and capability, they also point out the importance of geographical variation in water. Opio (2010) using the data collection for 147 countries and using only capacity and environment variables. It was observed that this was more cost-effective, and no information was lost. There was a strong positive and negative correlation of the above two variables with HDI and the Human Poverty Index. Regan (2004) uses WPI and GIS poverty mapping for effective management strategies to strengthen South Africa's municipal district's water situation. Meigh (2006), owing to population growth and lack of equality between demand and supply, a big water management problem has emerged to make policymakers' work more straightforward. WPI has been developed and implemented at various levels, including community, catchment, district and national, and has proved to be a satisfactory index.

Jielin (2011) tried to study water poverty reasons that could help handle water resources effectively in various provinces of China. For this purpose, a balanced approach in which each component of WPI has been given equal weights.

Vyver (2015) states that if demand is more than supply in a particular country, it is known as a water-stress country. WPI scores were calculated in three different South African towns and found that the capacity component has the lowest value despite giving more weight and concluded that education capacity, mainly primary education, can positively impact capacity components and increase WPI scores.

Sudha (2017) used WPI to show water status in Vellore district, Tamil Nadu; due to urbanization, the five components' scores were high for resource and low for the environment.

Chenoweth (2002) water scarcity is connected to availability, which contributes to a rise in water prices, which means that water supplies are costlier, increasing both average and marginal water costs. Steyl (2003) examined how water stress countries were where there was an actual water shortage and also the social and economic side. South Africa, Tanzania and Sri Lanka were the countries picked. Four communities were selected from each nation (two rural and two urban), while communities were selected based on geographical distances. It was shown how water poverty these countries were for this purpose, WPI was used. Communities in Sri Lanka were relatively water-poor with low WPI values compared with those in other countries. Jonsson (2013), the study of end-users and stakeholders was focused on a group in Madhya Pradesh, India, where a participatory process was carried out. Various WPI components were used and carried out exercises between members of the community and government officials. Access, ability, and environment were essential components for women and access, environment and use for men. According to Shrestha (2020), water conservation has become an important issue because of its limited availability and growing demand. Water stress or crises have been estimated and measured for 27 districts of the Koshi River Basin, Nepal, as Nepal had inadequate drinking water supply systems. The method used was WPI, which choose 12 indicators for five components based on the local condition and the availability of data. Resource had the lowest score among indexes followed by Capacity, then Environment, Use and finally Access. Kathmandu and Bhaktapur, urban areas in the Koshi Basin, had the lowest WPI scores indicating high water crises in these areas compared to other districts.

Mollinga (2003) ask what water poverty indicators are and how to measure them. Water poverty is dynamic, with many scarcity dimensions, including physical scarcity, economic scarcity, managerial scarcity, institutional scarcity and political scarcity. Gleick (1996) identify basic water requirements to satisfy basic human needs, such as drinking water, hygiene, sanitation and food requirements. The minimum water demand for individuals is 50 litres per person per day, where engagement by the government and institutions is necessary to meet this minimum requirement. Many studies have shown that lack of access to sanitation could lead to major water-related illness due to lack of sanitation. Koppen (2006) IWRM can help alleviate water poverty in developing countries such as India how water institutions can help manage water affairs by managing water demands. Countries' high HDI-value means less water poverty. Also, 80 percent of India's rural households manage their water from ponds, lakes, etc. or informal sectors and 75 percent of urban households have a formal water connection. In western or affluent countries or cultures, IWRM performs well than in poor ones. IWRM works better in modern or rich countries or societies rather than poor ones. IWRM focuses on community involvement in "make water everybody's business" The time needed to collect water increases with population growth, particularly in developing countries.

1.3. Rationale of the Study

It has been found that many studies have focused on water scarcity at both the national and international level. Still, there are hardly or almost no studies of water poverty in hills (mainly rural areas) that consider various aspects of water scarcity.

This research focuses on analyzing water poverty in rural and urban areas of the Kalimpong district, West Bengal. There can be various reasons for water poverty which may include insufficient sources of water supply, population growth, improper distribution, lack of access to sanitation, lack of access to clean water, water quality, water stress and so on. These issues are not appropriately studied for hill regions. Hence, Kalimpong district will be my study area as it is located in a hilly region. The study is regional.

The study's focus would be micro – nature where households water problems will be analyzed rather than entire district water concerns, i.e. macro nature. Most of the studies are macro – nature, i.e. country-level based on secondary data. But this study is at the primary level and want to study community-level water poverty because a macro study cannot give an idea about location-specific problems. The construction of such an index will provide a better understanding of water poverty issues at the local level. This index would be valid for a particular location or area; due to the limited sampling size, the findings cannot be generalized. However, this study may be an initial start in this field.

1.4. Research Objectives

1. To study the nature and distribution of water in the district.

2. To understand water poverty issues in rural and urban areas of the district.

3. To analyze water related disease in the district.

4. To understand policies to eradicate water poverty in the district.

1.5. Research Questions

1. Why is water distribution system in Kalimpong District characterized by more inequality?

2. What factors/variables affect water poverty in rural and urban areas of the district?

3. What are water related disease in the district?

4. What policies can be formulated to remove water poverty in the district?

1.6. Research Hypotheses

1. There is no equal water distribution in the district.

2. Water poverty in urban and rural areas do not differ significantly.

1.7. Methods

The data for this study was collected from both primary sources and secondary sources.

The primary data for this study was obtained via a household schedule, collecting information from different departments/municipality and meeting different local community/*samaj* members. The schedule consisted of the following five parts: (i) Part 1: Socio – Economic and Demographic Characteristics of the household. (ii) Part 2: Housing condition (iii) Part 3: Water Usage (iv) Part 4: General Information (v) Part 5: Water related health problems.

The secondary data for this study was obtained via reports of Municipality, Water Departments, District Census handbook (Census,2011), Concepts and Definitions (National Sample Survey Organization), Drinking Water, Sanitation, Hygiene and Housing Condition in India (NSS 76th Round July 2018 – December 2018), Ministry of Housing and Urban Affairs, Socio Economic and Caste Census 2011, West Bengal Board of Secondary Education, West Bengal Council of Higher Secondary Education, Tourism department (GTA) and Save the hills.

Household scheduled survey was carried out in rural and urban areas of Kalimpong District covering 60 rural households and 60 urban households so a total of 120 sample households. Stratified random sampling was used to select rural and urban areas with equal number of sample households. Within stratified random sampling a simple random sampling was done to select sample households.

Urban area includes all areas covered by the Municipality and Rural area includes all areas covered by Development Blocks and not by the Municipality (Concepts and Definitions used by NSSO). Urban area selected for study purpose was Kalimpong Town/Municipality and Rural area selected for the study purpose was Kalimpong – I i.e. Block – I villages.

1.7.1. Definitions used for the Study

1. **Household:** Household is a group of people living together and taking food from a common kitchen.

2. **Size of the households:** It is the total number of household members.

3. **Household head:** The member responsible for management of the household who may not be earning member usually head of the household is an aged and experienced member. However, members of the households decided the head.

4. **Household Social Group:** A household is classified as Scheduled Tribe (ST), Scheduled Caste (SC), Other Backward Classes (OBC) and Forward Caste (FC) if all the members of the household or at least household head belong to any social group.

5. **Educational Qualification:** The highest completed qualification of a member.

6. **Dwelling unit:** Accommodation used by a household for residential purpose. It consists of living rooms.

7. **Type of house:**

(i) **Pucca house:** A house whose walls and roofs were made of solid materials like cement, bricks, stones, cement plastered reeds, tiles, metal sheets etc.

(ii) **Katcha house:** A house whose walls and roofs were made of non – solid materials like unburnt bricks, mud, bamboo etc.

8. **Type of toilet/latrine used by the household:**

(i) **Flush latrine (sewerage system):** The system which collects human waste and removes them through pipes from household environment.

(ii) **Septic tank latrine:** The system which collects human waste in a tank underground.

9. **Monthly household expenditure (in RS):** Total expenditure on all goods and services made by the household monthly.

10. **Major sources of drinking water:** Different sources from where households receive or gets drinking water.

11. **Common Property Resources (CPRs):** CPRs are resources which are accessible with no individual or community having exclusive property rights such as springs or *dhara*. However, even if an individual or community have exclusive property right i.e. Private Property Resources (PPRs) but is used as a common resource the such PPRs are also considered as CPRs.

1.7.2. Statistical Methods used in the study are as follows

1. The trend in the responses of the households in regard to the questions asked has been shown using descriptive statistics. Different tables, charts, bar diagrams, pie diagrams have been used for representing and analyzing data.

2. In order to have a comparative study of water poverty in rural and urban areas of the Kalimpong district Water Poverty Index (WPI) following (Sullivan, 2003) was used. WPI has been used in many international studies but has been hardly used in case of India. Caroline Sullivan, Peter Lawrence and Jeremy Meigh are credited for development of concept of WPI. The index's value ranges between 0 to 1 or 0 to 100 scale.

(Sullivan, 2001) WPI will contribute to equitable allocation of resources, considering both the demand and supply side issues. (Lawrence et al., 2002) WPI guides water institutions for better governance and WPI also captures water poverty based on geographical variations. (Shrestha, 2020) WPI is important in understanding what factors lead to water poverty.

1.8. Structure of the Dissertation

This study is structured into five chapters. Chapter 2 describes the study area briefly and highlights the water situation in the study area. Chapter 3 shows the Socio – economic and demographic characteristics of households in the study area and their Water consumption pattern, dependency on CPRs, dependency on Water Vendors, Health problems related to water and water consumption across Social Category. Chapter 4 discusses WPI methodology, data sources, equations used in this study and

WPI calculation for rural areas, urban areas and district in detail. This chapter also focuses on sensitivity analysis to check robustness of the results obtained.

Lastly, chapter 5 summarizes the major research findings, limitations of the research and some policy recommendations.

CHPATER 2

DESCRIPTION OF THE STUDY AREA

2.1. Introduction

The word 'Kalim' means the minister of the King and 'pong' means the stronghold, hence the minister of the King's stronghold. It is often referred to by the Hill people as 'kalibong' or the black spur. 'Kalipong' stands for 'Kaulim' in the local dialect, which is a fibrous plant that in this area grows in abundance. The meaning that has found the greatest favour, though is the Lepcha meaning of the name,' the ridge where we play'. These local tribesmen are said to have used field sports to coordinate when not engaged in agricultural pursuits, hence the name.

Kalimpong enjoys the best climate in the country at an altitude of 1,250 meters (4,100 ft.). Golden oak forests are heavily forested, with moss and linchen, provide a perfect environment for leisurely walks in dense cushions of russet – brown leaves. One comes to this hill town for peaceful and relaxed holiday and to be pampered by the bounties of nature. Kalimpong is a bloom of colours during the year due to the abundance of its spectacular flora. In particular, the orchids and cacti of this area are famous for their endless variety as well as their delicate colours.

Kalimpong's most significant economic contributor is tourism. Kalimpong is one of India's big ginger growing regions. Together, Kalimpong and Sikkim account for 15% of the ginger produced in India. Darjeeling's tea is well-known all over the world, where most of the tea gardens are on the west side of the Teesta river, so tea gardens near Kalimpong contribute 4% of the region's total tea production. 90% of the land in Kalimpong is cultivable of which only 10% is used for production of tea. The education sector, with students from Sikkim, Bhutan, Nepal, Bangladesh, is a big contributor to Kalimpong's economy. Sales of traditional arts and crafts, wood carvings, bags and purses with tapestry work are also small contributors to the economy.

Table no. 2.1: Physical Aspects of Kalimpong district

1. Area	408 sq. km
2. Altitude	1250 meters (4100 ft.)
3. Location	27.06^0 north latitude 88.47^0 south longitude
4. Climate	Summer: Max 27^0 C, Min 15^0 C Winter: Max 15^0 C, Min 4^0 C Rainfall: 220 mm annually Best season: March to Mid – June & September to December
5. Clothing Required	Tropical in summer and light woolens in winter.
6. Languages spoken	Nepali, English, Hindi, Bengali and Tibetan

Source: Tourism department, Kalimpong.

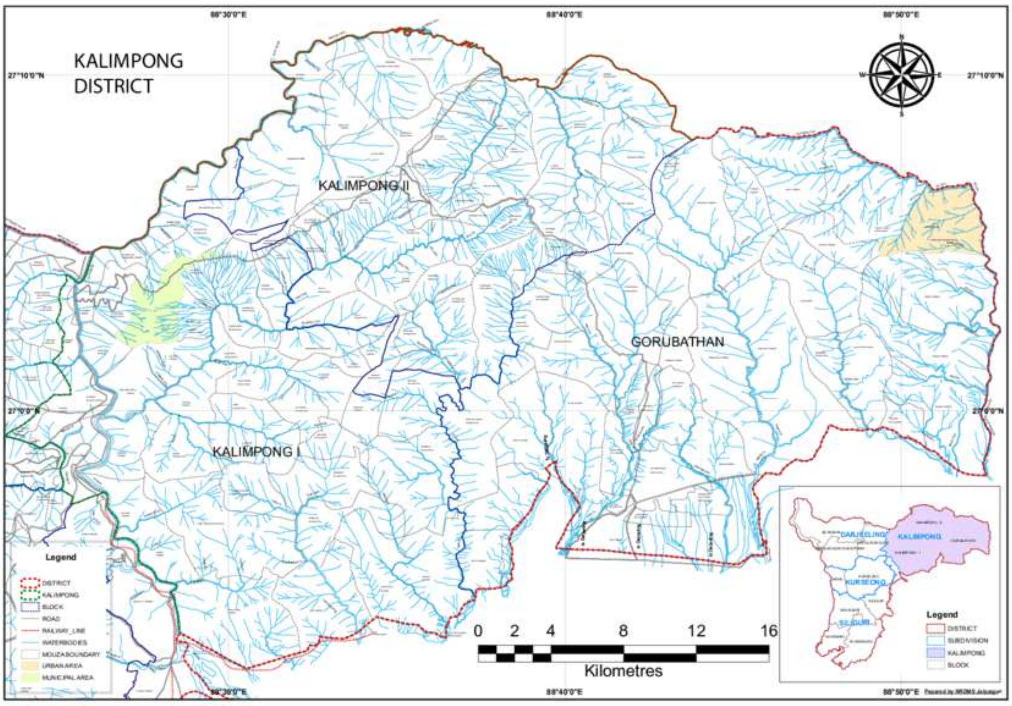
Until 2017, Kalimpong was a sub – division in the district of Darjeeling under the State of West Bengal. Kalimpong was declared the 21st district of West Bengal, India, in order to strengthen the delivery of services to the people on 14th February 2017. Kalimpong District consists of 23 wards of Kalimpong Municipality/Town and three community development blocks namely, Kalimpong – I, Kalimpong – II and Gorubhathan.

Table no. 2.2: Kalimpong District at a Glance

Items		Kalimpong – I	Kalimpong – II	Gorubathan	Kalimpong Municipality	Total
Basic Administrative Items						
No of GPs / Wards		18	13	11	23	65
No of Gram Sansads		138	92	94		324
No of Block Sansads		50	1	1		52
No of households		15338	13172	12662	10113	51285
Total population		74746	66830	60663	49403	251642
No of Police Stations (within jurisdiction)		0	0	2	1	3
No of Revenue Mouzas			17	13		30
No of Forest Mouzas			18	19		37
Total area under jurisdiction (sq km)		321.16	303.00	443	9.17	1075.92
Tea Gardens	Total no	0	0	6		6
	Workers	0	0	2834		2834
Other Plantations	Total no	0	4	1		5
	Workers	0	1225	1476		2701

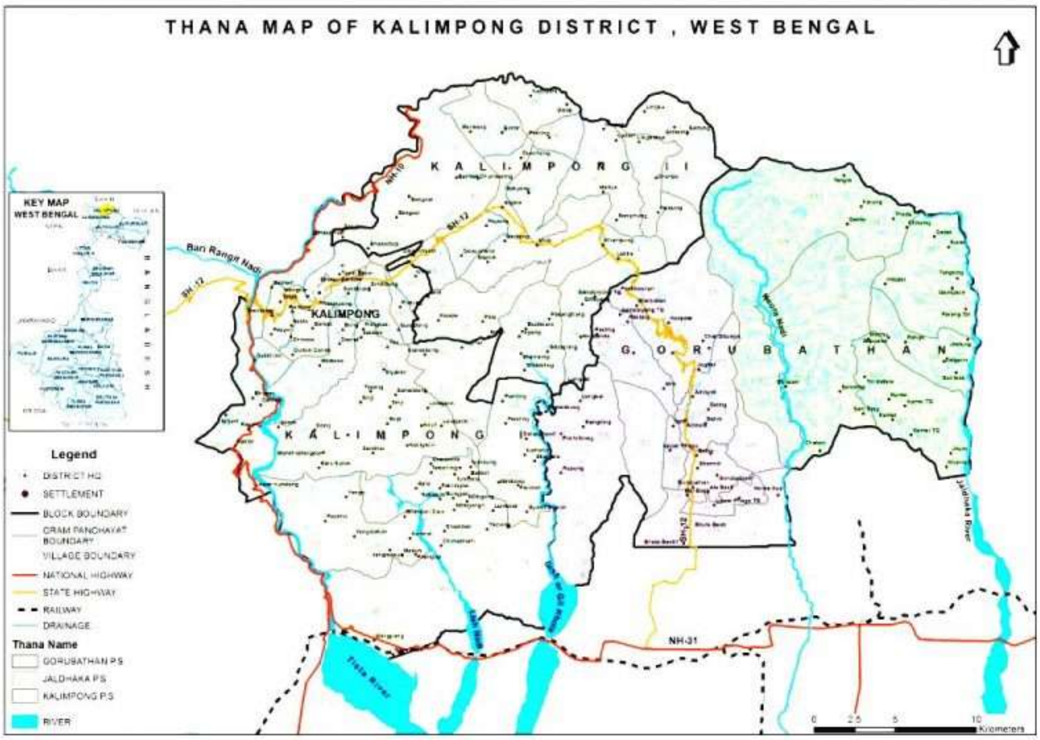
Source: Kalimpong District Profile

Map no 2.1: Map of Kalimpong District



Source:https://www.researchgate.net/figure/Kalimpong-district-map-Source-Natural-Resouce-Data-Management-System-NRDMS_fig1_336685411

Map no. 2.2: Thana Map of Kalimpong District



Source: https://kalimpong.gov.in/administrative-map/

2.1.1. Kalimpong Municipality (Urban Area)

The Kalimpong Municipality is the only municipality in the Kalimpong district. It was founded in 1945. It has an area of 3.54 square meters. There are 23 wards under Kalimpong Municipality for which elections are held every five years, latest elections were held in 2017. The municipality of Kalimpong has a population of 49,403 of which 25,100 are male, while 24,303 are female, as per Census India 2011.

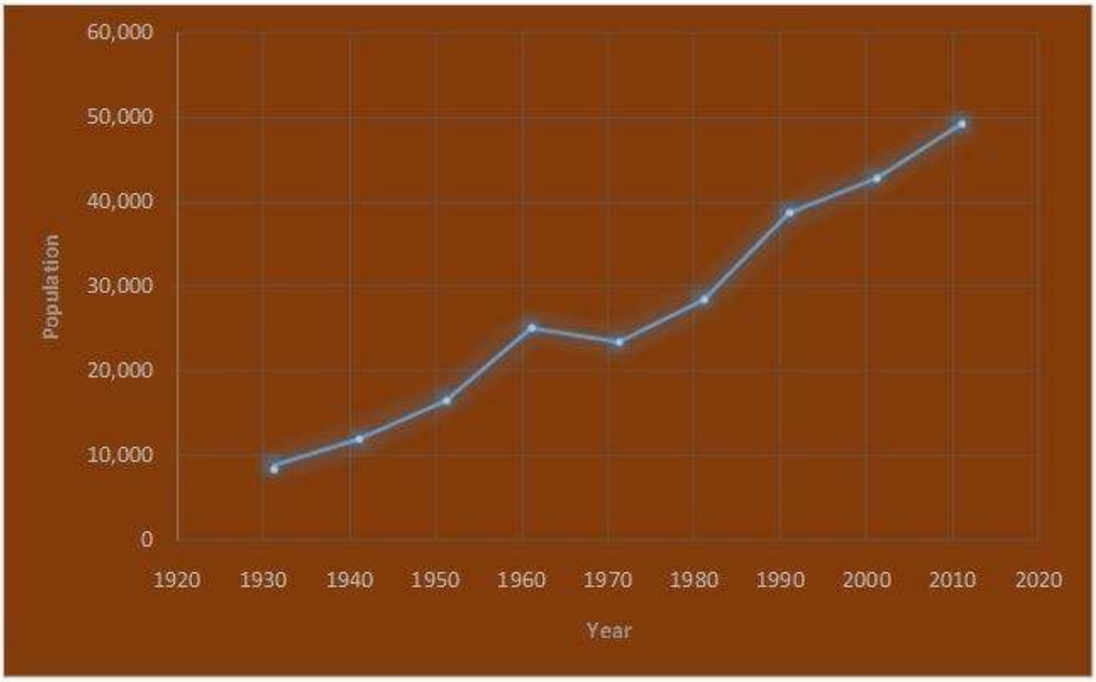
It has a total administration of more than 10,113 houses to which it supplies basic services such as water and sewerage. It is also allowed to build roads within the boundaries of the Municipality and to levy taxes on properties falling within its jurisdiction.

Table no. 2.3: Population Growth in Municipality Area (Urban Area)

Town	Administrative Status	Year	Population
Kalimpong	Municipality	1931	8,776
Kalimpong	Municipality	1941	11,958
Kalimpong	Municipality	1951	16,677
Kalimpong	Municipality	1961	25,105
Kalimpong	Municipality	1971	23,430
Kalimpong	Municipality	1981	28,590
Kalimpong	Municipality	1991	38,787
Kalimpong	Municipality	2001	42,998
Kalimpong	Municipality	2011	49,403 (25,100 male and 24,303 female)

Source: Kalimpong Municipality

Figure 2.1: Population growth in Kalimpong Municipality



Source: Author's own estimation based on field survey, 2020

Table no. 2.4: Number, Percentage and Sex Ratio of Schedule Castes (SC) and Schedule Tribes (ST) population in Kalimpong Urban Area

	Total Population	Total SC population	% of SC population to Total Population	SC Sex Ratio	Total ST population	% of ST population to Total Population	ST Sex Ratio
Kalimpong (M)	49403	5231	10.59	1039	10230	20.71	1095

Source: District Census Handbook, 2011

Table no. 2.5: Distribution of Workers by Sex in Four categories of Economic Activity in Kalimpong Urban Area, 2011

Town	Persons/M/F	Total population	Total workers	Category of Workers			
				Cultivators	Agricultural labourers	Household industry work	Other workers
				Total number	Total number	Total number	Total number
Kalimpong (M)	Persons	49403	16759	178 (1.06)	179 (1.07)	482 (2.88)	15920 (94.99)
	Males	25100	12815	126 (0.98)	113 (0.88)	354 (2.76)	12222 (95.37)
	Females	24303	3944	52 (1.32)	66 (1.67)	128 (3.25)	3698 (93.76)

Source: District Census Handbook, 2011.

Note: figures in parentheses are percentage.

2.1.2. Community Development Blocks (C.D.B) (Rural Area)

There are three community development blocks each headed by Block Development Officers (B.D.O.).

Table no. 2.6: Number, Percentage and Sex Ratio of Schedule Castes (SC) and Schedule Tribes (ST) population in Community Development Blocks (Rural Area)

C.D.B	Total Population	Total SC population	% of SC population to Total Population	SC Sex Ratio	Total ST population	% of ST population to Total Population	ST Sex Ratio
1. Kalimpong – I	67,957	4422	6.51	1002	23654	34.81	991
2. Kalimpong – II	66830	1961	2.93	1036	24773	37.07	954
3. Gorubathan	60663	4027	6.64	999	14315	23.60	973

Source: District Census Handbook, 2011.

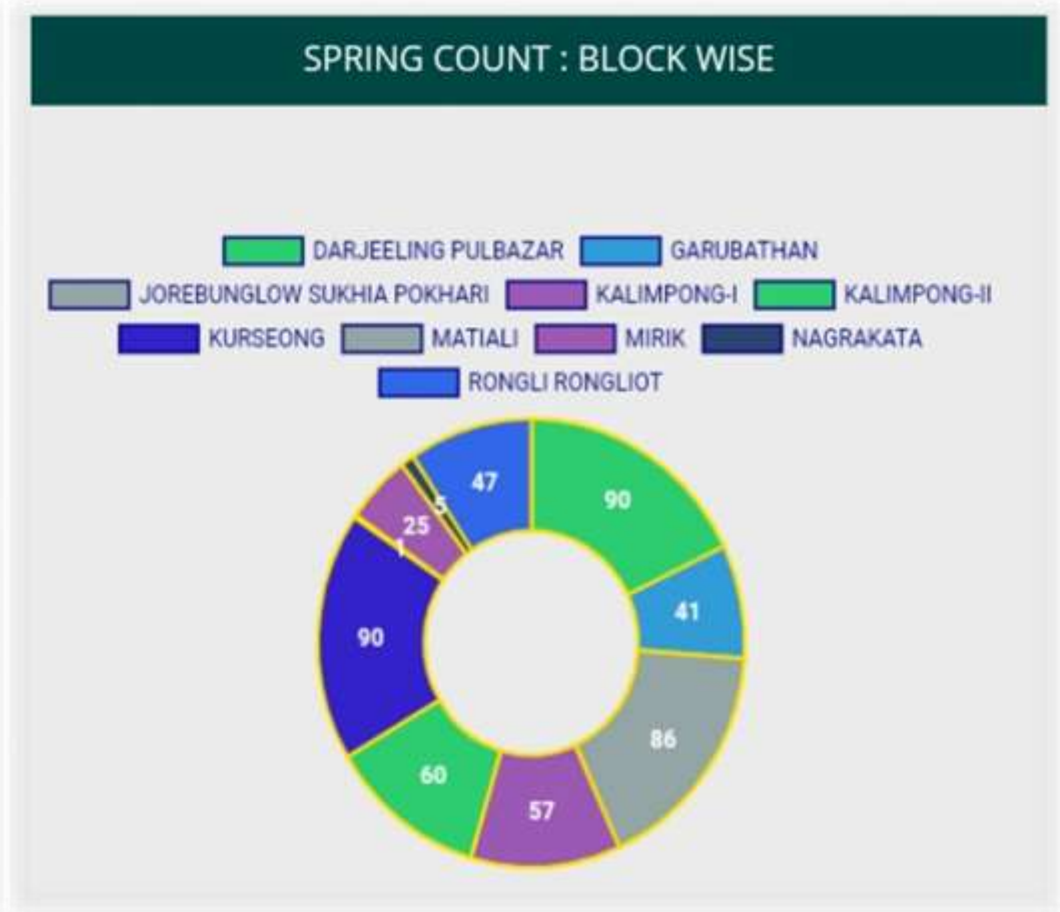
Table no. 2.7: Distribution of Workers in Economic Activity of Three Community Development Blocks (Rural Area), 2011

C.D.B	Persons/M/F	Total population	Total workers	Category of Workers			
				Cultivators	Agricultural labourers	Household industry work	Other workers
				Total number	Total number	Total number	Total number
1. KPG – I	Persons	67957	27196	6862 (25.23)	9553 (35.13)	366 (1.35)	10415 (38.30)
	Males	34474	18146	4750 (26.18)	5248 (28.92)	260 (1.43)	7888 (43.47)
	Females	33483	9050	2112 (23.34)	4305 (47.57)	106 (1.17)	2527 (27.92)
2. KPG – II	Persons	66830	25229	10741 (42.57)	4887 (19.37)	266 (1.05)	9335 (37.00)
	Males	34546	17789	7604 (42.75)	2834 (15.93)	203 (1.14)	7148 (40.18)
	Females	32284	7440	3137 (42.16)	2053 (27.59)	63 (0.85)	2187 (29.40)
3. Gorubathan	Persons	60663	24139	7480 (30.99)	4700 (19.47)	986 (4.08)	10973 (45.46)
	Males	31054	15200	4943 (32.52)	2546 (16.75)	580 (3.82)	7131 (46.91)
	Females	29609	8939	2537 (28.38)	2154 (24.10)	406 (4.54)	3842 (42.98)

Source: District Census Handbook, 2011.

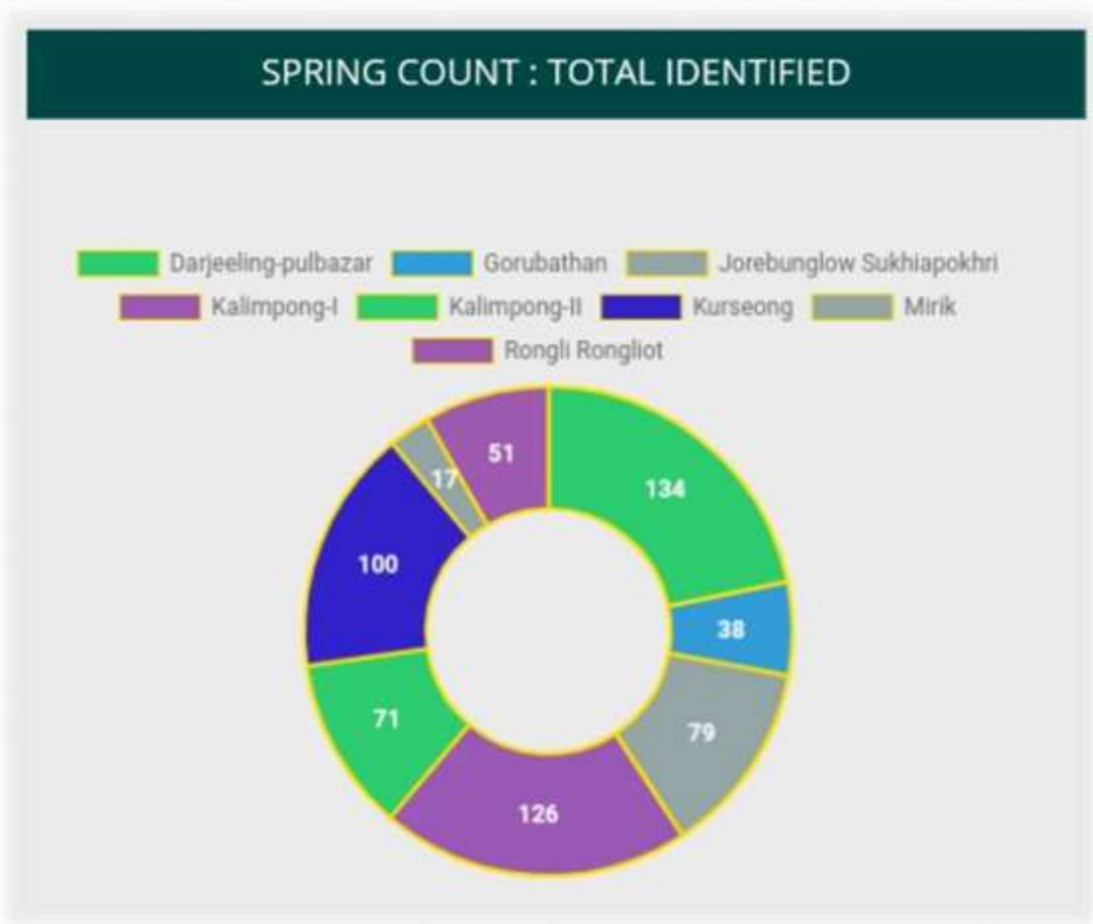
Note: figure in parentheses are the percentage.

Figure 2.2: Total number of springs in and around Kalimpong district as per the block



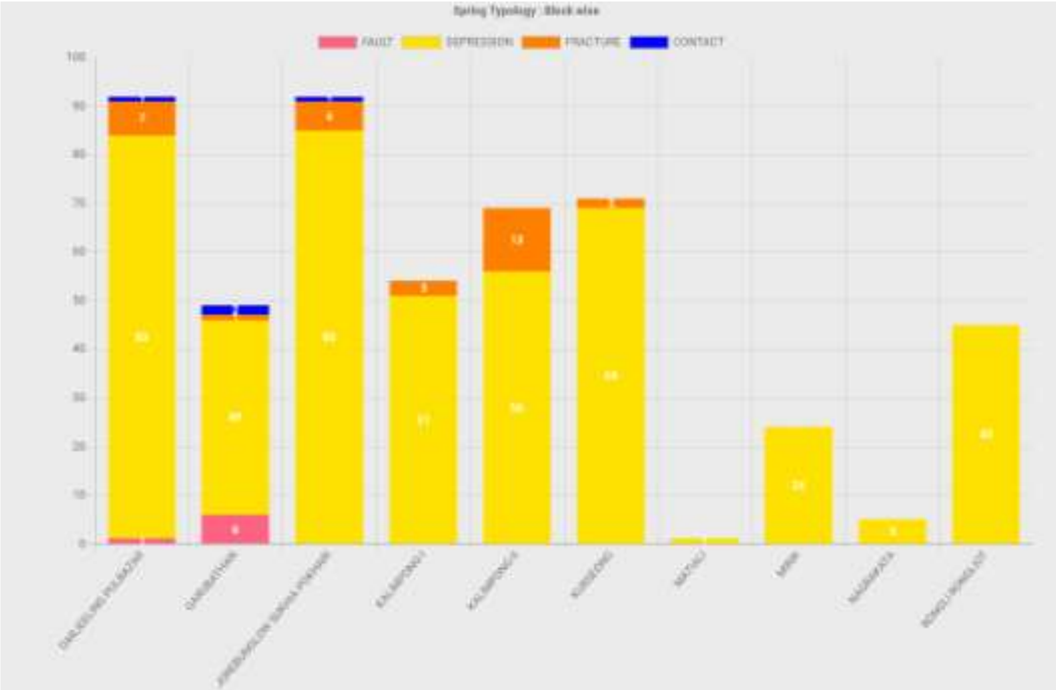
Source: Jharna*dhara*

Figure 2.3: Total number of springs identified in and around Kalimpong district as per the block



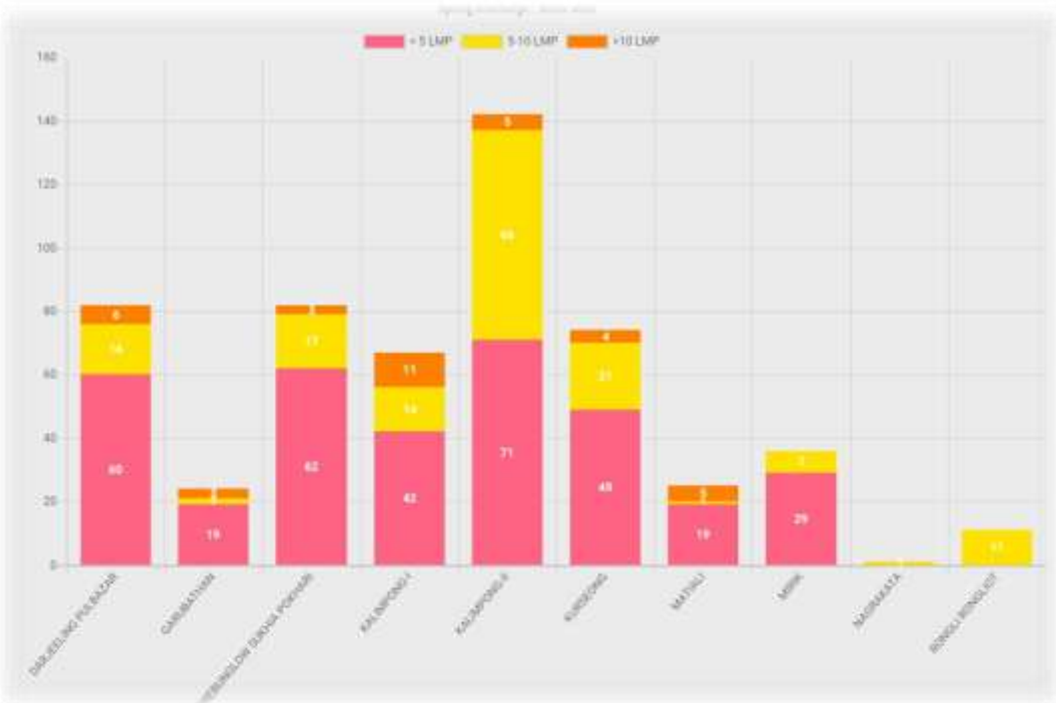
Source: Jharna*dhara*

Figure 2.4: Condition of the springs in and around Kalimpong district as per block



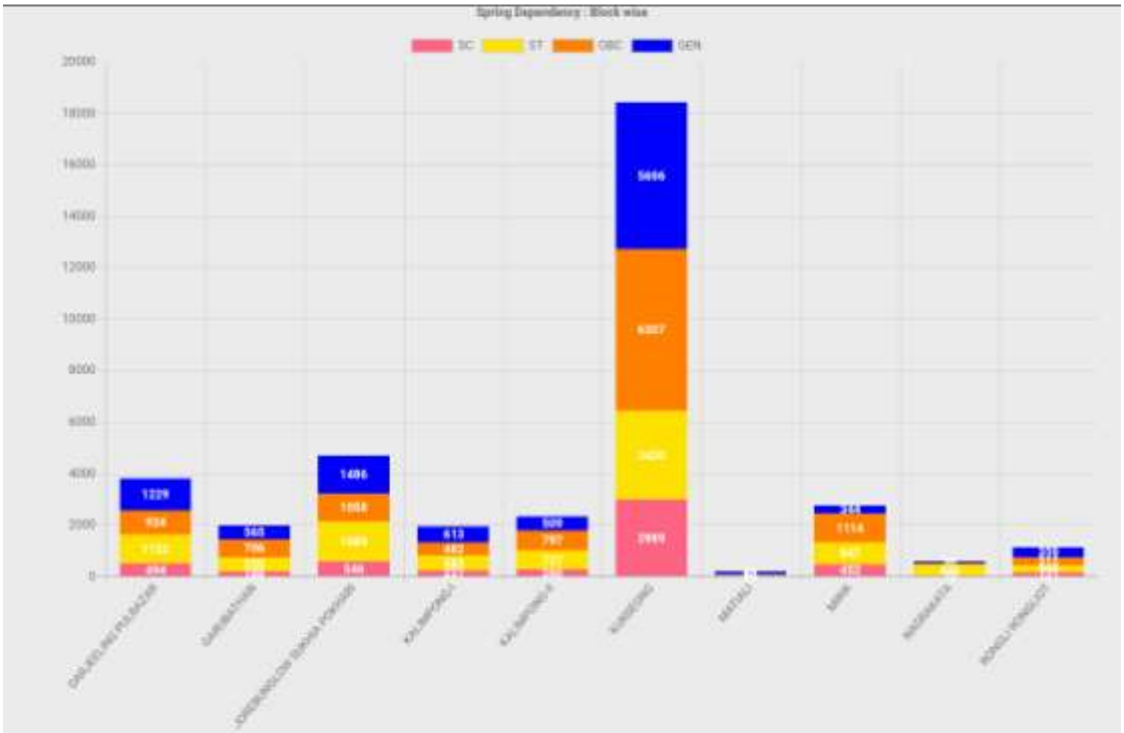
Source: Jharna*dhara*

Figure 2.5: Discharge from springs in and around Kalimpong district as per block



Source: Jharna*dhara*

Figure 2.6: Dependency on springs in and around Kalimpong district as per the block



Source: Jharna*dhara*

2.2. Kalimpong – I Community Block

There are 18 GP's in Kalimpong – I directly under the supervision B.D.O – I.

Table no. 2.8: List of Gram Panchayats in Kalimpong – I

Serial no.	Name of G.P.	Total Area	Total Population As per census 2011	Sex Ratio	Male	Female	SC Pop.	ST Pop.	OBC Pop.	Minority Pop.
1.	Dr. Graham's Homes	437.47 Hec	3904	1053	1902 (48.72)	2002 (51.28)	744 (19.06)	662 (16.96)	652 (16.70)	1185 (30.35)
2.	Upper Echhey	302.52 Hec	1962	1048	958 (48.83)	1004 (51.17)	168 (8.56)	632 (32.21)	476 (24.26)	797 (40.62)
3.	Lower Echhey	317.06 Hec	2210	973	1120 (50.68)	1090 (49.32)	133 (6.02)	485 (21.95)	265 (11.99)	435 (19.68)
4.	Pudung	391.74 Hec	2382	1002	1190 (49.96)	1192 (50.04)	161 (6.76)	986 (41.39)	645 (27.08)	494 (20.74)
5.	Sindebong	789.14 Hec	4616	1029	2275 (49.29)	2341 (50.71)	346 (7.50)	1425 (30.87)	1350 (29.25)	1466 (31.76)
6.	Bhalukhop	739.77 Hec	5254	977	2657 (50.57)	2597 (49.43)	411 (7.82)	863 (16.43)	2255 (42.92)	2741 (52.17)
7.	Dungra	427.76 Hec	6794	1069	3284 (48.34)	3510 (51.66)	825 (12.14)	2021 (29.75)	1449 (21.33)	1414 (20.81)
8.	Bong	1866.03 Hec	4609	1012	2291 (49.71)	2318 (50.29)	389 (8.44)	1250 (27.12)	567 (12.30)	917 (19.90)
9.	Kalimpong	376.36 Hec	5452	1068	2637 (48.37)	2815 (51.63)	797 (14.62)	2062 (37.82)	1434 (26.30)	2458 (45.08)
10.	Tashiding	975.30 Hec	3490	1014	1733 (49.66)	1757 (50.34)	252 (7.22)	1259 (36.07)	591 (16.93)	1194 (34.21)
11.	Teesta	2658.38 Hec	7249	931	3754 (51.79)	3495 (48.21)	890 (12.28)	1568 (21.63)	1446 (19.95)	1973 (27.22)
12.	Seokbir	980.97 Hec	2094	959	1069 (51.05)	1025 (48.95)	49 (2.34)	1077 (51.43)	118 (5.64)	511 (24.40)
13.	Samalbong	2336.27 Hec	4602	982	2322 (50.46)	2280 (49.54)	262 (5.69)	2429 (52.78)	255 (5.54)	2430 (52.80)
14.	Samthar	3291.35 Hec	4220	958	2155 (51.07)	2065 (48.93)	171 (4.05)	1185 (28.08)	2759 (65.38)	1113 (26.37)
15.	Yangmakum	4430.14 Hec	3356	868	1797 (53.55)	1559 (46.45)	13 (0.39)	1855 (55.27)	1325 (39.48)	1597 (47.59)
16.	Kaffer Kankebong	2577.47 Hec	2613	881	1389 (53.16)	1224 (46.84)	166 (6.35)	1579 (60.43)	279 (10.68)	1999 (76.50)
17.	Nimbong	3048.93 Hec	4386	936	2265 (51.64)	2121 (48.36)	84 (1.92)	1920 (43.78)	954 (21.75)	2168 (49.43)
18.	Pabringtar	12314.3 Hec	5471	892	2892 (52.86)	2579 (47.14)	177 (3.24)	2220 (40.58)	300 (5.48)	1527 (27.91)
	Total		***74,664***	***981***	***37,690***	***36,974***	***6038***	***25,478***	***17,129***	***26,419***

Source: Block – I Office

Note: figures in parentheses are percentage.

2.2.1. Profile of Pudung *Khasmahal*

Pudung *Khasmahal* is a Gram Panchayat, under Kalimpong – I Development Block.

Table no. 2.9: Physical Characteristics of Pudung *Khasmahal*

1.	Total Area	290 acres
2.	Area in square km	60 sq. km (approx.)
3.	Distance from district / block	7 km
4.	Nearest Rail Station	N.J.P. at 76 km (approx.)
5.	Nearest Bus Stop	Kalimpong at 7 km
6.	Year in which gram panchayat came into existence	1997
7.	Land allocated for Gram panchayat office	0.2 acres
8.	Post Office	Kalimpong
9.	Police Station	Kalimpong

Source: Pudung GP Office, 2020.

Table no. 2.10: Population of Pudung *Khasmahal*

1.	Total Population	2100 (1054 male and 1046 female) as per 2001 census
		2382 (1185 male and 1197 female) as per 2011 census
2.	Schedule Caste (SC) (total & percentage)	142 (74 male and 68 female) and in terms of percentage 7.09%
3.	Schedule Tribe (ST) (total & percentage)	844 (408 male and 436 female) and in terms of percentage 7.66%
4.	Other Backward Classes (OBC) (total)	501
5.	Minority	1466
6.	Number of B.P.L. household	215
7.	Total number of household	694

Source: Pudung GP Office, 2020.

Table no. 2.11: Educational Institutions & Health Centre's in Pudung *Khasmahal*

1.	Total number of Primary schools	5 (out of which 2 are government schools and 3 are private schools)
2.	Total number of Secondary School	1 (Chandramaya High School)
3.	Total number of Higher Secondary Schools	Nil
4.	Total number of Colleges	Nil
5.	Total number of Shishu Shiksha Kendra (SSK)	7
6.	Total number of ICDS Centre's	8
7.	Total number of Health Centre/Sub Centre	1 (Pudung Health Sub Centre)

Source: Pudung GP Office, 2020.

Table no. 2.12: Agriculture & Industry in Pudung *Khasmahal*

1.	Total cultivable land	475.17 acres
2.	Percentage of irrigated land	59.025%
3.	Percentage of fallow land	40.312%
4.	Cropping intensity	Paddy, Maize and Millets
5.	Major crops & vegetables	Paddy, Maize, Millets and Potatoes
6.	Major non – farm livelihoods	Piggery, Goatry, Milk production and Poultry
7.	Major activities done by SHG	Animal Husbandry, Floriculture, Dairy Farming, Poultry and Piggery.

Source: Pudung GP Office, 2020.

Table no. 2.13: Employment in Pudung *Khasmahal*

1.	Total Job Card	688 (SC – 35, ST – 243, Others – 410)

Source: Pudung GP Office, 2020.

Documentation of total springs/*dhara* at Pudung *Khasmahal*. There are 12 Perennial Springs in this area and 11 Seasonal springs which gets rejuvenated during the wet season.

Table no. 2.14: Spring/*Dhara* details of Pudung *Khasmahal*

Serial no.	Names of the Spring/*Dhara*	Remarks
1.	Gairi *Dhara*	Seasonal
2.	Jore *Dhara*	Perennial
3.	Aitabaray *Dhara*	Perennial
4.	Hem Kumar *Dhara*	Perennial
5.	Sadhu *Dhara*	Seasonal
6.	Gothay *Dhara*	Seasonal
7.	Adhikari *Dhara*	Seasonal
8.	Sukraj *Dhara*	Seasonal
9.	Nanday *Dhara* (Aitabaray 2)	Seasonal
10.	Aaulay *Dhara*	Perennial
11.	Jugay *Dhara*	Perennial
12.	Ram Saili *Dhara*	Perennial
13.	Sadhu *Dhara*	Perennial
14.	Jogi *Dhara*	Perennial
15.	Pranami *Dhara*	Perennial
16.	Simli *Dhara*	Seasonal
17.	Firfiray *Dhara*	Seasonal
18.	Sukbir *Dhara*	Seasonal
19.	Manbir *Dhara*	Seasonal
20.	Lampatay *Dhara*	Perennial
21.	Ratay *Dhara*	Perennial
22.	Tari *Dhara*	Perennial

Source: Pudung GP Office, 2020

2.2.2. Profile of Bong *Khasmahal*

Bong *Khasmahal* is a Gram Panchayat, under Kalimpong – I Development Block.

Table no. 2.15: Physical Characteristics of Bong *Khasmahal*

1.	Total Area	584.78 hectare
2.	Distance from district / block	4 km
3.	Nearest Rail Station	N.J.P. at km (approx.)
4.	Nearest Bus Stop	Kalimpong at km
5.	Year in which gram panchayat came into existence	1995
6.	Land allocated for Gram panchayat office	0.02 decimal
7.	Post Office	Kalimpong
8.	Police Station	Kalimpong

Source: Bong GP Office, 2020.

Table no. 2.16: Population of Bong *Khasmahal*

1.	Total Population	4046 as per census 2001
		4609 (2291 male and 2318 female) as per 2011 census
2.	Schedule Caste (S.C.) (total)	367
3.	Schedule Tribe (S.T.) (total)	1069
4.	Other Backward Classes (O.B.C.) (total)	2610
5.	Number of B.P.L. household	293
6.	Total number of household	851

Source: Bong GP Office, 2020.

Table no. 2.17: Educational Institutions & Health Centre's in Bong *Khasmahal*

1.	Total number of Primary schools	6
2.	Total number of Secondary School	1
3.	Total number of Higher Secondary Schools	Nil
4.	Total number of Colleges	Nil
5.	Total number of Shishu Shiksha Kendra (SSK)	3
6.	Total number of ICDS Centre's	11
7.	Total number of Health Centre/Sub Centre	2 (Salimbong Sub Centre and Tari Gaon Sub Centre)

Source: Bong GP Office, 2020.

Table no. 2.18: Agriculture & Industry in Bong *Khasmahal*

1.	Total agriculture land	1160.84 acres
2.	Percentage of irrigated land	65%
3.	Percentage of fallow land	25%
4.	Cropping intensity	65% using Manpower
5.	Major crops & vegetables	Rice, Maize, Millet, Potato and Cabbage
6.	Major non – farm livelihoods	Causal Labourers
7.	Major activities done by SHG	Collect village made local products like pickle, lollipop, Brum sticks, vegetables and sell in markets

Source: Bong GP Office, 2020.

Table no. 2.19: Employment in Bong *Khasmahal*

1.	Total Job Card	1,515

Source: Bong GP Office, 2020.

Documentation of total springs/*dhara* at Bong *Khasmahal*. All were Perennial Springs.

Table no. 2.20: Spring/*Dhara* details of Bong *Khasmahal*

Serial no.	Names of Spring/*Dhara*
1.	Subba *Dhara*
2.	Siktel *Dhara*
3.	Basnet *Dhara*
4.	Pema *Dhara*
5.	Shaaleen *Dhara*
6.	Binoy *Dhara*
7.	Dixit *Dhara*
8.	Dangal *Dhara*
9.	Pokhrel *Dhara*
10.	Gugay *Dhara*
11.	Jose *Dhara*
12.	Oasay *Dhara*
13.	Dahal *Dhara*
14.	Lepcha *Dhara*
15.	Adhikari *Dhara*
16.	Tamang *Dhara*
17.	Mukhia *Dhara*
18.	Bhandari *Dhara*
19.	Kaijalay *Dhara*

Source: Bong GP Office, 2020.

2.3. Water Situation in the Kalimpong District

Kalimpong was a very small village in 1865 and became a sub – divisional town in the year 1916. The population was approximately 8,500 at the time of being a sub – divisional town, and it was only after British opened up Kalimpong as an alternative hill station to Darjeeling and opened the trade route to Tibet through Kalimpong, that the population of Kalimpong increased.

Due to a serious epidemic of dysentery at Gitdubling in 1937, efforts were made to protect rural spring supply in the hills from contamination by the water flow in pipes (Bengal District Gazetteers, 1947).

The Kalimpong Waterworks operated by engineering branch of the Government of West Bengal namely, Public Health Department (P.H.E.). The supply of water came from two springs at the Relli and Thokchu 18½ mile from Kalimpong Town. Water was then transported to Sanser 12 miles from the town in the Masonry Conduit and chlorinated there. It was then carried by a 6 – inch pipe to storage reservoir of 3,00,000 gallons about 2½ mile from Sanser, from which it gravitates to different supply tanks and was supplied to households through 300 house connections and 44 street tanks. At an annual maintenance cost of about RS 11,000, the average daily supply was 2,10,000 gallons. The works completed in 1922 and the capital cost incurred was RS 8,75,000 (Bengal District Gazetteers, 1947).

By 1951, Kalimpong's official population was 16,677 (census report 1951). The British government took full responsibility of setting up water distribution system after it was declared a sub – division in 1961. This led to the establishment of Water Works Department. After the agitation in the year 1998 – 99 Water Works Department was handed over to D.G.H.C and then to G.T.A.

P.H.E. under G.T.A. has two divisions: 1. Rural Water Supply and 2. Water Works Department.

2.3.1. Rural Water Supply (RWS) for water supply in rural areas

This division is concerned with supply of water in the rural areas of the district namely, Kalimpong – I, Kalimpong – II and Gorubathan.

Under this division, the villages place their water demands before RWS, then a perennial spring/*dhara* is identified during the month of February – April i.e. lean/dry period by RWS.

Mechanism RWS scheme works:

1. Villagers place their water demand through a public application.

2. Junior Engineer (J.E.) the visits the village to identify perennial springs.

3. Estimate is prepared that is budget to implement the scheme.

4. Water Investigation Department (WID) gives source certificate whether the particular spring/*dhara* is perennial or not.

5. Administrative approval is made.

6. RWS gives tender to the concerned agency.

7. Agency implements the work.

Stages of work:

Stage – I: Perennial source is identified.

Stage – II: From the source water is brought to the reserve tank.

Stage – III: From reserve tank water is then distributed to different distribution tanks in different hamlets.

Stage – III: Hydrant (stand pose) is constructed at different distribution tanks from where hamlets get water. The scheme gets over at this stage.

The water flows for 24 hours so people in that particular hamlet manage the scheme, as demand increases people in that hamlet have their own control system i.e. timings. Minor maintenance work is looked after by the people but major maintenance is looked by RWS.

One RWS scheme has one reserve tank and three to four distribution tanks depending upon the population of village. The cost of one RWS scheme on average comes 45 lakhs including pipelines where maximum can go up to 5 core. List of RWS schemes till now in annexure.

In Kalimpong Block – I there are almost no perennial spring sources so maximum work has been done in Gorubathan area.

Other than springs/*dhara* in rural areas there are no alternative sources of water unlike in Gorubathan water can be pumped but such pumping cannot be done in Kalimpong – I and Kalimpong – II. The only alternative source may be *Jhora* with no sewerage lines.

Neora water cannot be given to rural areas as a Detailed Project Report (DPR) with cost 300 – 400 cores (approx.) has to be submitted to the department that too only in Kalimpong – II not in Kalimpong – I.

2.3.1.a. Role of NGO

Besides RWS, different NGO's too have started to work for protecting springs in rural areas by collaborating with government departments for spring shed management. Prasari a NGO gives technical support to MGNREGA workers for proper spring shed management where the cost of spring shed ranges from RS 90,000 – 1,20,000 only trenching and plantation of 600 Panisaaj plant sample are done. Till now 21 spring shed program has been done by MGNREGA workers with the help of Prasari.

2.3.1.b. Privatization of the Commons

Today, privatization and commercialization of spring/*dhara* has started increasing day by day in the rural areas. Springs/*dhara* are no more CPR i.e. no common access to all. The privatization happens in three ways firstly, the owner of the spring sells water to the households for charges ranging from RS 300 to RS 1,000 per month where the cost of carrying water through pipes and its maintenance has to be done by the households themselves which is RS 15,000 to 16,000 (approx.). Secondly, the source (*mul*) is sold to the households for life time by the owner of the spring till the spring/*dhara* dries up against the one-time payment ranging from RS 3,00,000 to RS 4,00,000. Finally, selling water to vendors which is increasing rapidly where vendors collect water in tankers at cost RS 30 for 1,000 liters. The cost for construction of storage tank comes to about RS 1,00,000 (approx.) incurred by the owner of the spring to store water and supply through pipes to water vendors from the storage tank.

Though selling water to vendors are both primary and secondary sources of income for the owner of the spring.

If privatization increases rapidly then situation in rural areas 10 years from now cannot be imagined so spring/*dhara* which was open to all before is disappearing and privatization of spring/*dhara* which was not there before has come up.

The big question on commons is who will look after it? So the question on governance comes into the picture. Usually free rider problem and over – exploitation of CPRs happen (tragedy of the commons) so they are privatized. Elinor Ostrom said that privatization is not a solution, commons are governed in different way. Governance or allocation mechanism is different across different regions or communities. And governance not necessarily by the government but Users Governance. For example, Sikkim in 2008 has started spring shed management under RMDD named it as '*Dhara Vikas*' to solve rural water scarcity problem by governing the springs/*dhara* through community participation (Sharma et al., 2020), Seri fishing group, FPO's in many places.

2.3.2. Water Works Department (WWD) for water supply in Town/Urban area

This division is concerned with water supply in Kalimpong Municipality/Town area.

Two reservoirs were built under the Water Works Department, one now located next to Deolo Tourist Lodge with a capacity of 2 mg and the other below the Lodge with a capacity of 4 mg. The two reservoirs were fed from Thokchu and Relli water sources, linked by 150 m dice of MS pipeline for a total of 28 km. The delivery to the public was through CI pipes running along the length of Kalimpong Town.

But Thokchu and Relli water sources were only for 14,000 – 16,000 town population with 24 hours' water supply. When Kalimpong was made a Sub – division by British various facilities came up such as schools, colleges, hospitals, tourism etc. so township started to increase, migration took place so water demand of the town started to increase. Also, the Indian Army's 27th Mountain Division was deployed in Kalimpong's Durpin, Pedong, Monsong and Paigong during the Chinese aggression of 1962. Due to growth of the population and the need to accommodate to the Army. Water Works were no longer able to maintain the supply, and as a result, the Neora Maintenance Division was formed in 1995 with the understanding that it would meet the Army's needs and also supply Kalimpong's civilian population with 8 lakh gallons per day (DPR, 2016).

2.3.2.a. Neora Khola Project

This division is responsible for supplying water to the Army stations at various locations and to the civil reservoir at Deolo under PHE, Darjeeling Division II, Kalimpong under GTA. PHE, Kalimpong under GTA is responsible for the distribution of water to the civilian population of Kalimpong Town. The term of this project completed in the year 2011 and currently only maintenance work is going on for this project.

To meet the demand for water, the Neora Khola Project was initiated by the Army and the Civil Representatives of Kalimpong Town. Mr. Tashi Pempa Hissey, then Chariman of the Kalimpong Municipality convinced the State Government and the Army that the Neora Khola Project was the only way to solve the water problem of the Army in various locations of Kalimpong and the civilian population of the Kalimpong.

Identified sources were (i) Neora Khola and (ii) Dhaula Khola with major discharge from Neora Khola.

The project includes construction of four open ground reservoirs (i) At Lava (ii) At Algarah, 3.2 km away from Algarah Bazar (iii) At Algarah, 1.80 km away from Algarah Bazar (iv) At Deolo, at Kalimpong Town.

Table no. 2.21: Capacities of the reservoirs

Reservoirs	Capacity	Original Capacity	Remarks
1. Lava	45 million lakh	80 million lakh	Under renovation and upgradation
2. Algarah (3.20 km away from Algarah Bazar)	85 million lakh	-	Incomplete
3. Algarah (1.82 km away from Algarah Bazar)	61 million lakh	80 million lakh	Below original capacity
4. Deolo (Middle Reservoir)	17 million lakh	40 million lakh	Below original capacity

Source: Field Survey, 2020.

The project is under the Neora Khola Supply and Maintenance Division, PHE, Government of West Bengal.

Table no. 2.22: Water distribution to Army and Civilian population as per project report

Serial no.	Items	Distribution
1.	Civil Population of Kalimpong Town	8 lakh gallons per day.
2.	Army	7 lakh gallons per day.
3.	Enroute Villages	1 lakh gallons per day.

Source: Field Survey, 2020.

Table no. 2.23: Present distribution

Serial no.	Items	Distribution
1.	Civil Population of Kalimpong Town	5 lakh gallons per day (average).
2.	Army	4 lakh gallons per day (average).
3.	Enroute Villages	1 lakh gallons per day (average).

Source: Field Survey, 2020.

The initial project cost was only RS 14 cores, but the revised cost came to RS 41 cores due to the escalation and the time to complete the project. The overall revised cost of capital of the project approved was RS 3,125 lakhs.

Table no. 2.24: Financial cost of the project

Institution	Share
1. Central Government and State Government	8/15 of the total estimated cost.
2. Army	7/15 of the total estimated cost.

Source: Field Survey, 2020.

Figure 2.7: Two Reservoirs fed by Neora, Relli and Thokchu

Source: Google Earth, Retrieved on 27-02-2021, 17:00 Hrs

Figure 2.8: Distance between the two reservoirs.

Source: Google Earth, Retrieved on 27-02-2021, 17:00 Hrs

Figure 2.9: Water Distribution Chamber at Deolo Reservoir No. 2.

Source: Field Survey, 2020

Figure 2.10: Water Distribution room set up during British period.

Source: Field Survey, 2020

Figure 2.11: Reservoir number 1 at Deolo.

Source: Field Survey, 2020

2.3.2.b. Town/Municipality distribution system (Urban Area)

In the year 1920 – 1922, the water distribution system of Kalimpong town was developed with the sole purpose of distributing water to the residents of Kalimpong who had a population of less than 8000 (approx.). It continued to function as an autonomous department after Independence under the name of Water Works, which was headed by a Superintendent. From 1st July, 1981, it was finally merged with PHE and continues to work to date.

Now the demand for water has risen to more than 14 lakh gallons per day with the formation of Kalimpong District and town population more than 60,000. After 20 years, the condition will be much worse.

Table no. 2.25: Present daily input of water

Serial no.	Sources	Inputs
1.	From Neora supplied by Neora Khola Supply and Maintenance Division.	5 to 5.5 lakh gallons per day.
2.	P.H.E own feed line from Thokchu and Relli	1 to 2 lakh gallons per day.

Source: DPR, Water Works Department.

All 23 wards, including hospitals, government offices, residence quarters and schools, are distributed water. After a gap of 3 days with a duration of 30 – 40 minutes, water is distributed during the dry season, so there is no chance of distributing water daily at present.

2.3.2.c. Total Demand and Total Supply in Kalimpong Town

Table no. 2.26: Total Town Population

Items	Population
1. Total population of Kalimpong Town	60,000
2. Floating population @ 5 %	3,000
3. Government buildings, educational institutions, hostels etc @ 15%	9,000
Total population	72,000

Source: DPR, Water Works Department.

Table 2.27: Total Demand for Water

Items	Demand
1. Demand per day	50,40,000 liters
2. Wastage @ 10%	5,04,000 liters
Total	55,44,000 liters per day
3. Supply to District Hospital	1,00,000 liters per day
4. Supply to Fire station @ 10% of 55,44,000	5,54,400 liters per day
Total Demand	**6198400 liters per day or 13,77,422 gallons per day**

Source: DPR, Water Works Department.

Table no. 2.28: Total Supply of Water

Items	Supply
1. Total water supply from Neora Khola	5,00,000 gallons per day
2. Total supply from Thokchu and Relli	2,00,000 gallons per day
Total supply	**7,00,000 gallons per day**

Source: DPR, Water Works Department.

Total water crises = 13,77,422 – 7,00,00

= **6,77,422 gallons per day.**

As the total supply of water is far too much lower than demand, water crises remain throughout the year. As per the department, per capita consumption is currently 70 liters per day but the water requirement for an average Indian town is given below:

Table no. 2.29: Requirement for an average Indian town

Purpose	Liters/person/day
1. Domestic Purpose (a) Drinking (b) Cooking (c) Bathing (d) washing hands, face, etc. (e) Household sanitary purposes	 2 5 35 8 50
2. Civic or public purposes (a) Road washing (b) Sanitation purposes (c) Ornamental purposes (d) Fire demand	 5 3 1 1
3. Industrial purposes (a) Moderate factories	 50
4. Business or Trade purposes (a) Diaries, hotels, etc.	 15
5. Loss and waste (assumed)	75
Grand total	250

Source: Water Supply and Sanitary Engineering.

The per capita water consumption per day for an average Indian town ranges from 150 – 300 liters. But the per capita consumption of 70 liters per day is below the normal 250 liters in Kalimpong town. Ranjita (2020) find per capita water consumption to be very less only 30 – 40 lpd in Kalimpong town.

Landslide wash away the pipelines during rainy seasons, thereby cutting off supply for many days and the sources from which the water is obtained significantly decrease during dry seasons as the sources are rain – fed and not snow – fed like Sikkim. The water problem occurs every year from February to June during the dry season. Over the years, the rainfall pattern has also changed as the area now experiences rainfall after a gap of 6 months, unlike after 2 – 3 months in previous years.

In sanitary engineering, for 1 person total 250 liters per day is needed to survive followed by PHE, GTA. So, demand is not fully covered as there is a gap of 5 lakhs gallons per day now next year again gap will increase so PHE, GTA has submitted a

Detailed Project Report (DPR) for augmentation of water by tapping different local sources namely (I) Lalikharka (II) No. 32 Jhora (III) Chagey (IV) Thotney (V) Chipley Jhora (VI) Cobrey Spring (VII) Singu Jhora.

Currently, there are two treatment plant (water filtration plant) each plant purifies 22.4 thousand gallons per hour i.e. 44.8 thousand gallons per hour but present requirement is 56 thousand gallons per hour so 50,000 gallons per hour water has to be filtered a total of eight filtration plants are needed. To meet this deficit bleaching powder which contains chlorine (1 kg bleaching powder contains 30% chlorine) is applied.

Connections are only for residential purposes and not for commercial purposes. A total of 9,043 household connections are available to date. All bills against such connections are paid annually with charges RS 300 per annum and RS 5,550 for new connections. If payments are delayed, a fine of 50% of the bill amount is charged. The Superintendent, Assistant Superintendent, and 59 technical and field workers are responsible for the entire distribution system. The main valve opens in the Deolo reservoir at 2 am and closes at 10 pm, so that water is distributed for 18 hours to all the 23 wards, ensuring 30 minutes of timing for each ward. In that particular ward, the Line Man is responsible for the distribution. Since the line man is the actual distributor on the ground corruption and pilferage which leads to inequality in the distribution. So some incentive compactable mechanisms should be framed for equal distribution of water.

Figure 2.12: Water Filtration Plant of WWD, PHE

Source: Field Survey, 2020

Figure 2.13: Urban people collecting water

Source: Field Survey, 2020

Source: Field Survey, 2020

2.3.2.d. Water Vendors

This gap in the demand for water and supply of water in town area is covered by water vendors to some extent.

In many parts of the world, vendors selling water to household are prevalent where water shortage restricts access to sufficient quantities of drinking water. Water vendors use variety of transport types to carry water, including tanker trucks and wheel trolleys. (WHO, 2008)

Water vendors in Kalimpong town have been supplying water to households for the last 15 years. There are a total of 105 (approx.) water vendors in the town The number of trips each vehicle makes is maximum during dry or tourist season approximately 5 to 6 trips per day per vehicle, during winter the number of trips slightly falls to 2 or 3 trips per day per vehicle and no or very minimum trips in wet seasons. Water charges ranges from Rs 250 – RS 400 per 1000 liters depending on the distance of the households.

During the dry season (March – May) vendors have to line up their vehicles at 2 a.m. in the morning to collect water from source. Water charge at source is RS 30 per 1000 liters. The educational qualification of vendors ranges from 12th pass to Masters due to no employment opportunity. Some vehicles are owned by the vendors and owners drive themselves supply water while some vehicle owners have kept drivers. Monthly salaries of these drivers are RS 3000 per month and addition RS 30 per trip so a driver approximately earns RS 12,000 per month.

Water vendors are just able to meet their subsistence needs by selling water but cannot expect quality life. *"We cannot expect our children to go private schools with this earnings (said by one of the water vendor)"*

Table no. 2.30: Revenue and expenditure estimation of water vendors

Items	Expenditure (in RS)
1. Per trip	300
2. Pay at source	30
Remainder	270
3. Driver Per trip	30
Remainder	240
4. Oil charges	100
Total amount left per trip	**140**

Source: Author's own estimation based on field survey, 2020.

So per trip RS 140 or RS 170 is left with the water vendor. Now, on an average if a vendor makes 4 trips in a day than he earns RS 560 or RS 680 per day and monthly RS 16,800 or RS 20,400 excluding maintenance charges.

So, in urban/town area there are two supply systems (I) PHE water supply where actual distribution is done by the line man and (II) Privatized water vendors because the PHE water is not sufficient.

Figure 2.14: Water Distribution by Vendors in Urban Area

Source: Field Survey, 2020

Source: Field Survey, 2020

CHAPTER 3

SOCIO – ECONOMIC AND DEMOGRAPHIC CHARACTERISTICS AND WATER CONSUMPTION PATTERN

3.1. Household Social Characteristics

(i) Gender wise distribution of the household head in the sample shows following pattern

The household sample consists of 83.3% male respondents and 16.67% female respondents out of total respondents. Among male respondents, 81.7% male respondents are from rural areas and 85% male respondents are from urban areas. Among female respondents, 18.3% female respondents are from rural areas and 15% female respondents are from urban areas.

Table no. 3.1: Gender wise percentage distribution of household head

	Combined	Rural	Urban
Gender	**Percent**	**Percent**	**Percent**
Male	83.3	81.7	85.0
Female	16.7	18.3	15.0
Total	100.0	100.0	100.0

Source: Field Survey, 2020.

(ii) Age wise distribution of the household head in the sample shows following pattern

The average age of the head of the household was 50.23 years (SD = 12.803). Average age of head of the household in rural area was 50.98 years (SD = 13.017) and the average age of head of the household in urban area was 49.48 years (SD = 12.650).

Table no. 3.2: Age wise percentage distribution of household head

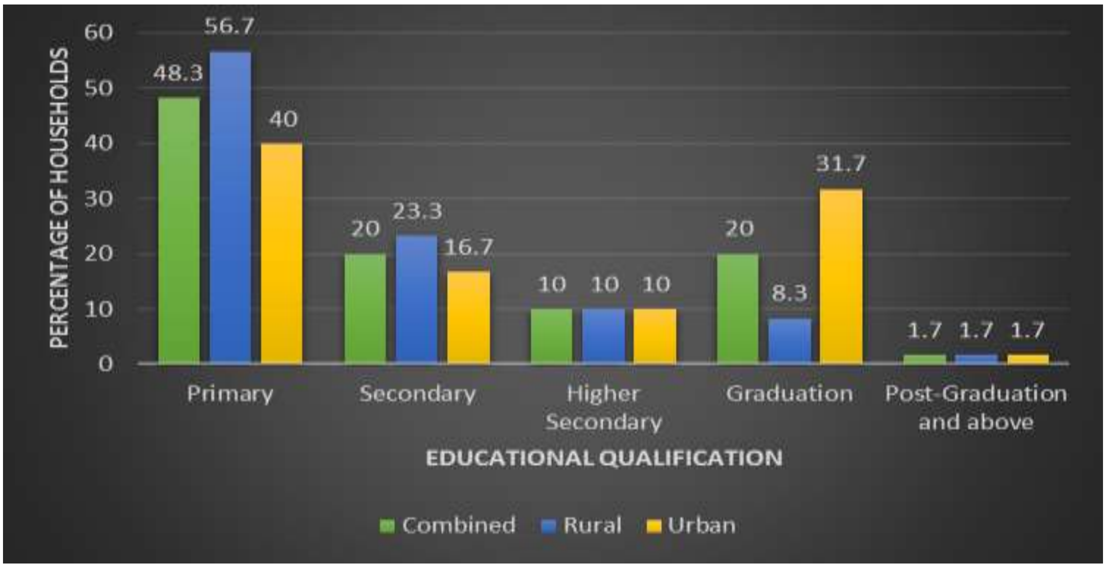
	Combined			Rural			Urban		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Age	120	50.23	12.803	60	50.98	13.017	60	49.48	12.650

Source: Field Survey, 2020

(iii) Educational Qualification wise distribution of the household head in the sample shows following pattern

The household sample consists 56.7% head of the households in rural area and 40% head of the households in urban area have completed primary education, 23.3% head of the households in rural area and 16.7% head of the households in urban area have completed secondary education, 10% head of the households in rural area and 10% head of the households in urban area have completed higher secondary education, 20% head of the households in rural area and 31.7% head of the households in urban area have completed graduation and 1.7% head of the households in rural area and 1.7% head of the households in urban area have completed post-graduation and above.

Figure 3.1: Education of household head



Source: Field Survey, 2020.

(iv) Marital Status wise distribution of the household head in the sample shows following pattern

Majority of the head of the households were married in both rural and urban areas 90% and 93.3% respectively. 6.7% of the household heads were unmarried in rural areas. 3.3% and 6.7% of household heads were widow/divorced in rural and urban areas respectively.

Table no. 3.3: Marital status wise percentage distribution of head

	Percentage of households		
Marital status	**Combined**	**Rural**	**Urban**
Married	91.7	90.0	93.3
Unmarried	3.3	6.7	-
Widow/Divorced	5.0	3.3	6.7
Total	100.0	100.0	100.0

Source: Field Survey, 2020.

(v) Social Category wise distribution of the households in the sample shows following pattern

Majority of the households in rural areas 41.7% belonged to Schedule Tribe (ST) while in urban areas majority of the households 43.3% belonged to Schedule Caste (SC). Only 15% of the households in rural areas belonged to Forward Caste (FC) and 6.7% of the households in urban areas belonged to Other Backward Classes (OBC).

Table no. 3.4: Percentage distribution of household according to Social Category

	Percentage of households		
Social Category	**Combined**	**Rural**	**Urban**
Schedule Tribe (ST)	27.5	41.7	13.3
Schedule Caste (SC)	33.3	23.3	43.3
Other Backward Classes (OBC)	13.3	20.0	6.7
Forward Caste (FC)	25.8	15.0	36.7
Total	100.0	100.0	100.0

Source: Field Survey, 2020.

3.2. Demographic Characteristics of the household

(i) Location of the households in the sample shows following pattern

The household sample comprised of 50% of rural households and 50% of urban households.

(ii) Total Household Size wise distribution of the households in the sample shows following pattern

Both in the rural and urban areas majority of the households have four members 35% each respectively.

Table no. 3.5: Percentage distribution of households according to Total Household Size

	Percentage of households		
Total household members	**Combined**	**Rural**	**Urban**
1	.8	1.7	-
2	8.3	10.0	6.7
3	23.3	18.3	28.3
4	35.0	35.0	35.0
5	19.2	18.3	20.0
6	8.3	11.7	5.0
7	4.2	5.0	3.3
8	-	-	-
9	.8		1.7
Total	100.0	100.0	100.0

Source: Field Survey, 2020.

(iii) Ownership of House in the sample shows following pattern

The household sample consists of all the respondents (100%) in rural areas live in their own households while most of the respondents (76.7%) in urban areas live in their own households and about 23.3% live on rented households. Usually in urban areas self-employed or casual workers lived on rented house.

Table no. 3.6: Percentage distribution of households according to ownership of house

	Combined		Rural		Urban	
Ownership	No.of households	Percent	No.of households	Percent	No.of households	Percent
Owned	106	88.3	60	100.0	46	76.7
Rented	14	11.7	-	-	14	23.3
Total	120	100.0	60	100.0	60	100.0

Source: Field Survey, 2020.

(iv) Type of house in the sample shows following pattern

In rural areas, majority of respondents (58.3%) lived in Katcha house and just about 41.7% of the respondents lived in Pucca house while in urban areas, majority of the respondents (98.3%) lived in Pucca house and only 1.7% of the households lived in Katcha house.

Table no. 3.7: Percentage distribution of households according to type of house

	Combined		Rural		Urban	
House Type	No.of households	Percent	No.of households	Percent	No.of households	Percent
Katcha	36	30.0	35	58.3	1	1.7
Pucca	84	70.0	25	41.7	59	98.3
Total	120	100.0	60	100.0	60	100.0

Source: Field Survey, 2020.

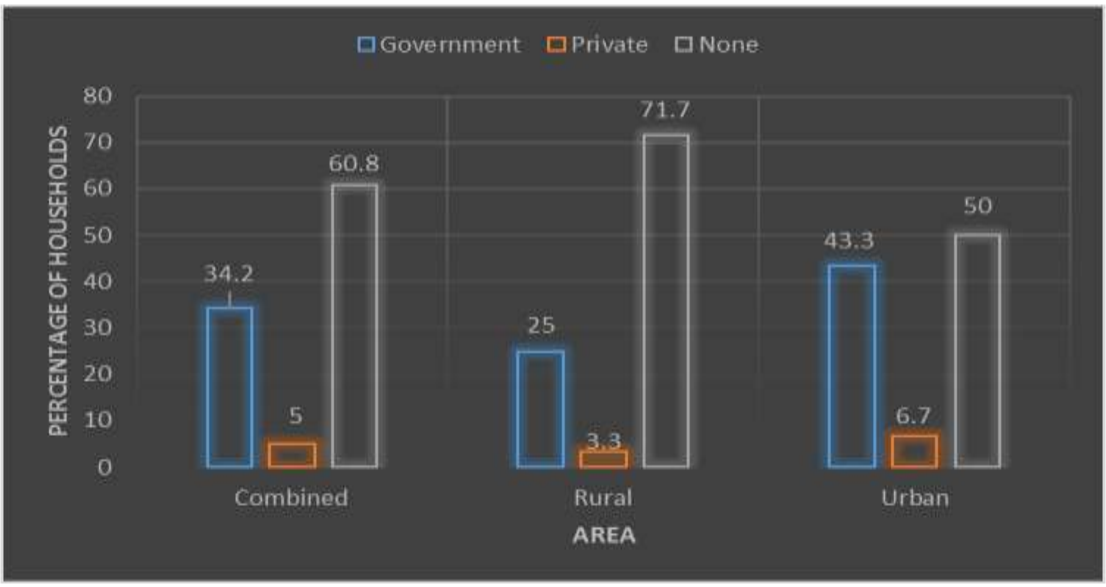
3.3. Economic Characteristics of the household

(i) Labour market characteristics

(a) Occupation wise distribution of the household head in the sample shows following pattern

The household sample consists of majority of the household heads 71.7% in rural areas and 50% in urban areas were neither employed in government sector nor in private sector, about 25% and 43.3% in rural and urban areas respectively were employed in government sector. Very few 3.3% and 6.7% in rural and urban areas respectively employed in private sector.

Figure 3.2: Occupation of household head



Source: Field Survey, 2020.

(b) Permanent Salaried wise distribution of the household head in the sample shows following pattern

The sample of household consists of majority of household heads 73.3% in rural areas and 50 % in urban areas were non – permanent salaried workers. Nearly, 26.7% and 50% of household heads in rural and urban areas respectively who were permanent salaried workers.

Table no. 3.8: Percentage distribution of head according to Permanent/Regular Salaried heads

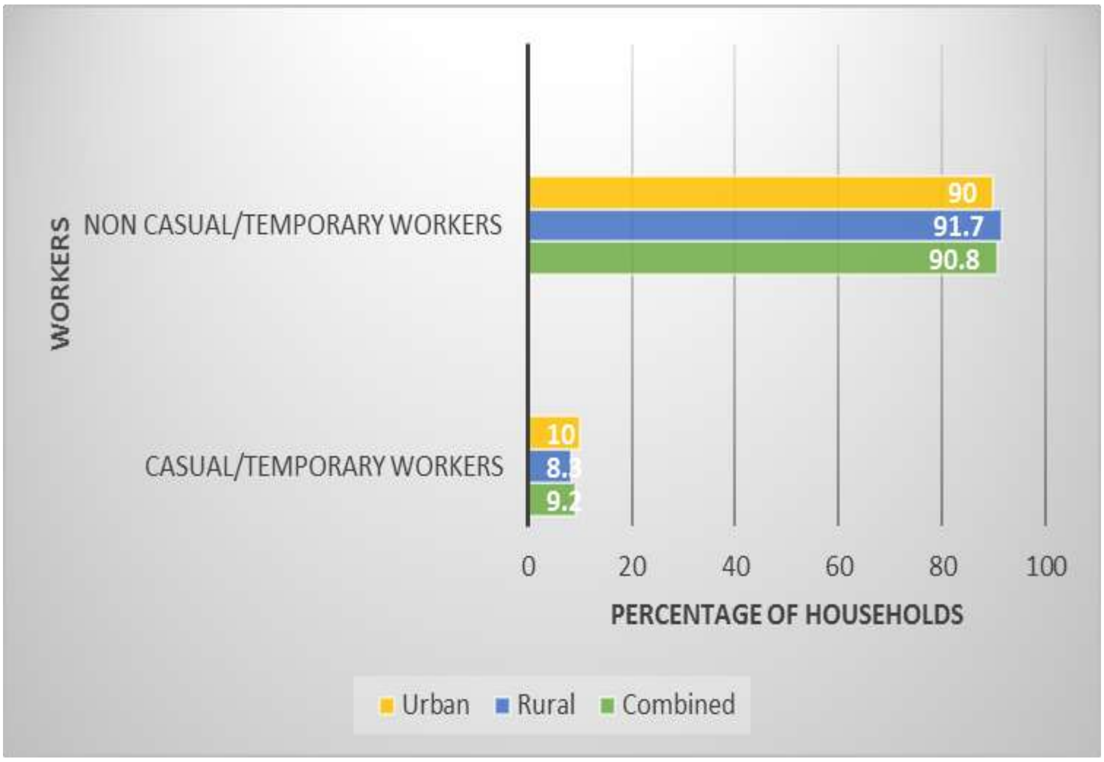
	Percentage of households		
Permanent/Regular Salaried	**Combined**	**Rural**	**Urban**
Permanent	38.3	26.7	50.0
Non -Permanent	61.7	73.3	50.0
Total	100.0	100.0	100.0

Source: Field Survey, 2020.

(c) Casual/Temporary Worker wise distribution of the household head in the sample shows following pattern

Majority of the households' head 91.7% and 90% in rural and urban areas respectively were non – casual/temporary workers and only 8.3% and 10% household heads were casual/temporary workers.

Figure 3.3: Causal worker



Source: Field Survey, 2020.

(d) Self Employed wise distribution of the household head in the sample shows following pattern

Majority of the household heads 63.3% in rural areas were self – employed and 36.7% were not self – employed whereas majority of household heads 60% in urban areas were not self – employed and only 40% household heads were self – employed.

Table no. 3.9: Percentage distribution of households according to Self Employed heads

	Percentage of households		
Employed	**Combined**	**Rural**	**Urban**
Self Employed	51.7	63.3	40.0
Not self employed	48.3	36.7	60.0
Total	100.0	100.0	100.0

Source: Field Survey, 2020.

(e) Migrant Worker households in the sample shows following pattern

Majority of the households in rural and urban areas do not have migrant workers 76.7% and 83.3% respectively. Only 23.3% and 16.7% households have migrant workers in rural and urban areas respectively.

Table no. 3.10: Percentage distribution of households according to Migrant worker

	Percentage of households		
Worker	**Combined**	**Rural**	**Urban**
Have Migrant	20.0	23.3	16.7
Do not have migrant	80.0	76.7	83.3
Total	100.0	100.0	100.0

Source: Field Survey, 2020

(ii) Number of earning members in the sample shows following pattern

Both in rural and urban areas majority of the households 58.3% and 61.7% respectively had one earning member and 1.7% of the households had four earning members in urban areas but no household had four earning members in rural area.

Table no. 3.11: Percentage distribution of household according to Earning members

	Percentage of households		
No. of members	**Combined**	**Rural**	**Urban**
1	60.0	58.3	61.7
2	34.2	38.3	30.0
3	5.0	3.3	6.7
4	.8	-	1.7
Total	100.0	100.0	100.0

Source: Field Survey, 2020.

(iii) Monthly Expenditure of the household in the sample shows following pattern

The average monthly expenditure of households was Rs 7937.50 (SD = 4779.843) for total households. The average monthly expenditure was high for households in urban areas Rs 8275 (SD = 4559.796) then households in rural areas Rs 7600 (SD = 5005.795) due to high cost of living and high income earning people in urban area.

Table no. 3.12: Descriptive statistics of households according to monthly expenditure (in RS)

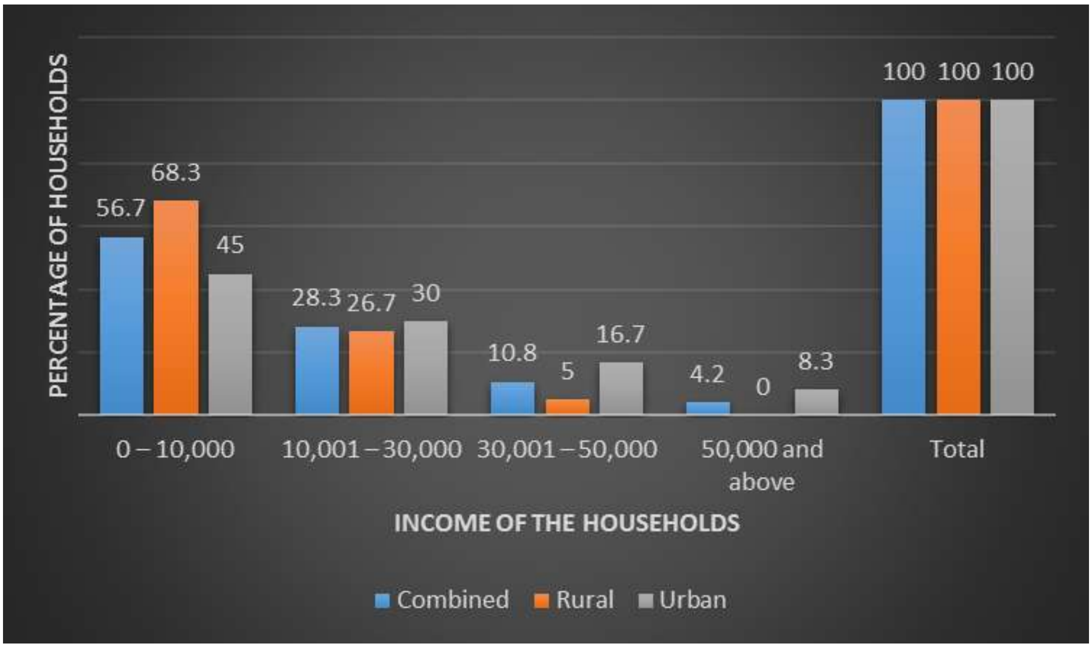
	Combined			**Rural**			**Urban**		
	No. of households	Mean	SD	No. of households	Mean	SD	No. of households	Mean	SD
Exp. (in RS)	120	7937.50	4779.843	60	7600.00	5005.759	60	8275.00	4559.796

Source: Field Survey, 2020.

(iv) Monthly Income (in Rs) wise distribution of the households in the sample shows following pattern

The household sample consists of 68.3% and 45% households whose monthly income were below Rs 10,000 in rural and urban areas respectively, 26.7% and 30 households with monthly income between Rs 10,001 – 30,000 in rural and urban areas respectively, 5% and 16.7% households with monthly income between Rs 30,001 – 50,000 in rural and urban areas respectively and only 8.3% households with monthly income Rs 50,001 and above in urban areas.

Figure 3.4: Income wise distribution of households (RS per month)



Source: Field Survey,2020

3.4. Water Consumption Pattern

3.4.1. Physical Availability of water of the household

Among rural households, majority (81.7%) of the households have very poor availability of water at their houses, 15 % of the households have poor availability of water at their houses, 1.7% of the households have good availability of water at their houses and 1.7% of the households have very acceptable availability of water at their house with no options for households other than to accept. Among urban households, majority 75% of the households have very poor availability of water at their house, about 10% of the households have poor availability of water at their house and 15%

of the households have good availability of water at their house as they had more number of connections or get extra supply for some payment.

Table no. 3.13: Percentage distribution of households according to physical availability of water

	Percent of households		
Availability	**Combined**	**Rural**	**Urban**
Very poor	45.8	81.7	10.0
Poor	45.0	15.0	75.0
Good	8.3	1.7	15.0
Acceptable	.8	1.7	-
Total	100.0	100.0	100.0

Source: Field Survey, 2020.

3.4.2. Water for Drinking Purpose

(i) Type of Water Sources for drinking purpose of the household in the sample shows following pattern

Piped water into dwelling was the only source of drinking water for all households (50%) in urban areas while spring/*dhara* was the only source of drinking water for all households (50%) in rural areas because there are no pipe connections in rural areas so the households in rural areas are totally dependent on spring/*dhara* water.

(ii) Time taken to collect drinking water (liters per day) of the household in the sample shows following pattern

The time taken to collect drinking water during dry season is more in rural areas compared to urban areas. Maximum time taken is 21 – 30 minutes for urban households whereas its 51 – 60 minutes for rural households. Reasons for this difference is that rural households lack pipe water connections so they have to fetch drinking water from spring/*dhara* which takes extra time for travelling and waiting.

In wet season, time taken to collect water decreases compared to dry season. This is because in rural areas the pressure from spring water increases hence it takes less time to fill the water containers. Also, due to frequent landslides and continues rain in rural area people were not able to go to spring/*dhara* so they managed from *Jhora* water. Similarly, in urban area the volume of water received by household increases due to good water pressure and supply time also increases.

Table no. 3.14: Percentage distribution of households for time taken in dry and wet seasons

	Percentage of households					
	Dry			**Wet**		
Time (minutes per day)	**Combined**	**Rural**	**Urban**	**Combined**	**Rural**	**Urban**
0 – 10	10.0	-	20.0	20.0	20.0	20.0
11 – 20	32.5	11.7	53.3	61.7	51.7	71.7
21 – 30	27.5	28.3	26.7	16.7	25.0	8.3
31 – 40	10.0	20.0	-	1.7	3.3	-
41 – 50	8.3	16.7	-	-	-	-
51 – 60	11.7	23.3	-	-	-	-
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field Survey, 2020.

(iii) Person Responsible for collecting drinking water of the households in the sample shows following pattern

Majority of the household family members equally participated in fetching or collecting water in both rural and urban areas 98.3% and 100% respectively during dry and wet seasons so the responsibility is not just on head or any particular family member.

(iv) Volume of drinking water collected (liters per day) of the households in the sample shows following pattern

Majority of the rural and urban households 98.3% and 80% respectively could collect only less than 50 liters. Volume collected by rural households is much less because in rural area people go to spring/*dhara* for which waiting time to collect water is quiet long and the water pressure also decreases thus. As per the group discussion, "to fill 5-liter jerry can it takes 15 minutes due to no pressure". In urban area most of the households lack good pressure of water supply in pipes hence households could not collect large volume and those households who had more than one connections could collect more volume of water.

The volume of water collected by rural households increases due to less waiting time and good water pressure during wet season while in urban households the water supply time increases about 40 – 45 minutes during wet season so volume of water collected increases.

Table no. 3.15: Percentage distribution of households for volume collected in dry and wet seasons

	Percentage of households					
	Dry			**Wet**		
Volume(in liters)	**Combined**	**Rural**	**Urban**	**Combined**	**Rural**	**Urban**
0 – 50	89.2	98.3	80.0	60.8	83.3	38.3
51 – 100	9.2	1.7	16.7	34.2	16.7	51.7
101 – 150	.8	-	1.7	3.3	-	6.7
151 – 200	.8	-	1.7	.8	-	1.7
201 – 250	-	-	-	.8	-	1.7
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field Survey, 2020.

(v) Households expenditure on drinking water in the sample shows following pattern

The household sample consists of all the urban households 100% incur RS 300 per annum as cost of water services and no rural households have to incur water expenditure for drinking purpose as common property resources was their major source.

(vi) Drinking Water Quality of the household in the sample shows following pattern

During dry season, all rural households (100%) who finds drinking water quality to be good as households perceive that spring/*dhara* water is the best pure water suitable for drinking. Majority of the urban households (88.3%) who finds drinking water quality received through pipes to be good and 11.7% of the households find quality to be bad. Water quality decreases during wet season where majority urban households find water quality to be bad (90%) due to bad colour, odour and taste of water received and only few rural households (6.7%) find quality to be bad due to muddy water.

Table no. 3.16: Percentage distribution of households according to drinking water quality

	Percentage of households					
	Dry			**Wet**		
Quality	**Combined**	**Rural**	**Urban**	**Combined**	**Rural**	**Urban**
Good	94.2	100.0	88.3	51.7	93.3	10.0
Bad	5.8	-	11.7	48.3	6.7	90.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field Survey, 2020.

(vii) Treatment of water for drinking water by the household in the sample shows following pattern

Both during dry and wet seasons, all the urban households treat their drinking water before consumption where the most common treatment methods used were boiling, filter, boil and filter, boil and use cloth and used bleaching. Every urban household treated their drinking water as it was supplied from open water reservoirs. Among rural households majority used boiling, boil and filter and boil and use cloth as the treatment methods before consumption and 31.7% of the rural households do not find it necessary to treat as they perceive spring water to be pure and clean as it comes from underneath the earth. Majority of the rural and urban households boiled their drinking water before consumption.

Table no. 3.17: Percentage distribution of households according to treatment methods followed

	Percentage of households			
	Methods	**Combined**	**Rural**	**Urban**
Treat	Boil	60.0	56.7	61.7
	Filter	6.7	-	13.3
	Boil & Filter	14.2	10.0	18.3
	Boil & Use cloth	2.5	1.7	3.3
	Bleaching	1.7	-	3.3
Do not treat		15.8	31.7	-
Total		100.0	100.0	100.0

Source: Field Survey, 2020.

3.4.3. Water for Other Purposes

(i) Type of Water Sources of the household for other purposes in the sample shows following pattern

Jhora water was the major water source for majority of the rural households (46.7%) both in dry and wet seasons. Water vendor was the major water source for majority of the urban households (53.3%) in dry season which shifts to rainwater (58.3%) in wet season. In rural areas, privatization of the commons was seen as nearly 30% of the rural households source had private connections where the households bought water from private springs nearby with two types of payment systems (i) either the source could be bought at one time for RS 3 to 4 lakhs, the household is continuously supplied water for life time till the spring dries up under this system (ii) the other is a monthly system where every month RS 300 – 1000 is charged by owner of the private spring for water supply but the expenditure on raw materials RS 15,000 – 20,000 (approx.) to carry water from source to the concerned house has to be borne by that particular household.

Rural households did not depend on rainwater instead collected jhora water.

Table no. 3.18: Percentage distribution of household according to Other Purpose water sources during dry season

	Percentage of households					
	Dry			Wet		
Sources	Combined	Rural	Urban	Combined	Rural	Urban
Piped water into dwell.	14.2	-	28.3	14.2	-	28.3
Private connections	15.0	30.0	-	15.0	30.0	-
Spring/*Dhara*	20.8	23.3	18.3	11.7	23.3	-
Water Vendor	26.7	-	53.3	6.7	-	13.3
Rainwater	-	-	-	29.2	-	58.3
Jhora	23.3	46.7	-	23.3	46.7	-
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field Survey, 2020.

(ii) Time taken to collect water for other purposes (liters/day) of the household in the sample shows following pattern

The distribution of time required for water collection shows following pattern. During dry season, majority of the rural households (46.7%) collect water between 51 – 60 minutes and 15% of the households collect water in 61 minutes & above and while majority of the urban households (58.3%) collect water between 11 – 20 minutes. This is because in rural areas some springs or jhora dry up and water has to be fetched from different alternative springs/jhora while in urban areas supply time decreases for pipe connections so their dependency on water vendor increases where it takes 15 minutes (approx.) to fill 1000 liters.

During wet season, time taken to collect water reduces compared to dry season where majority of the rural households (35%) collect water between 11 – 20 minutes because pressure of jhora water increases. Still there were households nearly 20% who took 51 – 60 minutes while majority of the urban households (58.3%) depend on rainwater so time taken to collect rainwater could not be quantified.

Table no. 3.19: Percentage distribution of households according to time taken in dry season

	Percentage of households					
	Dry			**Wet**		
Time (in minutes)	**Combined**	**Rural**	**Urban**	**Combined**	**Rural**	**Urban**
0 – 10	10.8	-	21.7	7.5	1.7	13.3
11 – 20	33.3	8.3	58.3	31.7	35.0	28.3
21 – 30	15.0	13.3	16.7	15.0	30.0	-
31 – 40	4.2	5.0	3.3	3.3	6.7	-
41 – 50	5.8	11.7	-	2.5	5.0	-
51 – 60	23.3	46.7	-	10.0	20.0	-
61 & above	7.5	15.0	-	.8	1.7	-
No time record	-	-	-	29.2	-	58.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field Survey, 2020.

(iii) Person Responsible for collecting water of the households in the sample shows following pattern

Both in rural and urban areas all the members equally participate in fetching or collecting water both during dry and wet seasons. Unlike (Chakraborty, 2018) who analysed water scarcity in Darjeeling.

(iv) Volume of water collected (liters per day) of the households in the sample shows following pattern

During dry season, as springs/*dhara* dry up majority of the rural households collect water below 100 liters and very few households who feed animals collect 1001 and above liters. Majority 51.7% of the urban households collect 1001 and above because these households purchase from water vendors due to acute scarcity. So, in dry season majority of the urban households depend on water vendors for water supply.

During wet season, majority 31.7% of the households collect water within 0 – 100 liters but percentage of households decreased compared to dry season and some rural households are able to now collect more volume because springs supply of water increases and small springs which dry up during dry season gets recharged so households get water from these springs too. *Jhora* water supply too increases. While majority of the urban households (58.3%) adopted rainwater harvesting where volume could not be quantified. So dependency on water vendors of urban households decreases slightly during wet season but due to changes in rain pattern the district has been experiencing less rainfall compared to previous years.

Table no. 3.20: Percentage distribution of households according to water collected in wet season

	Percentage of households					
	Dry			Wet		
Volume (in liters)	Combined	Rural	Urban	Combined	Rural	Urban
0 – 100	45.0	48.3	41.7	21.7	31.7	11.7
101 – 200	17.5	30.0	5.0	13.3	21.7	5.0
201 – 300	3.3	6.7	-	4.2	6.7	1.7
301 – 400	1.7	3.3	-	5.0	8.3	1.7
401 – 500	5.8	10.0	1.7	15.0	20.0	10.0
601 – 700	-	-	-	.8	1.7	-
701 – 800	-	-	-	.8	1.7	-
901 – 1000	25.8	-	51.7	8.3	5.0	11.7
1001 & above	0.8	1.7	-	1.7	3.3	-
No record	-	-	-	-	-	58.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field Survey, 2020.

(v) Households expenditure on water needed for other purposes in the sample shows following pattern

During dry season, among rural households majority (70%) do not incur any water expenditure as they either use spring water or *Jhora* water and on an average Rs 500 is spend every month for purchasing water from private springs by rural households. Among urban households, only 18.3% do not incur water expenditure as they carry water from springs while majority of the households (73.3%) spend Rs 201 – 400. Urban households have expenditure usually on water vendors and extra supply from pipe lines.

During wet season, among rural households majority 71.7% do not have water expenditure as these households carry water from spring or *Jhora* hence, dependency on spring or *Jhora* increased slightly in wet season but still expenditure on water supply from private springs had to be made. Among urban households, majority 58.3% had no expenditure as these households' were dependent on rainwater and only

41.7% spend on water vendors. So rainwater harvesting is more common in urban areas compared to rural.

Table no. 3.21: Percentage distribution of households according to water expenditure during dry and wet seasons

	Percentage of households					
	Dry			Wet		
Exp. (in Rs)	**Combined**	**Rural**	**Urban**	**Combined**	**Rural**	**Urban**
0 – 200	.8	-	1.7	-	-	-
201 – 400	40.8	8.3	73.3	25.0	8.3	41.7
401 – 600	10.8	20.0	1.7	9.2	18.3	-
601 – 800	1.7	-	3.3	-	-	-
801 - 1000	1.7	1.7	1.7	.8	1.7	-
No exp.	44.2	70.0	18.3	65.0	71.7	58.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

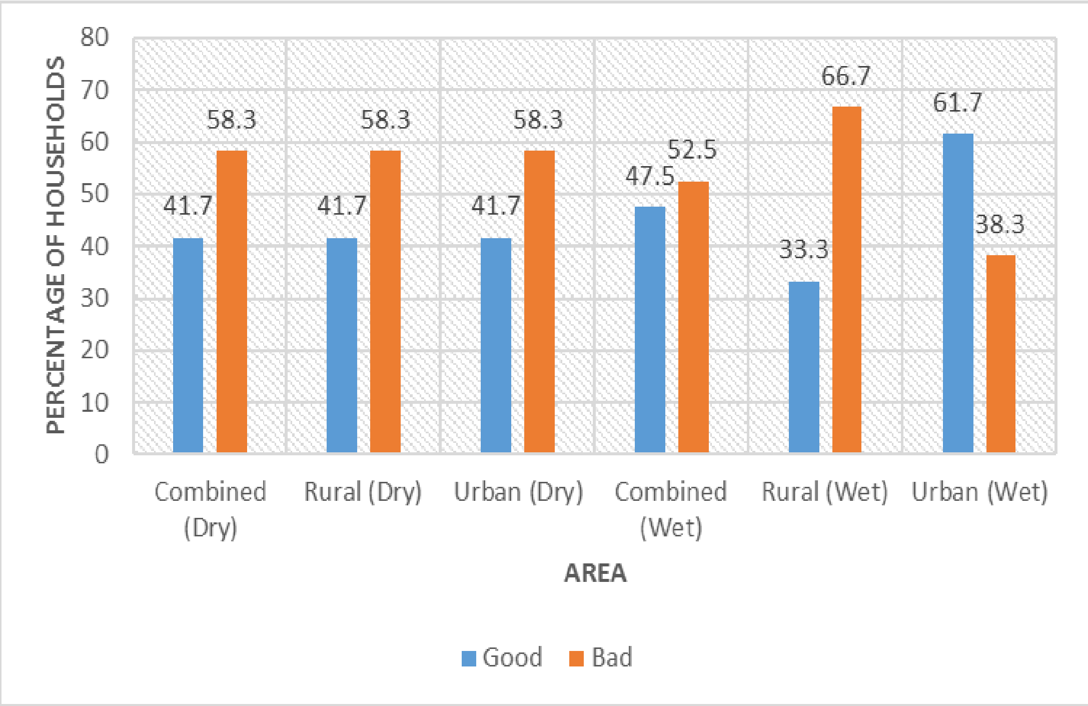
Source: Field Survey, 2020.

(vi) Water Quality of the household in the sample shows following pattern

In dry season, both among rural households and urban households, majority 58.3% of the households find water quality to be bad and 41.7% of the households find water quality to good. Rural households find *Jhora* water to be so bad that it causes water borne diseases such as cold and cough are very frequently. The urban households find pipe water as well as water from vendors not good for drinking purpose.

In wet season, percentage of rural households who find water quality to be bad increases to 66.7% while this percentage decreases to 38.3% for urban households. 66.7% rural households find bad quality because spring water becomes little muddy in colour and *Jhora* water quality becomes very bad in colour and ordour. Majority of urban households find water quality to be good because they find rainwater quality to be good than pipe or vendor water.

Figure 3.5: Water quality



Source: Field Survey, 2020.

(vii) Treatment of water for other purposes by the household in the sample shows following pattern

Both during dry and wet seasons, majority of the households in rural and urban areas i.e. 98.3% and 76.7% respectively do not treat water used for other purposes as households think that since it's not for drinking purpose so they do not treat however percentage is little less for urban households because of awareness regarding health issues and only 1.7% and 23.3% rural and urban households respectively treat water for other purposes by using cloth the pipe through which households collect water.

Table no. 3.22: Percentage distribution of households according to treatment methods followed

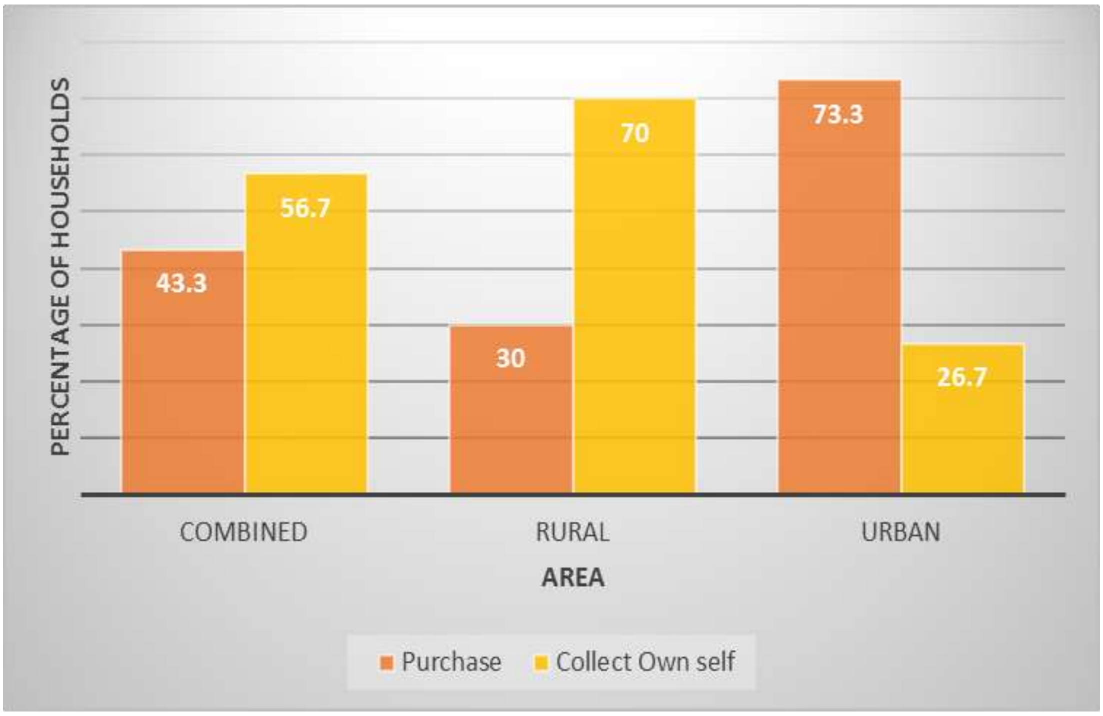
		Percentage of households		
	Methods	**Combined**	**Rural**	**Urban**
Treat	Use cloth	12.5	1.7	23.3
Do not treat		87.5	98.3	76.7
Total		100.0	100.0	100.0

Source: Field Survey, 2020.

3.4.4. Purchase water or collect own self by the household in the sample shows following pattern

In rural areas, majority of the households (85%) carried water by the household members to their house from springs or *Jhora* and only 15% of the households purchased water from private springs. In urban areas, majority 73.3% of the households purchase water from water vendors and only 26.7% of the households carried from springs.

Figure 3.6: Purchase water



Source: Field Survey, 2020.

3.4.5. Regularity in Purchase of water by the household in the sample shows following pattern

Among rural households, majority 98.3% of the households did not purchase regularly from water vendors only 1.7% of the households purchased from vendors particularly for construction purpose. Among urban households, water is purchased from water vendors regularly both during dry and wet seasons by 60% of the households and 10% of the households purchase during dry season only as during wet season they manage from rainwater and only 30% of the households do not purchase regularly these households either purchase occasionally during marriage, death religious program or they collect from springs.

Table no. 3.23: Percentage distribution of households according to regularity in purchase of water

	Percent of households		
Regularity	**Combined**	**Rural**	**Urban**
During dry season	5.8	1.7	10.0
Both dry and wet seasons	30.0	-	60.0
No purchase	64.2	98.3	30.0
Total	100.0	100.0	100.0

Source: Field Survey, 2020.

3.4.6. Water consumed (liters per day)

The distribution of overall water consumption per day shows following pattern. The overall water consumption is high for rural households compared to urban households. Rural households are engaged with small kitchen garden, livestock's and fishery which needs more water while urban households purchased water from vendors for higher consumption.

Table no. 3.24: Percentage distribution of households according to water consumed per day

	Percent of households		
Consumption in liters	**Combined**	**Rural**	**Urban**
0 – 100	45.8	46.7	45.0
101 – 200	37.5	35.0	40.0
201 – 300	10.0	10.0	10.0
301 – 400	.8	1.7	-
401 – 500	4.2	3.3	5.0
501 – 600	.8	1.7	-
601 & above	.8	1.7	-
Total	100.0	100.0	100.0

Source: Field Survey, 2020.

3.4.7. Per capita consumption in liters per person per day (lpd)

The daily mean per capita water consumption of overall 120 households was M = 43 lpd and SD = 33.47.

The standards given for rural areas by Jal Jeevan Mission is 55 lpd. The sample rural households consist of only 12 household members who could meet the 55lpd standards. The mean difference from the standard was 20 lpd. The 55lpd standard is too low as rural people in some areas do not have access to water bodies so revision is needed.

The standards given for urban areas by Jal Jeevan Mission is 135 lpd. No urban household member could meet the 135lpd standards. The mean difference from the standard was 95 lpd.

Table no. 3.25: Descriptive statistics of per capita consumption

	Descriptive statistics					
	Combined		Rural		Urban	
	Mean	SD	Mean	SD	Mean	SD
Per capita Consumption (in lpd)	43	33.47	45	39.34	40	26.49

Source: Field Survey, 2020.

3.4.8. Perception regarding water

All the households in rural and urban areas perceive that there should urgently be government policy to solve water poverty.

3.4.9. Water use pattern (in liters per day)

(i) Rural and Urban households water consumption pattern

The mean water consumption among rural households was more than mean water consumption among urban households because water requirements for rural households are more than in urban households as water is needed in every urban household only three purposes for drinking, washing and cleaning but in every rural household water is needed not just for drinking, washing and cleaning but also for agriculture and feeding animals.

Table no. 3.26: Descriptive statistics for rural and urban water consumption patterns

	Combined			Rural			Urban		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Consumption in liters	169	150	165.09	183	150	209.46	155	150	103.49

Source: Field Survey, 2020.

(ii) Water consumption pattern depending upon household heads

In both the rural and urban households, female headed households consume or use more water per day than male headed households. Female heads in urban households save more water than female heads in rural. Also, female heads in urban households mostly rent their flats to students and working people as they use less water compared to families and girls.

Within rural households, female headed households mean water consumption is much more the male headed households because female headed households were also engaged in gardening and livestock which needed more water so family members of these households had to frequently travel spring/*dhara* to carry water. One female headed household had kept a person to carry water from spring for fooding, clothing and shelter.

Within urban households, water consumption per day of male headed and female headed households are almost equal.

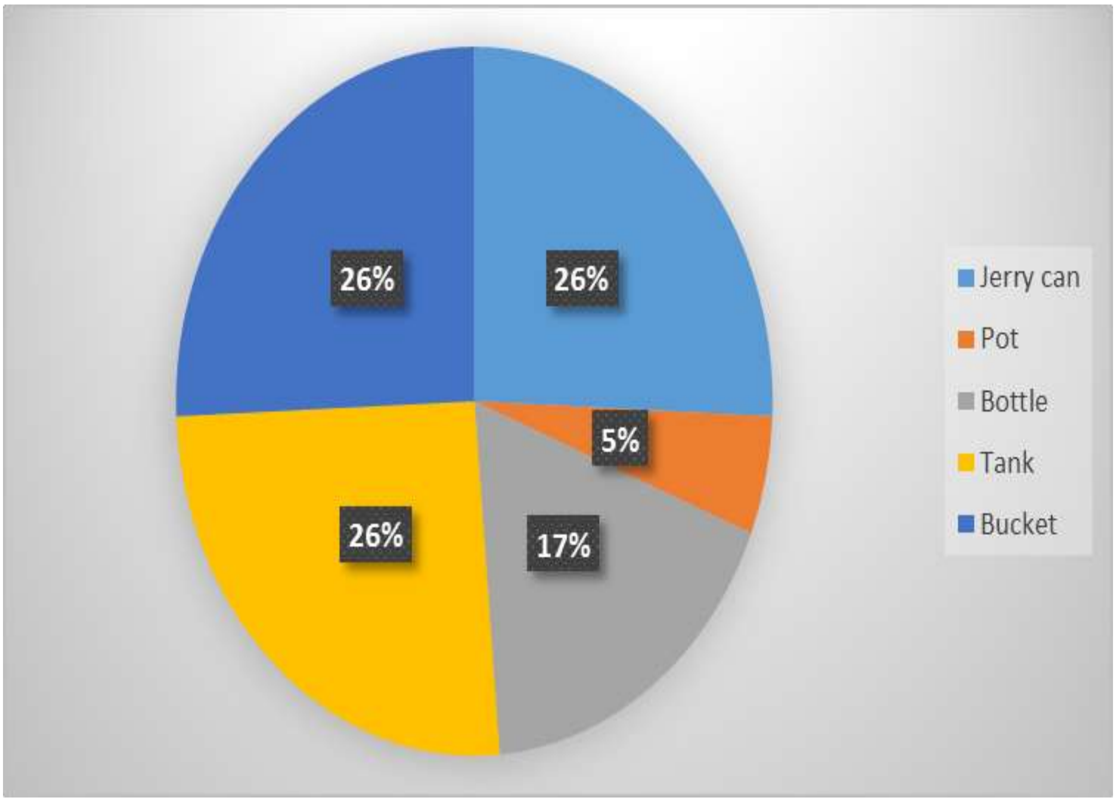
Table no. 3.27: Descriptive statistics of water consumption pattern as per head of the household

	Descriptive Statistics																	
	Male head									**Female head**								
	Combined			**Rural**			**Urban**			**Combined**			**Rural**			**Urban**		
	M	Median	SD	M	Median	SD	M	Median	SD	M	Median	SD	M	Median	SD	M	Median	SD
Consp.in liters	154	150	107.07	153	120	116.37	155	150	98.46	255	150	327.62	317	200	411.73	156	100	135.66

Source: Field Survey, 2020.

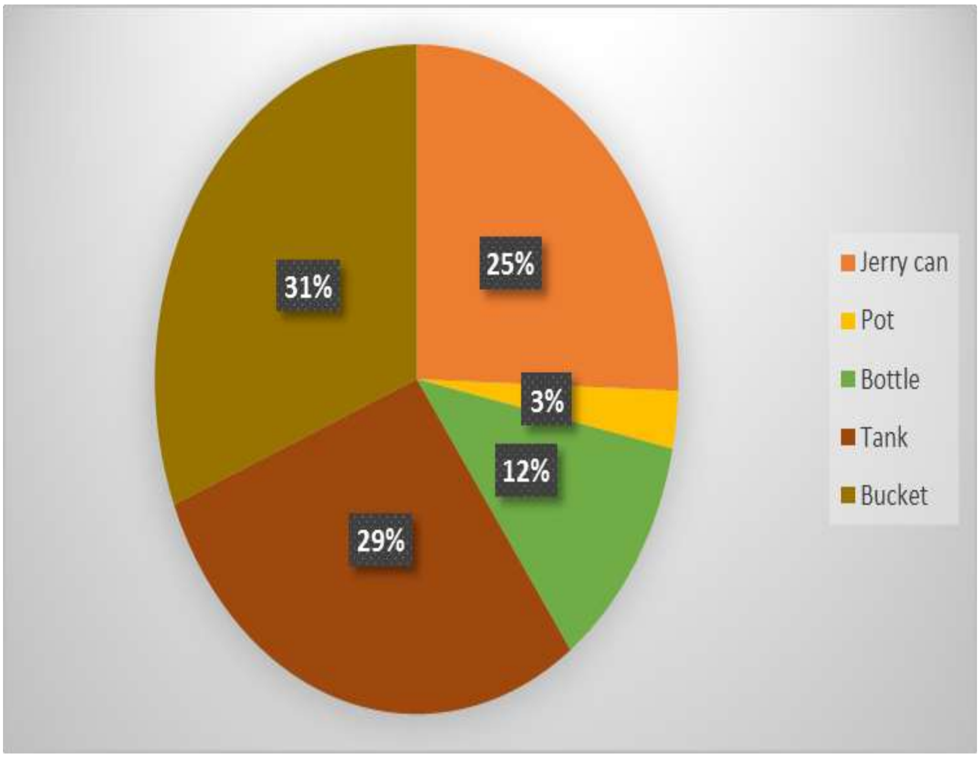
3.4.10. Water Containers to store water

Figure 3.7: Water containers used by rural households



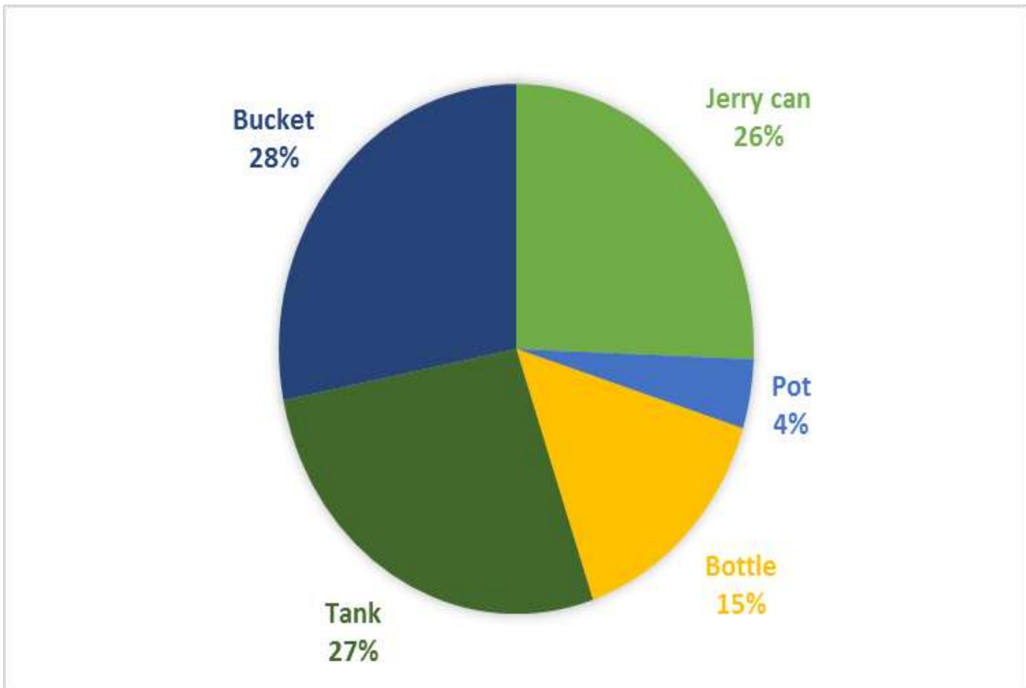
Source: Field Survey, 2020.

Figure 3.8: Water containers used by urban households



Source: Field Survey, 2020.

Figure 3.9: Water containers used by all the sample households



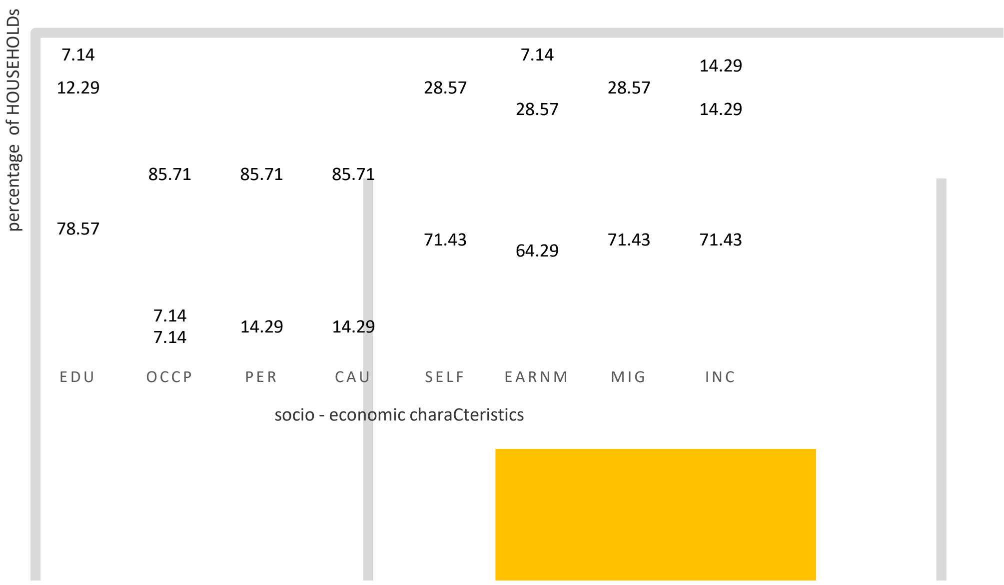
Source: Field Survey, 2020.

3.5. Dependency on Common Property Resources (spring/*dhara*)

Urban and rural households, whose head were self-employed and who had no government or private regular salary job with low household income RS 0 – 10,000 per month were mainly dependent on CPR because these rural households had no rainwater harvesting awareness and these urban households were unable to bear the expenditure of purchasing water from water vendors. Also households in both rural and urban areas who had no migrant workers were dependent upon CPR because all the members equally participated in carrying/fetching water so they could not go out to work.

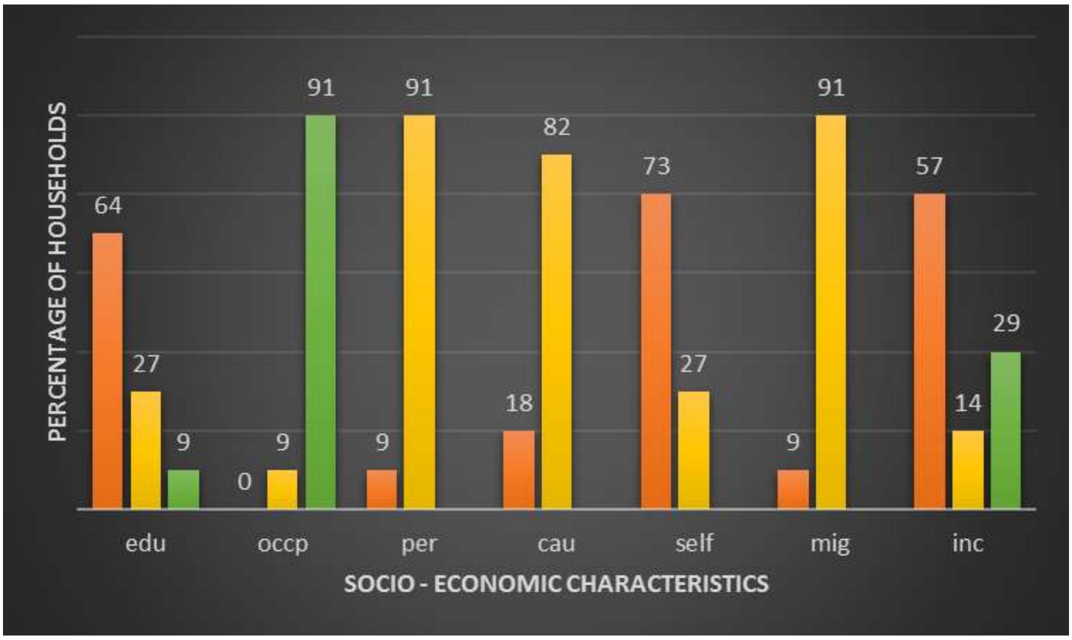
During wet season, all the urban households decreased their dependency upon CPR and shifted to rainwater harvesting.

Figure 3.10: Dependency on CPR for rural households



Source: Field Survey, 2020.

Figure 3.11: Dependency on CPR for urban households



Source: Field Survey, 2020.

3.6. Dependency on Water Vendors (Urban Areas)

In urban areas, during dry season 53.33% of the households were dependent on water vendors. Households whose head had government and permanent regular salaried job usually purchased water from vendors.

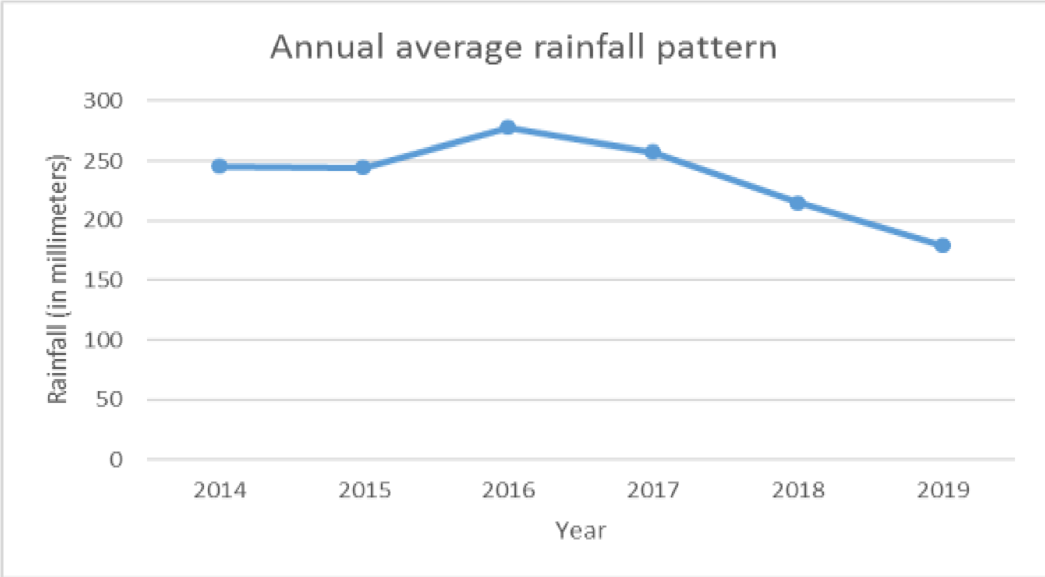
During the wet season, 40% of the urban households dependency on water vendors decreased and these households shifted to rainwater. However, dependency on water vendors did not decrease fully due to changes in the rainfall pattern in the study area.

Table no. 3.28: Socio – economic characteristics of the households depending on water vendors

	Occupation			Permanent Salaried		Causal/Temporary worker		Self – employed	
	Govt.	Pvt.	None	Yes	No	Yes	No	Yes	No
Percentage of households	**30**	**3.33**	**20**	**33.33**	**20**	**6.66**	**46.67**	**10**	**43.33**

Source: Field Survey, 2020.

Figure no. 3.12: Changes in rainfall pattern



Source: Author's own estimation based on available secondary data, 2020

3.7. Health problems related to water

3.7.1. Water Borne diseases of the household in the sample shows following pattern

Among rural households 50% reported that they did not suffer from any water borne diseases while 5% of the households frequently suffered from skin problems, 28.3% of the households frequently suffered from cold, cough and fever, 1.7% of the households frequently suffered from diarrhoea, skin problems, cold, cough and fever and 15% of the households frequently suffered from diarrhoea and gastroenteritis. Most of these diseases were caused by *Jhora* water which rural households used for other purposes like washing, bathing, cleaning etc. Among urban households only 38.3% reported that they did not suffer from any water borne diseases while 3.3% of the households frequently suffered from diarrhoea, 6.7% of the households frequently suffered from skin problems, 28.3% of the households frequently suffered from gastroenteritis, 1.7% of the households frequently suffered from cold, cough and fever, 1.7% of the households frequently suffered from skin problems, cold, cough and fever, 18.3% of the households frequently suffered from diarrhoea and gastroenteritis and 1.7% of the households frequently suffered from diarrhoea, vomiting and gastroenteritis, the percent of households suffering are more in urban areas as the overall both drinking and other purpose water quality is not good.

Table no. 3.29: Percentage distribution of households according to water borne diseases

	Percent of households			
	Diseases	**Combined**	**Rural**	**Urban**
Problems	Diarrhoea	1.7	-	3.3
	Skin problems	5.8	5.0	6.7
	Gastroenteritis	14.2	-	28.3
	Cold/cough/fever	15.0	28.3	1.7
	Diarrhoea, Skin problems, Cold, Cough, Fever	.8	1.7	-
	Skin problems, Cold, Cough, Fever	8.3	-	1.7
	Diarrhoea and gastroenteritis	9.2	15.0	18.3
	Diarrhoea, vomiting and gastroenteritis	.8	-	1.7
No problems		44.2	50.0	38.3
Total		100.0	100.0	100.0

Source: Field Survey, 2020.

3.7.2. Death of household members due to water borne diseases in the sample shows following pattern

According to the surveyed households, there were no deaths in both rural and urban households due to water borne diseases till now. Lack of death due to water disease was surprising as percent of households suffered was quiet high. Such low death outcome may be due to lack of good medical facilities or reporting of such cases due lack of medical advancement.

Table no. 3.30: Descriptive statistics for monthly expenditure on water related health problems

	Percent of households					
	Combined		Rural		Urban	
	Mean	SD	Mean	SD	Mean	SD
Expenditure (in RS)	2383.33	2126.675	2075.00	1471.495	2691.67	2600.671

Source: Field Survey, 2020.

3.7.3. Monthly medical expenditure on water related health problems of the household in the sample shows following pattern

The mean monthly medical expenditure on water related health problems for were Rs 2075 (SD = Rs 1471.495) and Rs 2691.67 (SD = 2600.671) for rural and urban households respectively. Health expenditure was more volatile and higher for urban households compared to rural households.

3.7.4. Type of toilet/latrine facilities of the household in the sample shows following pattern

In rural area, all the households had personal septic tank toilet/latrine 100% and in urban areas too all the households had personal flush toilet/latrine (sewerage system) 100%. So both rural and urban households had good sanitation facilities.

3.7.5. Solid waste disposal methods of the household in the sample shows following pattern

Among rural households' majority 93.3% of the households burned solid waste on their land, 3.3% of the households burned and decomposed solid waste on their land, 3.3% of the households burned and threw their solid waste on *Jhora – khola*. Among urban households majority 90% of the households gave solid waste to the municipality waste collector early in the morning, 6.7% of the households burned solid waste on their land and 3.3% of the households gave solid waste to the municipal collector early in the morning and burned themselves.

Table no. 3.31: Percentage distribution of households according to methods to dispose solid waste

	Percent of households		
Disposal methods	**Combined**	**Rural**	**Urban**
Burn	50.0	93.3	6.7
Municipal Waste Collector	45.0	-	90.0
Burn and decompose	1.7	3.3	-
Jhora – khola and Burn	1.7	3.3	-
Burn and municipal collector	1.7	-	3.3
Total	100.0	100.0	100.0

Source: Field Survey, 2020.

3.8. Comparison between rural and urban water consumption patterns (t – test)

3.8.1. Drinking Purpose

(i) Time taken to collect water in dry season.

H0: mean time taken to collect water in dry season do not differ between rural and urban households.

H1: mean time taken to collect water in dry season differs between rural and urban households.

Equal variance not assumed, an independent samples t – test was done to compare the time to collect water for rural and urban households. The difference was statistically significant (t (84.417) = 10.168, p = 0.000 < 0.05) with mean time for rural households (M = 40.67, SD = 14.216) was more than urban households' (M = 20, SD = 6.765). The magnitude of the variation between the means, (mean difference = 20.667 with 95% confidence interval 16.625 to 24.708) was significant. So, we reject H0 and accept H1 at 5% level of significance. Hence, there is a difference in mean time taken to collect water between rural and urban households in dry season.

Table no. 3.32: Time taken to collect water for drinking purpose for dry season

				Levene's Test for Equality of Variances		t-test for Equality of Means						
		Mean	SD	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
											Lower	Upper
Time (minutes/day)	Rural	40.67	14.216	38.909	.000	10.168	84.417	.000	20.667	2.032	16.625	24.708

(ii) Time taken to collect water in wet season

H0: mean time taken to collect water in wet season do not differ between rural and urban households.

H1: mean time taken to collect water in wet season differs between rural and urban households.

Equal variance not assumed, an independent samples t – test was done to compare the time to collect water for rural and urban households. The difference was statistically significant (t (104.017) = 2.148, p = 0.03 < 0.05) with mean time for rural households' (M = 19.83, SD = 7.700) was more than urban households (M = 17.25, SD = 5.242). The magnitude of the variation between the means, (mean difference = 2.583 with 95% confidence interval .199 to 4.968) was significant. So, we reject H0 and accept H1 at 5% level of significance. Hence, there is a difference in mean time taken to collect water between rural and urban households in wet season.

Table no. 3.33: Time taken to collect water for drinking purpose for wet season

				Levene's Test for Equality of Variances		t-test for Equality of Means						
		Mean	SD	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
											Lower	Upper
Time (minutes/day)	Rural	19.83	7.700	4.695	.032	2.148	104.017	.034	2.583	1.203	.199	4.968

(iii) Volume of water collected water in dry season

H0: mean volume of water collected in dry season do not differ between rural and urban households.

H1: mean volume of water collected in dry season differs between rural and urban households.

Equal variance not assumed, an independent samples t – test was done to compare the volume of water collected for rural and urban households. The difference was statistically significant (t (74.234) = -4.659, p = 0.000 < 0.05) with mean time for rural households' (M = 27.08, SD = 11.472) was less than urban households (M = 47.33, SD = 31.656). The magnitude of the variation between the means, (mean difference = -20.250 with 95% confidence interval -28.911 to -11.589) was significant. So, we reject H0 and accept H1 at 5% level of significance. Hence, there is a difference in mean volume of water collected between rural and urban households in dry season.

Table no. 3.34: Volume of water collected for drinking purpose in dry season

				Levene's Test for Equality of Variances		t-test for Equality of Means						
		Mean	SD	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
											Lower	Upper
Volume (liters/day)	Rural	27.08	11.472	8.930	.003	-4.659	74.234	.000	-20.250	4.347	-28.911	-11.589

(iv) Volume of water collected water in wet season

H0: mean volume of water collected in wet season do not differ between rural and urban households.

H1: mean volume of water collected in wet season differs between rural and urban households.

Equal variance not assumed, an independent samples t – test was done to compare the volume of water collected for rural and urban households. The difference was statistically significant (t (77.148) = -6.203, p = 0.000 < 0.05) with mean time for rural households' (M = 35.42, SD = 16.857) was less than urban households' (M = 72.00, SD = 42.458). The magnitude of the variation between the means, (mean difference = -36.583with 95% confidence interval -48.326 to -24.840) was significant. So, we reject H0 and accept H1 at 5% level of significance. Hence, there is a difference in mean volume of water collected between rural and urban households in wet season.

Table no. 3.35: Volume of water collected for drinking purpose in wet season

				Levene's Test for Equality of Variances		t-test for Equality of Means						
		Mean	SD	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
											Lower	Upper
Volume (liters/day)	Rural	35.42	16.857	17.399	.000	-6.203	77.148	.000	-36.583	5.898	-48.326	-24.840

3.8.2. Other Purpose

(i) Time taken to collect water in dry season

H0: mean time taken to collect water in dry season do not differ between rural and urban households.

H1: mean time taken to collect water in dry season differs between rural and urban households.

Equal variance not assumed, an independent samples t – test was done to compare the time to collect water for rural and urban households. The difference was statistically significant (t (67.510) = 10.436, p = 0.000 < 0.05) with mean time for rural households' (M = 59.42, SD = 28.908) was more than urban households' (M = 19.08, SD = 7.784). The magnitude of the variation between the means, (mean difference = 40.333 with 95% confidence interval 32.620 to 48.047) was significant. So, we reject H0 and accept H1 at 5% level of significance. Hence, there is a difference in mean time taken to collect water between rural and urban households in dry season.

Table no. 3.36: Time taken to collect water for other purpose for dry season

				Levene's Test for Equality of Variances		**t-test for Equality of Means**						
		Mean	SD	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
											Lower	Upper
Time (minutes/day)	Rural	59.42	28.908	19.891	.000	10.436	67.510	.000	40.333	3.865	32.620	48.047

(ii) Time taken to collect water in wet season

H0: mean time taken to collect water in wet season do not differ between rural and urban households.

H1: mean time taken to collect water in wet season differs between rural and urban households.

Equal variance not assumed, an independent samples t – test was done to compare the time to collect water for rural and urban households. The difference was statistically significant (t (76.836) = 7.396, p = 0.000 < 0.05) with mean time for rural households' (M = 34.00, SD = 17.462) was more than urban households' (M = 15.80, SD = 4.933). The magnitude of the variation between the means, (mean difference = 18).200 with 95% confidence interval 13.300 to 23.100) was significant. So, we reject H0 and accept H1 at 5% level of significance. Hence, there is a difference in mean time taken to collect water between rural and urban households in wet season.

Table no. 3.37: Time taken to collect water for other purpose for wet season

				Levene's Test for Equality of Variances		**t-test for Equality of Means**						
		Mean	SD	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
											Lower	Upper
Time (minutes/day)	Rural	34.00	17.462	25.208	.000	7.396	76.836	.000	18.200	2.461	13.300	23.100
	Urban	15.80	4.933									

(iii) Volume of water collected water in dry season

H0: mean volume of water collected in dry season do not differ between rural and urban households.

H1: mean volume of water collected in dry season differs between rural and urban households.

Equal variance not assumed, an independent samples t – test was done to compare the volume of water collected for rural and urban households. The difference was statistically significant (t (84.128) = -5.365, p = 0.000 < 0.05) with mean time for rural households' (M = 196.83, SD = 221.250) was less than urban households' (M = 555.33, SD = 467.896). The magnitude of the variation between the means, (mean difference = -358.500 with 95% confidence interval -491.372 to -225.628) was significant. So, we reject H0 and accept H1 at 5% level of significance. Hence, there is a difference in mean volume of water collected between rural and urban households in dry season.

Table no. 3.38: Volume of water collected for other purpose in dry season

				Levene's Test for Equality of Variances		**t-test for Equality of Means**						
		Mean	SD	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
											Lower	Upper
Volume (liters/day)	Rural	196.83	221.250	181.720	.000	-5.365	84.128	.000	-358.500	66.818	-491.372	-225.628

(iv) Volume of water collected water in wet season

H0: mean volume of water collected in wet season do not differ between rural and urban households.

H1: mean volume of water collected in wet season differs between rural and urban households.

Equal variance not assumed, an independent samples t – test was done to compare the volume of water collected for rural and urban households. The difference was not statistically significant (t (43.867) = -1.381, p = 0.174 > 0.05) with mean time for rural households' (M = 349.08, SD = 362.960) was less than urban households' (M = 470.80, SD = 373.262). The magnitude of the variation between the means, (mean difference = -121.717 with 95% confidence interval -299.366 to 55.933) was significant. So, we accept H0 and reject H1 at 5% level of significance. Hence, there is no difference in mean time taken to collect water between rural and urban households in wet season.

Table no. 3.39: Volume of water collected for other purpose in wet season

				Levene's Test for Equality of Variances		**t-test for Equality of Means**						
		Mean	SD	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
											Lower	Upper
Volume (liters/day)	Rural	349.08	362.960	.960	.330	-1.381	43.867	.174	-121.717	88.140	-299.366	55.933

3.8.3. Monthly expenditure on purchase of water

H0: there is no difference in mean monthly expenditure on purchasing water between rural and urban households.

H1: there is a difference in mean monthly expenditure on purchasing water between rural and urban households.

Equal variance not assumed, an independent samples t – test was done to compare monthly expenditure on purchase of water for rural and urban households. The difference was statistically significant (t (56.091) = -7.202, p = 0.000 < 0.05) with mean expenditure for rural households' (M = 450.00, SD = 172.354) was less than urban households' (M = 1130.23, SD = 559.138 The magnitude of the variation between the means, (mean difference = -680.233 with 95% confidence interval -869.433 to -491.032) was significant. So, we reject H0 and accept H1 at 5% level of significance. Hence, there is a difference in mean monthly expenditure on purchasing water between rural and urban households.

Table no. 3.41: Monthly water expenditure

				Levene's Test for Equality of Variances		**t-test for Equality of Means**						
		Mean	SD	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
											Lower	Upper
Expenditure (RS)	Rural	450.00	172.354	25.872	.000	-7.202	56.091	.000	-680.233	94.451	-869.433	-491.032

3.9. Water consumption across Social Category

3.9.1. Water Consumption per day

Majority of the rural and urban households across all categories consume within 0 – 100 liters per day. Rural households' majority consume within 0 – 100 liters/day due to no alternative sources of water other than spring/*dhara* where travelling and waiting time is quiet large especially during dry season which makes households carry water less frequently. Water consumption of ST and FC households are higher than other categories because these households get water from *Jhora* which is used for purposes other than drinking. Among rural households SC households and OBC households' consumption is within 0 – 100 liters/day.

Very few ST and FC urban households consumed within 401 – 500 liters per day due to no sufficient water received in pipes.

Table no.3.41: Percentage distribution of social category households for water consumption

Social Cat. / Vol.in liters	Number of households											
	Combined				**Rural**				**Urban**			
	ST	**SC**	**OBC**	**FC**	**ST**	**SC**	**OBC**	**FC**	**ST**	**SC**	**OBC**	**FC**
0 – 100	42.42	40	62.5	45.16	44	50	50	44.5	37.5	34.6	100	45.4
101 – 200	36.36	45	31.25	35.48	32	35.7	41.7	33.3	50	50	-	36.4
201 – 300	9.09	15	6.25	6.45	12	14.3	8.3	-	-	15.4	-	9.1
301 – 400	-	-	-	3.23	-	-	-	11.1	-	-	-	-
401 – 500	9.09	-	-	6.45	8	-	-	-	12.5	-	-	9.1
501 – 600	-	-	-	3.23	-	-	-	11.1	-	-	-	-
601 and above	3.03	-	-	-	4	-	-	-	-	-	-	-
Total	**33**	**40**	**16**	**31**	**25**	**14**	**12**	**9**	**8**	**26**	**4**	**22**

Source: Field Survey, 2020

3.9.2. Expenditure on water

The expenditure on purchasing water was relatively more in urban households compared to rural households.

Majority of the rural households across all social categories 64% of the ST households, 78.6% of the SC households, 66.4% of the OBC households and 77.8% of the FC households carry water themselves from common property resources (spring/*dhara*) as these households could not afford the cost of service from private springs. Within social categories Schedule Caste (SC) households (78.6%) mainly depends on common property resources (spring/*dhara*).

Among urban households, all the ST households (100%) made regular expenditure on water due to short supply from PHE pipelines. Around 30.8% SC households, 50% OBC households and 31.9% FC households had no regular expenditure on water so these households depend upon springs during dry season and on rainwater during wet season.

Table no. 3.42: Percentage distribution of social category households for expenditure on water

Social Cat. / Exp.in RS	Number of households											
	Combined				Rural				Urban			
	ST	SC	OBC	FC	ST	SC	OBC	FC	ST	SC	OBC	FC
0 – 300	15.15	2.5	12.5	6.45	20	7.1	16.7	22.2	-	-	-	-
301 – 600	18.18	10	12.5	16.13	16	14.3	16.7	-	25	7.7	-	22.7
601 – 900	3.03	15	12.5	9.68	-	-	-	-	12.5	23.1	50	13.6
901 – 1200	6.06	12.5	-	-	-	-	-	-	25	19.2	-	-
1201 – 1500	3.03	-	-	-	-	-	-	-	12.5	-	-	-
1501 – 1800	3.03	5	-	16.13	-	-	-	-	12.5	7.7	-	22.7
1801 - 2100	-	7.5	-	6.45	-	-	-	-	-	11.5	-	9.1
2101 and above	3.03	-	-	-	-	-	-	-	12.5	-	-	-
Total	**33**	**40**	**16**	**31**	**25**	**14**	**12**	**9**	**8**	**26**	**4**	**22**

Source: Field Survey, 2020

3.9.3. Medical Expenditure on water borne diseases

The mean medical expenditure is quiet high across all categories in both rural and urban households because majority of households are dependent on *Jhora* water which is very unhygienic and bad in quality. And also due to very poor water quality particularly in wet season water received is very muddy and with bad odour too. Mean expenditure of SC households were high in both rural and urban areas.

Table no. 3.43: Medical expenditure on water borne diseases by Social Category households

	Expenditure per month (in RS)											
	Combined				Rural				Urban			
Social Category	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD
ST	500	8000	2081.82	1648.57	500	5000	1788	1155.88	1000	8000	3000	2563.48
SC	500	15000	2912.5	2630.9	500	6000	2392.86	1745.09	500	15000	3192.31	2996.92
OBC	500	5000	1893.75	1482.55	500	5000	1983.33	1620.79	500	3000	1625	1108.68
FC	500	11000	2274.19	2081.02	500	5000	2500	1658.31	500	11000	2181.82	2260.14

Source: Field Survey, 2020

3.9.4. Water Sources for drinking purpose

All the households across all social categories depend on spring/*dhara* water in rural households and piped water into dwelling in urban households for drinking purpose both during dry and wet seasons.

Table no. 3.44: Percentage distribution of social category households for drinking water sources

	Percentage of households					
	Combined		Rural		Urban	
Social category	Spring	Piped water into dwelling	Spring	Piped water into dwelling	Spring	Piped water into dwelling
ST	100	100	100	-	-	100
SC	100	100	100	-	-	100
OBC	100	100	100	-	-	100
FC	100	100	100	-	-	100

Source: Field Survey, 2020

3.9.5. Water Sources for other purpose

(i) Dry Season

In rural area, majority of the category households had *Jhora* water source for other purposes particularly, OBC households were using *Jhora* water more than other households followed by FC households than SC households and ST households. Secondly, households used private connection water against monthly payment system where majority of the ST households had such private connections followed by OBC households than by FC households and SC households. For water used for other purposes OBC households were not dependent on springs, SC households and FC households were more dependent upon springs than private connections.

In urban area, majority of the ST, SC and FC households purchased and used water from water vendors to meet their demands however, less OBC households purchased from water vendors and were more dependent upon piped water supply. SC households were carried water from springs frequently than any other category. ST households do not use spring water due to no person to carry water or lot of time wasted to carry it.

Table no. 3.45: Percentage distribution of social category households for other purpose water sources in dry season

	Percentage of households											
	Combined						Rural			Urban		
Social category	**Pip.**	**Pvt.**	**Sp.**	**Ven.**	**Rain.**	**Jho.**	**Pvt.**	**Sp.**	**Jho.**	**Pip.**	**Sp.**	**Ven.**
ST	9.09	27.27	18.18	15.15	-	30.30	36	24	40	37.5	-	62.5
SC	10	7.5	30	37.5	-	15	21.4	35.7	42.9	15.4	26.9	57.7
OBC	12.5	25	6.25	6.25	-	50	33.3	-	66.7	50	25	25
FC	25.81	6.45	19.35	35.48	-	12.90	22.2	33.4	44.4	36.4	13.6	50

Source: Field Survey, 2020

Note that: Pip. = Piped water into dwelling; Pvt. = Private Connection; Sp. = Spring/*Dhara*, Ven. = Water Vendors; Rain. = Rainwater; *Jho.* = *Jhora* water.

(ii) Wet Season

For social category households in rural areas the source of water for other purposes remains the same as dry season.

However, among urban social category households, majority of the households' dependency shifts from spring and water vendors to rainwater across all categories because in wet season rainwater harvesting is carried out by majority of the urban households where rainwater is collected from roof into drums, plastic containers which reduced their dependency on water vendors and springs/*dhara*. SC households carry out rainwater harvesting more followed by FC households and then by SC and OBC households. Also, due to frequent landslides and continuous rain household members cannot walk to springs/*dhara* to collect water.

But the dependency on water vendors cannot be fully reduced due to change in the rainfall patterns.

Table no. 3.46: Percentage distribution of social category households for other purpose water sources in wet season

	Percentage of households											
	Combined						Rural			Urban		
Social category	**Pip.**	**Pvt.**	**Sp.**	**Ven.**	**Rain.**	**Jho.**	**Pvt.**	**Sp.**	**Jho.**	**Pip.**	**Ven.**	**Rain.**
ST	9.09	27.27	18.18	3.03	12.12	30.31	36	24	40	37.5	12.5	50
SC	10	7.5	12.5	12.5	42.5	15	21.4	35.7	42.9	15.4	19.2	65.4
OBC	12.5	25	-	-	12.5	50	33.3	-	66.7	50	-	50
FC	25.81	6.45	9.68	6.45	38.71	12.90	22.2	33.4	44.4	36.4	9.1	54.5

Source: Field Survey, 2020

CHAPTER 4

WATER POVERTY INDEX

4.1. Water Poverty Index (WPI) Framework

Our inability to balance the demand for water to supply was one of the most critical weaknesses in the development process. This has meant that a large portion of the world's population lack of access to sufficient water for domestic use has resulted in a loss of time and effort. Knowing better the relationship between the physical extent of water availability, ease of abstraction and usage, and the level of household and community welfare would allow water policymakers to make allocation decisions more rationally and equitably (Sullivan, 2001).

Poverty is now regarded as a lack of access to various resources for livelihoods (Sen, 1999). Sen has shown that poverty results from a lack of at least one essential requirement that is a necessary for a good living. In this context, lack of water is interpreted as consistent with the lack of one of these prerequisites (Sullivan et al., 2003). People may be "water-poor" because they do not have enough water for basic needs. After all, it is not available, so they will have to travel a long way to get it or even if they have access to nearby water supplies may be limited for several reasons. Also, people can be "water-poor" because they are "income poor" and cannot afford to pay for it (Lawrence et al., 2002).

Goal number 1 of UN Sustainable Development Goals focuses on eradicating poverty in all forms where the first six goals are indissolubly connected.

The Water Poverty Index (WPI) aims to reflect an interdisciplinary measure that links household welfare to the availability of water and indicates the degree to which humans are affected by water scarcity. This index makes it possible to rank countries or communities within countries, considering both physical and socio-economic factors associated with water scarcity. This helps organizations and policymakers concerned with water management to evaluate available resources and socio-economic factors that impact access to and use of those resources (Lawrence et al., 2002). WPI is also represented graphically, enabling policymakers to find areas that need immediate attention (Vyner, 2015).

Indices are commonly used by decision-makers because, in a single number, they encapsulate more than one measure of growth. The resulting single index value presents an uncomplicated measure that can set one country or location's performance against others (Sullivan et al., 2003; Lawrence et al., 2002). India WPI was in the medium poverty category with a 58.2 index score (Lawrence et al., 2002)

WPI has several applications; importantly (i) WPI can be used at community, regional, national and international levels to compare water situations and formulate policies (ii) WPI can be used to get the connection between water poverty and socio-economic variables. There are four methods to calculate the WPI (i) Composite Index Method (ii) Gap Method (iii) Matrix Method and (iv) Time Analysis Method (Sullivan, 2001). The Composite Index Method is the most widely used. In the Composite Index Method, WPI is a simple arithmetic mean (AM) of different components. This method has been used by (Sullivan 2002), (Sullivan et al. 2003), (Garriga et al. 2010), (Koirala et al., 2020), (Sullivan et al., 2006), (Cho et al., 2010), (Vyver, 2015), (Lawrence, 2002), (Xin et al., 2011), (Heidecke, 2006), (Zahar et al., 2012) and many more.

There are five different components: Resources, Access, Capacity, Use and Environment, with several subcomponents of WPI. In order to get the component index, all the subcomponent indices are averaged. All the five component indices are then multiplied by 20 following the balanced weight approach and added together to obtain the final index value in the range 0 – 100. The range given to WPI is from 0 – 100 scale where 0 represents highest water poverty, and 100 represents lowest water poverty (Lawrence et al., 2002; Sullivan 2002; Sullivan et al., 2003). To represent the water situation at a specific location, a single number may be used (Sullivan et al., 2003).

4.2. WPI Structure

Water Poverty Index (WPI) has a structure close to the HDI structure. Simple weighted arithmetic mean of the five components (Lawrence et al., 2002; Sullivan et al., 2003):

$$WPI_i^{AM} = \frac{\sum_{i=1}^{n} w_i X_i}{\sum_{i=1}^{n} w_i} \quad (i)$$

where wi's are the weights given to each component and Xi's are the components of WPI. Further, equation (i) can be written as:

$$WPI_i^{AM} = \frac{w_r R + w_a A + w_c C + w_u U + w_e E}{w_r + w_a + w_c + w_u + w_e} \quad (ii)$$

Table no. 4.1: Application of WPI at different levels

Serial no	Levels	Studies
1.	Country	(Lawrence et al., 2002), (Cho et al., 2010), (Jemmali and Sullivan, 2014), (Gafy, 2018)
2.	Community	(Sullivan et al., 2003), (Sullivan et al., 2006), (Heidecke, 2006), (Fenwick, 2010), (Zahar et al., 2012)
3.	Districts	(Koirala et al., 2020), (Garriga and Foguet, 2010), (Xin et al., 2011), (Maheswari et al., 2017)

For this study, WPI was calculated for rural and urban areas of the district and for Kalimpong district as a whole.

4.3. Description of Components, Sub – components and Calculation of WPI used in this study

1. Resource (R)

This component indicates water availability (Lawrence et al., 2002). There were two sub-components for resource component, namely (i) Physical availability of water resources in the households was considered as the first sub-component and (ii) Proportion of households who treat their water supply.

Since the physical availability of water was not available for the district, so physical availability of water in the house had to be taken for the study. Then households were to rank the availability on five scales given very poor, poor, good, acceptable and excellent (Zahar et al., 2012). Then the proportion of households in each scale was taken, and finally, the average of all the proportion values was taken.

Similarly, the proportion of households who treat water supply was obtained by dividing the number of households who used any treatment method by the total number of households.

$$Treat = \frac{T_i}{N} \qquad (iii)$$

where Ti and N are the number of households who treat water supply and total number of households in each area "i" respectively.

The value for resource component was therefore obtained by taking average of the two sub – components as follows:

$$\boldsymbol{R = \frac{Availability + Treat}{2}} \quad (\boldsymbol{iv})$$

2. Access (A)

This component takes into account essential water and sanitation needs (Lawrence et al., 2002). There are two sub-components for the access component, namely (i) the proportion of households having access to piped water services and (ii) the proportion of households having access to sanitation. Data for this purpose was collected from households in the study.

$$(a)\ Piped\ water = \frac{P_i}{N} \qquad (v)$$

$$(b)\ Sanitation = \frac{S_i}{N} \qquad (vi)$$

Where and are the number of households who treat water supply and the total number of households in each area respectively.

The value for the resource component was therefore obtained by taking the average of the two sub-components as follows:

$$\boldsymbol{A = \frac{Piped\ water + Sanitation}{2}} \quad (\boldsymbol{vii})$$

3. Use (U)

This component takes in account water used for drinking purposes and other purposes (except drinking). There are two sub – components for use component namely (i) Water used for drinking purpose (DP) and (ii) Water used for other purpose (OP).

For obtaining the values of sub – components, dimension index method to calculate HDI (HDII, 2018 Statistical Update) was used.

$$Dimension\ index = \frac{Actual\ value - Minimum\ value}{Maximum\ value - Minimum\ value} \quad (\boldsymbol{viii})$$

where actual, minimum and maximum values were defined the sample data collected from households in each area "i". Minimum and maximum values are set in order to transform the indicators expressed in different units into indices between 0 and 1 (HDII, 2018 Statistical Update).

So,

$$DP = \frac{Actual\ value - Minimum\ value}{Maximum\ value - Minimum\ value} \quad (ix)$$

$$OP = \frac{Actual\ value - Minimum\ value}{Maximum\ value - Minimum\ value} \quad (x)$$

The value for use component was therefore obtained by taking average of the two sub – components as follows:

$$\boldsymbol{U = \frac{DP + OP}{2}} \quad (\boldsymbol{xi})$$

4. Capacity (C)

At the community level and the government and administrative level, water management capacity is required. The skills required to manage water efficiently and to advocate for change are essential at the community level. These can be indicated by education and income levels (Lawrence et al., 2002; Sullivan et al., 2003 and Vyner, 2015). There are two sub-components for the capacity component, namely (i) Education level and (ii) Income level.

The first sub-component for this study has been taken as the head of the household (Foguet & Garriga, 2011), assuming that the more the educational level of the household head better will be the water management capacity. Educational level was calculated (Vyner, 2015) as:

$$Edu.\,level = \frac{Household\ head\ with\ education\ greater\ than\ higher\ secondary\ (HS)}{Population\ in\ that\ area} \quad (xii)$$

(Vyner, 2015) study took grade 4 as threshold level for education in South Africa because at this grade people get education on responsible use of water so people above grade 4 are considered in Vyner's study. Hence, for this study Higher Secondary (HS) that is standard XII is considered as the threshold level for education because after going through West Bengal Board syllabus it is only at this standard people are taught Environmental Science where some topics on water conservation or management are taught.

The second sub – component for this study has been taken as income level of the household. (Vyner, 2015) finds that on an average people are willing to spend 5% of their disposable income on water services in the study area where R 26,400 per annum is used as the threshold level for income and considered households having income greater then R 26,400 per annum. For this study, on consultation with the households they were willing to spend RS 300 per month for water services, then the percentage of income spent per month was calculated following (Vyner, 2015) and finally arrived at the threshold level of RS 90,000 per annum. Income level was then calculated (Vyner, 2015) as:

$$Income\ level = \frac{Households\ having\ income\ greater\ than\ RS\ 90{,}000\ per\ annum}{Total\ Households} \quad (xiii)$$

The value for capacity component was therefore obtained by taking average of the two sub – components as follows:

$$\boldsymbol{C = \frac{Edu.level + Income\ level}{2} \quad (xiv)}$$

5. Environment (E)

This component is an assessment of the environmental integrity of water and ecosystem goods & services rendered by natural environments in the area. As it is difficult to collect data at the community level to quantify environmental integrity or environmental water needs; hence, omitting the environment component could still be measured. This is certainly not wholly satisfactory, but it shows that even though certain data is missing, estimated findings can be derived. The question of missing data is often a concern when gathering household data (Sullivan et al., 2003).

However, for this study, qualitative water quality evaluation was done households were to rank the water quality on five scales given very poor, poor, good, acceptable and excellent (Zahar et al., 2012; Garriga et al.2010) then the proportion of households who consider water quality to be good was obtained.

$$Quality = \frac{Q_i}{N} \quad (xv)$$

where Qi and N are number of households who consider water quality to be good and total number of households in each area "i" respectively.

The value for environment component since there was only one sub – component was therefore obtained as follows:

$$E = \frac{Q_i}{N} \quad (xvi)$$

4.4. Weighting mechanism for the Components

WPI has been calculated using the Composite Index Method with a balanced weight approach to assume the equal contribution of all components in WPI (Lawrence et al., 2002), (Koirala et al., 2020). The five components were then multiplied by 0.2 following the balanced weight approach and added together to obtain the final index value in the range 0 – 1. The range given to WPI is from 0 – 1 (Heidecke, 2006; Zahar 2012), similar to HDI, where 0 represents severe water poverty and 1 represents low water poverty (Lawrence et al., 2002). The sub-components have been selected based on local data availability (Sullivan et al.,2003; Heidecke, 2006).

In short,

Table no. 4.2: Description of components and sub – components in brief

Serial no.	Components	Source	Sub – components
1.	***Resources (R)***	*Primary data*	*(i) Physical availability of water in house*
		Primary data	*(ii) Proportion of households who treat their water supply*
2.	***Access (A)***	*Primary data*	*(i) Access to piped water*
		Primary data	*(ii) Access to sanitation*
3.	***Use (U)***	*Primary data*	*(i) Water used for drinking purpose*
		Primary data	*(ii) Water used for other purposes (except drinking)*
4.	***Capacity (C)***	*Primary data*	*(i) Education of the head of the household*
		Primary data	*(ii) Income of the household*
5.	***Environment (E)***	*Primary data*	*Water quality*

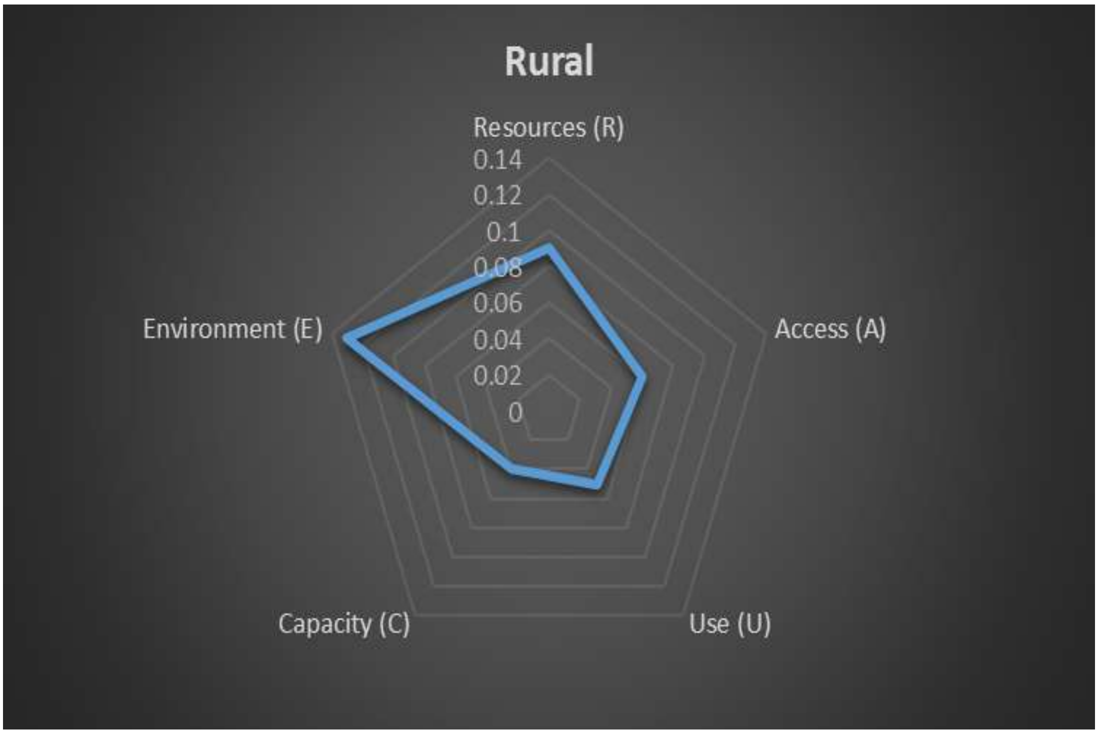
4.5. Results and Discussion

Table no. 4.3: Values of Water Poverty Index and components in the study area

	Components					
Area	***Resources (R)***	***Access (A)***	***Use (U)***	***Capacity (C)***	***Environment (E)***	***WPI***
Rural	*0.09*	*0.06*	*0.05*	*0.04*	*0.13*	**0.37**
Urban	*0.13*	*0.13*	*0.07*	*0.08*	*0.05*	**0.46**
District	*0.11*	*0.09*	*0.04*	*0.06*	*0.09*	**0.39**

Source: Author's own estimation based on field survey, 2020

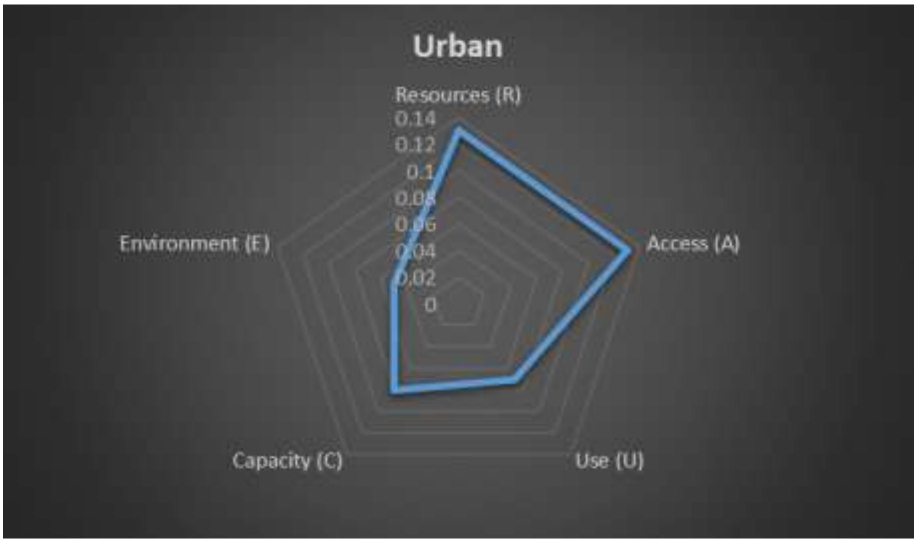
Figure 4.1: Values of WPI components for rural area of the Kalimpong district



Source: Author's own estimation based on field survey, 2020

It in a rural area, among the different components of WPI Environment was found to have the highest value (0.13), followed by Resource (0.09), Access (0.06), Use (0.05) and Capacity (0.04). Among the sub-components of education, water used for other purposes, and the physical availability of water contributed to water poverty with low values.

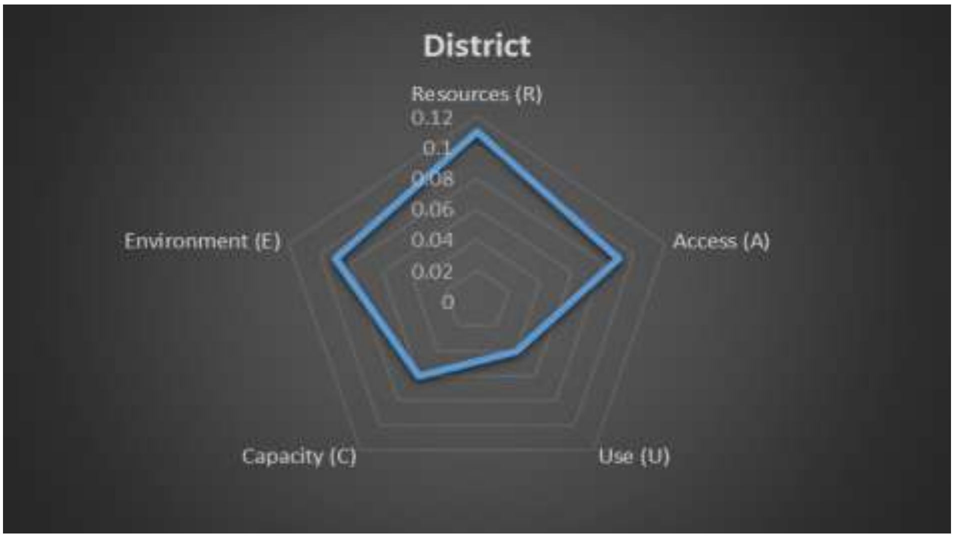
Figure 4.2: Values of WPI components for urban area of the Kalimpong district



Source: Author's own estimation based on field survey, 2020

The diagram shows in an urban area, among the different components of WPI Resource and Access was found to have the highest values (0.13) and (0.13) respectively, followed by Capacity (0.08), Use (0.07) and Environment (0.05). Among the sub-components, water quality, water used for drinking purpose, and physical availability of water had more contribution to water poverty with low values.

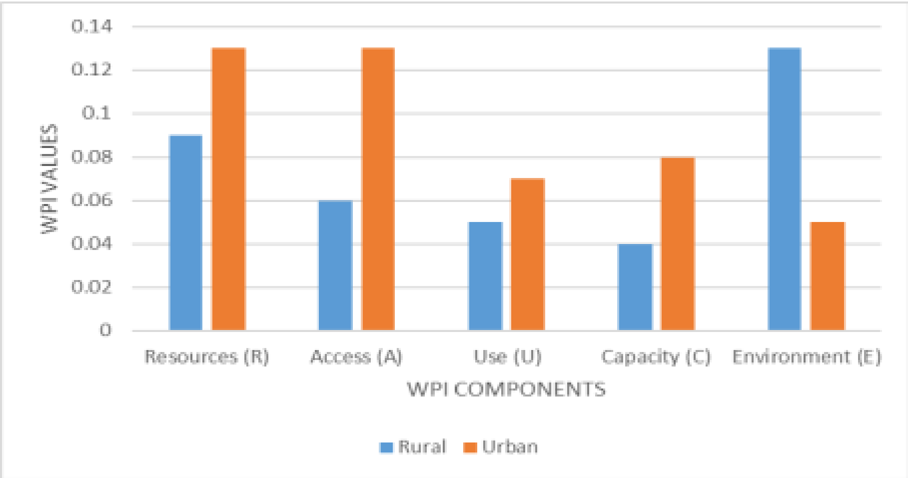
Figure 4.3: Values of WPI components for Kalimpong district



Source: Author's own estimation based on field survey, 2020

The diagram shows that in the district as a whole, among the different components of WPI, Resource was found to have the highest value (0.11) followed by Access and Environment, both having the same value (0.09), Capacity (0.06) and Use (0.04) and Environment (0.05). Among the sub-components, access to sanitation, water used for drinking purpose and physical availability of water contributed to water poverty with low values.

Figure 4.4: Values of WPI components for rural and urban areas of the district



Source: Author's own estimation based on field survey, 2020

Figure 4.5: WPI values for rural and urban areas of the district

Source: Author's own estimation based on field survey, 2020

The values of WPI for rural and urban areas are 0.37 and 0.46, respectively. Water poverty exists in both rural and urban areas of the district as these WPI values are below 0.5 and far below the lowest water poverty value 1. However, poverty is more in the rural area than in urban area, as shown in Figure 6.4. values of all the components (Resource, Access, Capacity and Use) except for Environment are low for rural area and relatively high for the urban area.

The difference in the component values are high for Access (rural = 0.06 and urban = 0.13) followed by Resource (rural = 0.09 and urban = 0.13) and Capacity (rural = 0.04 and urban = 0.08). Some sub-components such as income, education, and sanitation access have very low values in rural areas. During the field survey, schools in the rural area were only up to standard ten (X) and had no higher secondary schools. Hence, people in a rural area had to go outside the village to study where some go, and some do not. In contrast, in the urban area, people have accessibility and good education, so they have a voice, but they do not have the platform to speak up in rural areas, so lack of voice and a problem in understanding. Also, there is a lack of awareness of water conservation methods such as rainwater harvesting, spring shed management, etc.

The majority of the households' head had completed primary education. It was either causal labourers or self-employed, so the income capacity to manage or purchase rural people's water was low compared to urban people. So rural people carried water from spring/*dhara* or dependent on *Jhora* water.

The rural area lacks sanitation because of no piped water supply majority of the people are mainly dependent upon *Jhora* water, where all the urban dirt gets in, which is very unhygienic and have to suffer from other water-borne diseases. Hence, people in rural area are at a risk zone. However, no investment is made until now on filtration or to get alternative water sources by the local government again due to no good education. People in rural areas lack a voice.

4.6. Sensitivity Analysis

For robustness of the results weighted geometric mean method is used (Gafy, 2015; Garriga & Foguet, 2010). WPI by weighted geometric mean method:

$$\boldsymbol{WPI_i^{GM}} = \left(\prod_{i=1}^{n} X_i^{w_i}\right)^{1/\sum_{i=1}^{n} w_i} \qquad (xvii)$$

Equation (xx) can be rewritten as,

$$\boldsymbol{WPI_i^{GM}} = (R)^{0.2}\ x\ (A)^{0.2}\ x\ (U)^{0.2}\ x\ (C)^{0.2}\ x\ (E)^{0.2} \qquad (xviii)$$

where $w_i's$ are the weights given to each component and Xi's are the components namely Resources, Access, Use Capacity and Environment of WPI. Balanced weight approach on the assumption of equal contribution of all components in WPI (Lawrence et al., 2002). The components are given equal weights of 0.2 so the sum of weights equals 1.

4.6.1. Results

Table no. 4.4: Values of Water Poverty Index and components using Weighted Geometric Mean Method in the study area

	Components					
Area	***Resources (R)***	***Access (A)***	***Use (U)***	***Capacity (C)***	***Environment (E)***	***WPI***
Rural	*0.86*	*0.79*	*0.75*	*0.73*	*0.92*	**0.34**
Urban	*0.92*	*0.91*	*0.82*	*0.84*	*0.76*	**0.44**
District	*0.89*	*0.86*	*0.72*	*0.79*	*0.86*	**0.37**

Source: Author's own estimation based on field survey, 2020

4.7. WPI Values by Weighted Arithmetic Mean Method and Weighted Geometric Mean Method

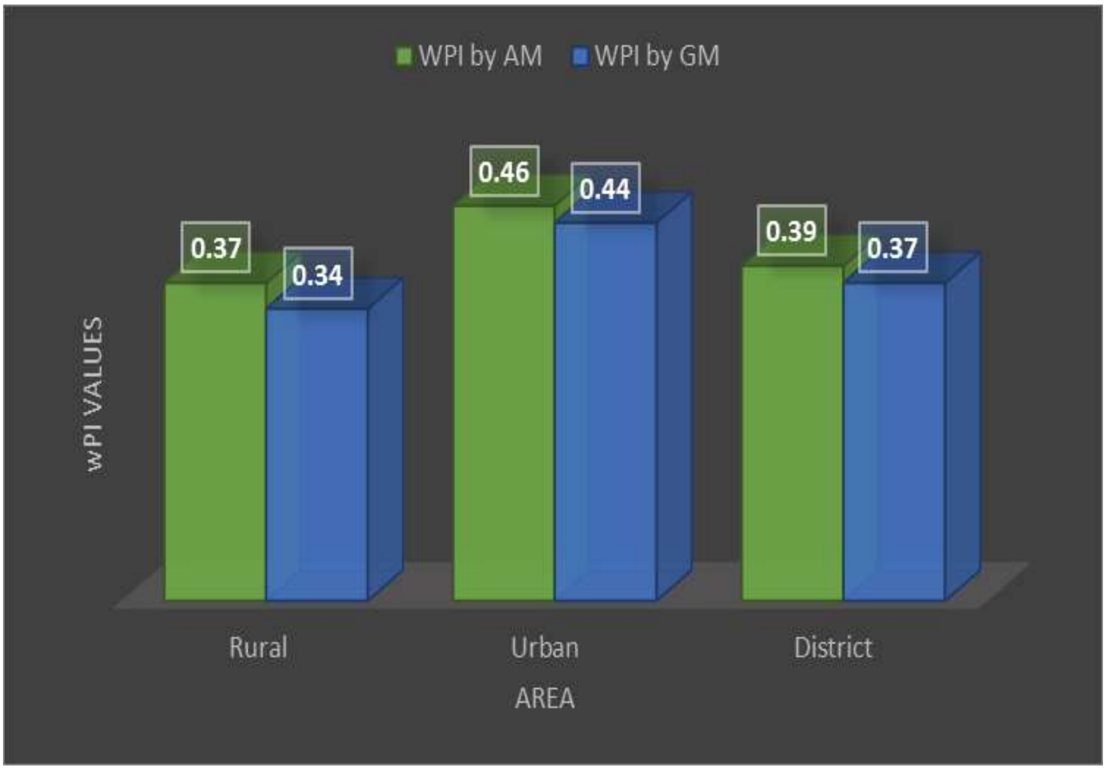
WPI values are low. Hence, water poverty tends to increase when the Weighted Geometric Mean Method is applied even though the difference in values is minimal. Similar results by Garriga & Foguet, 2010 in their results.

Table no. 4.5: Values of WPI by weighted AM and GM methods

Area	WPI_i^{AM}	WPI_i^{GM}
Rural	**0.37**	**0.34**
Urban	**0.46**	**0.44**
District	**0.39**	**0.37**

Source: Author's own estimation based on field survey, 2020

Figure 4.6: WPI values Weighted Arithmetic Mean Method and Weighted Geometric Mean Method for rural, urban areas and district



Source: Author's own estimation based on field survey, 2020

CHAPTER 5

CONCLUSION AND POLICY IMPLICATIONS

This chapter summarizes the study's main findings, provides policy implications to reduce water poverty and its limitations.

5.1. Conclusion

The present study focuses on water poverty in urban and rural areas of Kalimpong District, West Bengal. Using data from 120 households (60 rural and 60 urban).

If people are unable to meet their water needs, then they are water-poor. Goal no. 1 of Sustainable development to eradicate poverty in all forms, but it was found during the survey that water available per person per day is only 70 litres in urban areas. In contrast, the standard followed by the local department was 250 litres per person per day, so a deficit of 180 litres per person per day or standard followed by Jal Jeevan Mission is 135 litres per person per day, so a deficit of 65 litres per person per day. There is no estimation of water available for the rural person. The difference between demand and supply in town was seven lakhs gallons per day (approx.) This is poverty where people are unable to meet their water needs.

Chapters three and four are the kernel of this study. They highlight Socioeconomic and demographic characteristics of the households and their water consumption pattern, dependency on CPRs, dependency on water vendors, health issues related to water, water consumption pattern across social category and Water Poverty Index (WPI) for rural areas, urban areas and district as a whole respectively.

To summarize chapter three, urban areas are better than rural areas in terms of socio-economic and demographic characteristics, but more rural households are female-headed than urban households. Physical availability of water was not good both among rural and urban households. For drinking purpose, springs and piped water into dwelling were the principal sources in rural and urban households. Time taken to collect water was more for rural households. In contrast, most rural and urban households collected only 0 – 50 litres per day during the dry season and in the wet season were able to collect more. Only urban households had expenditure on water services. The majority of rural and urban households viewed water quality as good, where some rural households did not use any treatment methods. All the household members equally participated in collecting water for his purpose.

For other purposes, private connections and water vendors were the principal sources in rural and urban households. It takes more time to collect water in the dry season than wet in rural areas, but most households practice rainwater harvesting in the wet season in urban areas. The volume of water collected increases in the wet season in both areas, but rainwater could not be quantified. Expenditure of urban households decreased during the wet season, and the majority of the rural households did not have water expenditure. Water quality was bad for urban households in the dry season and good in the wet season. The majority of rural and urban households do not use any treatment methods. All the household members equally participated in collecting water for his purpose.

Most rural households collected water themselves, while most urban households purchased water regularly, with most urban households spending RS 601 – 900 per month.

The majority of the rural and urban households consumed only between 0 – 100 litres, where the average per person consumption for rural households less than urban households. The average water consumption of rural households was more than urban households. Particularly female-headed households consumed more water than male-headed in both rural and urban areas.

All the rural households were dependent upon CPR for drinking water. For other purposes, heads who were self-employed and had no government or private regular salary job with low household income RS 0 – 10,000 per month were mainly dependent on CPR in rural and urban areas. Moreover, Households whose head had the government and permanent regular salaried job purchased water from vendors.

Urban households had more health issues related to water than rural households. Diarrhoea and gastroenteritis were the frequent health issues among urban households, and cold/cough/fever was frequent among rural households. Mean medical expenditure was high among urban households than rural households.

Among social category households, ST and FC households water consumption was more than any other category in rural areas. The majority of the social category households in rural areas have no water expenditure, whereas urban ST households have more water expenditure. Due to inadequate water quality, the medical spending of all the category households is high enough. The majority of the OBC households used Jhora water, and ST used private connection in rural areas. In contrast, ST, SC and FC households purchased water frequently from vendors in urban areas.

Summary of chapter four, to quantify the extent of water poverty, the Water Poverty Index (WPI) given by Sullivan, Lawrence and Meigh was used for this study. This index takes into account physical, socio-economic and environmental characteristics. There are five components in WPI with several sub-components. For this study, nine sub-components were used based on data availability. WPI was calculated using the arithmetic mean for rural areas, urban areas and the district. The values were WPIR = 0.37, WPIU = 0.46 and WPID = 0.39. The results showed that water poverty exists in rural areas and urban areas of the district, but rural areas are more water-poor than urban areas. Capacity component scored lowest in rural areas, Environment component scored lowest in urban areas and Use component scored lowest in the district. WPI was also calculated using weighted geometric mean to check the results' robustness, the values for which were WPIR = 0.34, WPIU = 0.44 and WPID = 0.37. Levels of water poverty increase when a weighted geometric mean is used.

Water poverty exists in both rural and urban areas of the district. There is more water poverty in rural areas compared to urban areas. Rural people are unable to highlight their problems due to no platform to speak. However, rural areas are not much focused.

5.2. Policy Implications

Immediate action has to be taken to reduce water poverty in both rural and urban areas.

1. Capacity building regarding water management in the district to be increased by organizing workshops or programs for better water management and rainwater harvesting to be implemented more so that households' dependency on Jhora water decreases.
2. Time taken to collect water is high, which can be reduced by increasing accessibility of piped water and sanitation, which will improve use capacity.
3. Rejuvenation of springs should be done through forestation, especially in rural areas, to reduce springs drying up.

4. Common resources should be saved as they are an essential water supply source in hill regions through village initiatives (community participation) and by stopping its commercialization.
5. Surcharge should be levied households with more water connections and use that fund to supply water in rural areas (cross-subsidization).
6. Springs nearby town to be integrated for more number of sources in the urban area.
7. Water quality should be improved in rural and urban areas by setting up more water filtration units to reduce medical expenditure.
8. Incentive compactible mechanisms should be framed root level so that there is no lobbying and corruption.

5.3. Limitation of the Study

The time frame was less due to COVID 19, so less area and sample was covered. Also, all the households could not be visited due to Containment Zones. Due to the risk of infection, there was hesitation from the households and group discussions during the survey. Only limited households could be surveyed due to limited time and financial resources.

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ANNEXURE – I

I. List of latest RWS schemes till now:

Serial no.	Name of the Scheme	GP/Block
1.	DWS Scheme from Reank Khola to Pembling	Nimbong
2.	DWS scheme from Gitdabling	Kalimpong PHEC & sub Center in Gitdabling
3.	DWS scheme from Jholung Khola to Dalgaon Tourist view point	Rongo GP Gorubathan
4.	DWS scheme by Sinking of borewell in Mal Busty (Chettri Gaon) by pumping	Gorubathan
5.	DWS scheme from Padheri Jhora to Jaldhaka Model High School	Paten Godak GP Gorubathan
6.	DWS scheme from Dhaula Khola to Lava Bazaar	Lava GP
7.	Laying of 15 MM Dia GI pipes for water supply to Secretariat Building near Bomkin Chand Park from Park Tank	KPG
8.	Repair of 6" Dia pipelines beside Kalimpong District Hospital	MRI Unit
9.	Lifting of different Dia GI pipes by providing MS Angles to support pipes from 10th mile fatak to Dhawang Dara	Tripai
10.	Removing od different Dia GI pipes from Road side drain and providing MS Angles	Kalimpong Town Area
11.	Repair & Maintenance damaged 2" underground pipe	Near DM Bunglow
12.	Repair & Maintenance damaged 2" underground pipe	Kanchan Cinema
13.	Repair & Maintenance damaged different Dia GI pipelines	Near Tripai Tank
14.	Repair & Maintenance damaged different Dia GI pipelines	Near Strawberry shop
15.	Repair & Maintenance damaged 3/4 & other Dia GI pipelines	Near Hotel King Thai
16.	Repair & Maintenance damaged 11/2" other Dia GI pipelines	Thana Dhara
17.	Diverting & shifting of 6" Dia Mainline GI pipe for water supply	Tripai tank
18.	Emergent Restoration of Thokchu water source including construction of Rcc "T" beam bridge	Santook GP
19.	DWS scheme from Dobhaney Jhora to 2 nos. phase six and bus stand area	Godak GP Gorubathan
20.	Laying of 20 MM Dia pipes for additional water supply to Missionaries of charity at Relli Road from	Tripai

	Dhawang Dara to above Harkay Jhora	
21.	DWS scheme from Jholing Khola to Sangam Gaon	Rongo GP
22.	DWS scheme from Bhupaley Khola to Jaldhaka Primary HC & SHC	Godak GP
23.	DWS scheme (i) Chaiaikar (Mongpong by pumping) (ii) Bhanga (Mongpong) (iii) Mongpong forest village	Mongpong
24.	DWS scheme from Sangbir Jhora to Barbot	Pabringtar GP
25.	DWS scheme from Rongo Upper and Lower Maidan Gaon from Yabah Kholcha	Upper Rongo GP
26.	Laying of 20 MM Dia GI pipes Rcc Tank & distribution system for public of Kanpur House area from Ringkingpong tank	Ward no. 21
27.	DWS scheme from Khani Khola to Baidar Gaon, Karki Basnet gaon, Lusuney Gairi goan and Sansari Dara gaon	Samalbong GP
28.	DWS scheme from Tarchu Khola to Tar Khola F.V. 10th mile	Sangsay GP
29.	DWS scheme from Simsarey Jhora to Upper Kamjer Gumba	Lolay GP
30.	DWS scheme from Dabaipani Jhora to Rangpo forest village	Sangsay GP
31.	PWS scheme from Narag Jhora to Munshidhara gaon	Sangsay GP
32.	DWS scheme from Rabling Khola to Munthung busty	Upper Kaffer Kankey
33.	DWS scheme from Bhalu Khola to Lower Newar gaon	Bhalukhop GP
34.	DWS scheme from Kali Khola to Upper Fagu	Nim GP
35.	DWS scheme from Main Tank to Panchayat Bhawan & Public below Panchayat Bhawan	Pedong GP
36.	Emergent restoration of 6th mile Jhora to Algarah Bazar	Santook GP
37.	Emergent temporary restorative work from 17th mile to Army Camp	Kalimpong
38.	DWS scheme from Juranti Khola to Middle and Lower Chuikhim	Pabringtar GP
39.	DWS scheme from Devithan Jhora to Esmali Bazar gaon	Lower Bidyang Dalapchand GP
40	DWS scheme from Ambiok Khola to Dalimtar Busty	DalimGP
41.	Repair & Maintenance of distribution system of GI pipes sub – mainline of mission tank	Ward no. 2
42.	Repair & Maintenance of GI pipeline & distribution system	Ward no. 4
43.	Repair & Maintenance of distribution ferrule system above Park Tank	Ward no.23

44.	Maintenance & readjustment of distribution ferrule system above Park Tank	Ward no. 21
45.	Repair & Maintenance of distribution system of Bagdhara tank near Crown lodge	Ward no. 10
46.	Maintenance of distribution system & main line below Pradhan Provision	Ward no. 7
47.	Laying of 15 mm dia GI pipes for water supply to community hall at Homes	Kalimpong
48.	Laying of 20 mm dia GI pipes for water supply to the dialysis unit of District Hospital from Hospital WHO tank above Disha	Kalimpong

Source: Rural Water Supply Department, PHE, GTA, Kalimpong.

II. List of Springs/Dhara in Urban Area

Serial No.	Ward No.	Name of Spring/Dhara
1 .	Ward No.- 4	Dhobi Dhara, below S.U.M.I. School
2 .	do	WBSEDCL Dhara, 10th. Mile
3 .	Ward No.- 7	Barpiple Dhara, Topkhana
4 .	do	Gumba Dhara, 11th. Mile
5 .	do	11th. Technical School Dhara
6 .	do	C.S.T. fatak Dhara, below C.S.T. School
7 .	Ward No.- 8	Biralo Khothi Dhara, Biralo Khothi, 10.5 Mile
8 .	do	Raja Dhara,
9 .	Ward No.- 9	Rai Bahadhur Dhara (done)
10 .	Ward No.- 10	Kazi Compound Dhara, Relli Road.
11 .	Ward No.- 11	Bhotey Dhara, below Kundaley Wine Shop
12 .	do	O Dhara, below bhotey dhara
13 .	do	Shutter House Dhara, Goyanka Area
14 .	Ward No.- 12	Bagdhara
15 .	Ward No.- 13	Upper Sadhu Dhara
16 .	do	Bhujel Dhara, Middle Bong.
17 .	do	ITBC Dhara, Near ITBC.
18 .	do	Jiwan Dhara, Karkee Gaon.
19 .	do	Ghysing Dhara, Ghysing Gaon.
20 .	do	Newpaney Dhara, Above T.B. Basnet House.
21 .	do	Lower Sadhu Dhara
22 .	do	Below Kumudini School Ground Dhara
23 .	do	Ganesh Dhara, H.L.Dixit Road
24 .	do	Dhobi Dhara, below Kali Mandir, Primtam Road
25 .	do	Rai Dhara, below M.B.Sir house
26 .	do	Juicee Dhara, Primtam Road

27 .	do	Julee Dhara, Primtam Road
28 .	do	Limbu Dhara (Kazi compound. -II)
29 .	do	Oraray Dhara near Urgen Moktan House.
30 .	do	Hawaldar Dhura Dhara, below Mount Carmel School
31 .	Ward No.- 14	Bhola Dhara, B.L.Dixit Road
32 .	do	Dhamodar Dhara, Tamang Goan.
33 .	do	Kamala Pradhan Dhara, Sahuji Gaon.
34 .	do	Dhambar Dhara, Tamang Gaon.
35 .	do	Tabey Dhara, Dixit Gaon.
36 .	Ward No.- 15	Below B.T.College Dhara
37 .	do	Sudhama Dhara, Gurung Gaon.
38 .	do	Kamal Jyoti Dhara, Public of Ward No. XV.
39 .	do	Sinchurey Gaon Dhara
40 .	do	Thapa Siping Gaon Dhara
41 .	Ward No.- 16	Chinna Danra Dhara
42 .	do	Poudiyal Dhara, Public of Ward No. XVI
43 .	do	Lakai Danra Dhara
44 .	do	Shadu Dhara, Poudiyal Danra
45 .	do	Karthak Dhara, near Animal Shellter
46 .	do	Santhi Sewa Samity Dhara
47 .	do	Sitla Devi Dham Dhara
48 .	do	P.N. Dhara, Satra Gharey
49 .	do	Anup Dhara, near Santhi Sewa Samity
50 .	do	Durpin Gumba Dhara, below Gumba
51 .	do	Lakai Dhara
52 .	do	Bom Church Police Gaon Dhara
53 .	Ward No.- 17	Maharaji Jhora Dhara
54 .	do	Chaya Dhara, Chalisey Gaon
55 .	do	Sweeper Dhara, Upper Chibo Busty
56 .	do	Souri Dhari, Middle Chibo Busty
57 .	do	Pasupati Dhara, Middle Chibo Busty
58 .	Ward No.- 18	Manip Dhara, Happy Villa
59 .	do	Khet Dhara, Happy Villa.
60 .	do	Shashi Dhara, Pradhan Gaon.
61 .	do	Poonam Dhara, Gauri Kunj
62 .	do	Tiwari Dhara, Geelenka
63 .	do	Gauri Dhara
64 .	do	Bhandari Compound Dhara
65 .	Ward No.- 19	Happy Villa Dhara
66 .	do	Dhobi Dhara, Upper Bong.
67 .	do	Tirtirey Dhara, Mangal Danra
68 .	do	Upper Phurbung Dhara, Dhupi Danra
69 .	do	Lower Phurbung Dhara, below S.A.S.
70 .	do	Switch Diary Dhara, 7th. Mile,near S.P.S.

71 .	do	Tamang Gaon Dhara, Tamang Gaon
72 .	do	Changchangey Dhara
73 .	do	Forest Dhara
74 .	do	Tirtirey Dhara
75 .	do	Himaley Gaon Dhara, near Standered Nursery
76 .	Ward No.- 20	Dhara below K.B.Garage, 9th. Mile
77 .	do	Topaban Dhara, 9th Mile Gaon.
78 .	do	Litchi Ground Dhara, Litchi Ground
79 .	do	Atisa Dhara, below C.K.Pradhan Residence
80 .	do	Maney Dhara, near Virus Office, 8th. Mile
81 .	Ward No.- 21	Park Dhara, below Samaj Area
82 .	do	Virdan Dhara, Ward No, XXII.
83 .	do	Dhobi Dhara, Taxari Rd. Thakurbari.
84 .	do	Dumsipakha Dhara, below 9th. Engine Danra
85 .	do	Devi Dhara
86 .	do	Basuripool Dhara, near Basuripool
87 .	Ward No.- 22	Dhara, below Sabitri Ghising Road, near Rumba House
88 .	do	Raja Dhara, Ward No. VIII.
89 .	Ward No.- 23	B.T.College Jhora Dhara,B.T.College, above school danra
90 .	do	Nak Dhara, Public of BT College area.
91 .	do	Dhobi Dhara, Dhobi Gaon, below Worling Golai
92 .	do	Sunakhari Dhara, Sunakhari Samaj, East Main Road
93 .	do	Kishor's Dhara, Dhobi Dhara Gaon, above East Main Road
94 .	do	Dhara near Social Forestry Area, Worling Golai

Source: Water Works Department, PHE, GTA, Kalimpong.

ANNEXURE – II

WPI calculation steps

I. Using Weighted Arithmetic Mean Method

A. For Rural Areas

1. Resource

(a) Physical availability of water (Availability Index):

(i) Very poor = 0.816 (ii) Poor = 0.15 (iii) Good = 0.017 (iv) Acceptable = 0.017

$$\text{Availability} = \frac{0.816 + 0.15 + 0.017 + 0.017}{4}$$

$$= 0.25$$

(b) Proportion of households who treat water of dry and wet seasons for drinking purpose only.

$$Treat = \frac{41}{60}$$

$$= 0.683$$

Therefore, $$\boldsymbol{Resource\ Index} = \frac{\mathbf{0.25+0.68}}{\mathbf{2}}$$

$$\mathbf{= 0.465\ or\ 0.47}$$

2. Access

(a) Proportion of households having access to piped water services both govt. and private connections.

$$Piped\ water = \frac{18}{60} = 0.3$$

(b) Proportion of households having access to sanitation (only households who have private connections and spring):

$$Access\ of\ sanitation = \frac{18}{60} = 0.3$$

$$\boldsymbol{Access\ Index} = \frac{\mathbf{0.3 + 0.3}}{\mathbf{2}} = \frac{\mathbf{0.6}}{\mathbf{2}} = \mathbf{0.3}$$

3. Use

(a) Water used for drinking purpose (DP):

$$DP = \frac{Actual\ value - Minimum\ value}{Maximum\ value - Minimum\ value}$$

Maximum value = 60 liters and Minimum value = 10

$$= \frac{20.5}{60} = 0.341$$

(a) Water used for other purpose (OP):

$$OP = \frac{Actual\ value - Minimum\ value}{Maximum\ value - Minimum\ value}$$

Maximum value = 1500 liters and Minimum value = 30

$$= \frac{6.809524}{60} = 0.113492$$

$$\boldsymbol{Use\ index = \frac{0.341 + 0.113492}{2} = \frac{0.453492}{2} = 0.226746}$$

4. Capacity

Look at households' ability to manage water (education) and income of the households to allow purchase improved water.

(a) Education capacity (head with education greater then Higher Secondary):

$$Education\ Capacity\ (EC) = \frac{6}{60} = 0.1$$

(b) Income capacity (IC):

Mean income (expenditure) of rural and urban areas = RS 7,937.50

What % of income is spent on water: 7937.50 * x% = 300

7937.50 * x/100 = 300

x = 3.779 = 4%

Cost of service = 300 p.m. and 3600 p.a. (willing to pay).

Therefore, 3600 = 4% * x

x = RS 90,000 (threshold)

$$IC = \frac{HHDs\ with\ income\ greater\ than\ RS\ 90{,}000}{Total\ Households}$$

$$= \frac{19}{60} = 0.3166 = 0.32$$

$$\boldsymbol{Capacity\ Index = \frac{0.1 + 0.32}{2} = \frac{0.42}{2} = 0.21}$$

5. Environment

Drinking Purpose	
Dry Season	***Wet Season***
Good = 60 Bad = 0	Good = 56 Bad = 4

Other Purpose	
Dry Season	***Wet Season***
Good = 25 Bad = 35	Good = 20 Bad = 40

Good: $Dry = \frac{60+25}{2} = \frac{85}{2} = 42.5 = 43$

$Wet = \frac{56+20}{2} = \frac{76}{2} = 38$ $Average = \frac{43+38}{2} = 40$

Bad: $Dry = \frac{0+35}{2} = 17.5 = 18$

$Wet = \frac{4+40}{2} = \frac{44}{2} = 22$ $Average = \frac{22+18}{2} = \mathbf{20}$

Proportion of households who consider water quality to be good: Environment Index $= \frac{40}{60} = \mathbf{0.67}$

Water Poverty Index for Rural Areas (WPI_R):

$$WPI_R^{AM} = \frac{\sum w_i X_i}{\sum w_i}$$

Where $w_i's$ are the weights given to each components and balanced weight approach has been followed hence the components are given equal weights of 0.2 so the sum of weights equals 1.

$X_i's$ are the components namely Resource (R), Access (A), Capacity (C), Use (U) and Environment (E).

$$WPI_R^{AM} = \frac{w_r R + w_a A + w_c C + w_u U + w_e E}{w_r + w_a + w_c + w_u + w_e}$$

$$= \frac{0.2x0.47 + 0.2x0.3 + 0.2x0.23 + 0.2x0.21 + 0.2x0.67}{0.2 + 0.2 + 0.2 + 0.2 + 0.2}$$

$$= 0.09 + 0.06 + 0.05 + 0.04 + 0.13$$

$$\mathbf{WPI_R^{AM} = 0.37}$$

B. For Urban Areas

1. Resource

(a) Physical availability of water (Availability Index):

(i) Very poor = 0.1 (ii) Poor = 0.75 (iii) Good = 0.15

$$\text{Availability} = \frac{0.1 + 0.75 + 0.15}{3} = 0.33$$

= 0.25

(b) Proportion of households who treat water of dry and wet seasons for drinking purpose only.

$$Treat = \frac{60}{60} = 1$$

Therefore, $$\boldsymbol{Resource\ Index} = \frac{0.33+1}{2} = \mathbf{0.665}$$

2. Access

(a) Proportion of households having access to piped water services both govt. and private connections.

$$Piped\ water = \frac{60}{60} = 1$$

(b) Proportion of households having access to sanitation (only households who have private connections and spring):

$$Access\ of\ sanitation = \frac{17}{60} = 0.283$$

$$\boldsymbol{Access\ Index} = \frac{\mathbf{1\ + 0.283}}{\mathbf{2}} = \frac{\mathbf{1.283}}{\mathbf{2}} = \mathbf{0.6415}$$

3. Use

(a) Water used for drinking purpose (DP):

$$DP = \frac{Actual\ value - Minimum\ value}{Maximum\ value - Minimum\ value}$$

Maximum value = 200 liters and Minimum value = 15

$$= \frac{10.48649}{60} = 0.17477$$

(a) Water used for other purpose (OP):

$$OP = \frac{Actual\ value - Minimum\ value}{Maximum\ value - Minimum\ value}$$

Maximum value = 1000 liters and Minimum value = 20

$$= \frac{32.77551}{60} = 0.546259$$

$$\boldsymbol{Use\ index} = \frac{\mathbf{0.17477 + 0.546259}}{\mathbf{2}} = \frac{\mathbf{0.721029}}{\mathbf{2}} = \mathbf{0.3605}$$

4. Capacity

Look at households' ability to manage water (education) and income of the households to allow purchase improved water.

(a) Education capacity (head with education greater then Higher Secondary):

$$Education\ Capacity\ (EC) = \frac{20}{60} = 0.33$$

(b) Income capacity (IC): Income of households greater than RS 90,000 per annum.

$$IC = \frac{HHDs\ with\ income\ greater\ than\ RS\ 90{,}000}{Total\ Households}$$

$$= \frac{29}{60} = 0.483$$

$$\boldsymbol{Capacity\ Index = \frac{0.33 + 0.483}{2} = \frac{0.813}{2} = 0.4065}$$

3. Environment

Proportion of households who view water quality to be good:

$$\boldsymbol{Environment\ Index = \frac{16}{60} = 0.26}$$

Water Poverty Index for Urban Areas (WPI_U):

$$\boldsymbol{WPI_U^{AM} = \frac{\sum w_i X_i}{\sum w_i}}$$

Where $w_i{}'s$ are the weights given to each components and balanced weight approach has been followed hence the components are given equal weights of 0.2 so the sum of weights equals 1.

$X_i's$ are the components namely Resource (R), Access (A), Capacity (C), Use (U) and Environment (E).

$$WPI_U^{AM} = \frac{w_r R + w_a A + w_c C + w_u U + w_e E}{w_r + w_a + w_c + w_u + w_e}$$

$$= \frac{0.2x0.67 + 0.2x0.64 + 0.2x0.36 + 0.2x0.41 + 0.2x0.26}{0.2 + 0.2 + 0.2 + 0.2 + 0.2}$$

$$= 0.13 + 0.13 + 0.07 + 0.08 + 0.05$$

$$\boldsymbol{WPI_U^{AM} = 0.46}$$

C. For Kalimpong District

1. Resource

(a) Physical availability of water (Availability Index):

(i) Very poor = 0.46 (ii) Poor = 0.45 (iii) Good = 0.08 (iv) Acceptable = 0.01

$$\text{Availability} = \frac{0.46 + 0.45 + 0.08 + 0.01}{4}$$

= 0.25

(b) Proportion of households who treat water of dry and wet seasons for drinking purpose only.

$$Treat = \frac{101}{120}$$

= 0.842

Therefore, $\boldsymbol{Resource\ Index = \frac{0.25+0.842}{2}}$

= 0.546

2. Access

(a) Proportion of households having access to piped water services both govt. and private connections.

$$Piped\ water = \frac{78}{120} = 0.65$$

(b) Proportion of households having access to sanitation (only households who have private connections and spring):

$$Access\ of\ sanitation = \frac{35}{120} = 0.292$$

$$\boldsymbol{Access\ Index = \frac{0.65 + 0.292}{2} = \frac{0.942}{2} = 0.471}$$

3. Use

(a) Water used for drinking purpose (DP):

$$DP = \frac{Actual\ value - Minimum\ value}{Maximum\ value - Minimum\ value}$$

Maximum value = 200 liters and Minimum value = 10

$$= \frac{17.18421}{120} = 0.1432$$

(a) Water used for other purpose (OP):

$$OP = \frac{Actual\ value - Minimum\ value}{Maximum\ value - Minimum\ value}$$

Maximum value = 1500 liters and Minimum value = 20

$$= \frac{28.87162}{120} = 0.2405$$

$$\boldsymbol{Use\ index = \frac{0.1432 + 0.2405}{2} = \frac{0.3837}{2} = 0.1918}$$

4. Capacity

Look at households' ability to manage water (education) and income of the households to allow purchase improved water.

(a) Education capacity (head with education greater then Higher Secondary):

$$Education\ Capacity\ (EC) = \frac{26}{120} = 0.22$$

(b) Income capacity (IC):

Mean income (expenditure) of rural and urban areas = RS 7,937.50

What % of income is spent on water: 7937.50 * x% = 300

7937.50 * x/100 = 300

x = 3.779 = 4%

Cost of service = 300 p.m. and 3600 p.a. (willing to spend).

Therefore, 3600 = 4% * x

x = RS 90,000 (threshold)

$$IC = \frac{HHDs\ with\ income\ greater\ than\ RS\ 90{,}000}{Total\ Households}$$

$$= \frac{48}{120} = 0.4$$

$$\boldsymbol{Capacity\ Index = \frac{0.22 + 0.4}{2} = \frac{0.62}{2} = 0.31}$$

5. Environment

Proportion of households who consider water quality to be good: Environment Index $= \frac{56}{120} = \mathbf{0.467}$

Water Poverty Index for District (WPI_D):

$$WPI_D^{AM} = \frac{\sum w_i X_i}{\sum w_i}$$

Where $w_i's$ are the weights given to each components and balanced weight approach has been followed hence the components are given equal weights of 0.2 so the sum of weights equals 1.

$X_i's$ are the components namely Resource (R), Access (A), Capacity (C), Use (U) and Environment (E).

$$WPI_D^{AM} = \frac{w_r R + w_a A + w_c C + w_u U + w_e E}{w_r + w_a + w_c + w_u + w_e}$$

$$= \frac{0.2x0.546 + 0.2x0.471 + 0.2x0.1918 + 0.2x0.31 + 0.2x0.467}{0.2 + 0.2 + 0.2 + 0.2 + 0.2}$$

$$= 0.11 + 0.09 + 0.04 + 0.06 + 0.09$$

$$\boldsymbol{WPI_D^{AM} = 0.39}$$

II. Using Weighted Geometric Mean Method

A. For Rural Areas

Using equation $(\boldsymbol{xviii})$, WPI for rural areas is as follows:

$$WPI_R^{GM} = (0.47)^{0.2}\ x\ (0.3)^{0.2}\ x\ (0.23)^{0.2}\ x\ (0.21)^{0.2}\ x\ (0.67)^{0.2}$$

$$= 0.86\ x\ 0.79\ x\ 0.75\ x\ 0.73\ x\ 0.92$$

$$= \boldsymbol{0.34}$$

B. For Urban Areas

Using equation $(\boldsymbol{xviii})$,WPI for urban areas is as follows:

$$WPI_U^{GM} = (0.67)^{0.2}\ x\ (0.64)^{0.2}\ x\ (0.36)^{0.2}\ x\ (0.41)^{0.2}\ x\ (0.26)^{0.2}$$

$$= 0.92\ x\ 0.91\ x\ 0.82\ x\ 0.84\ x\ 0.76$$

$$= \boldsymbol{0.44}$$

C. For Kalimpong District

Using equation $(\boldsymbol{xviii})$,WPI for district is as follows:

$$WPI_D^{GM} = (0.55)^{0.2}\ x\ (0.47)^{0.2}\ x\ (0.19)^{0.2}\ x\ (0.31)^{0.2}\ x\ (0.47)^{0.2}$$

$$= 0.89\ x\ 0.86\ x\ 0.72\ x\ 0.79\ x\ 0.86$$

$$= \boldsymbol{0.37}$$

SURVEY QUESTIONNAIRE, 2020

PART 1: SOCIO – ECONOMIC AND DEMOGRAPHIC CHARACTERISTICS

1. NAME:

2. GENDER:

3. AGE:

4. HEAD OF THE FAMILY OR RELATION:

5. EDUCATIONAL QUALIFICATION:

6. MARITAL STATUS:

7. JOB/OCCUPATION (Govt. or Private sector):

8. PERMANENT / REGULAR SALARIED WORKERS: Yes / No

9. CASUAL / TEMPORARY WORKER: Yes / No

10. SELF EMPLOYED: Yes / No

11. NUMBERS OF EARNING MEMBERS:

12. ANY MIGRANTS WORKER FROM FAMILY: Yes / No

13. INCOME (PER CAPITA IN RS):

14. TOTAL HOUSEHOLD MEMBERS:

15. SOCIAL CATEGORY: ST / SC / OBC / Forward Caste

PART 2: HOUSEHOLD TYPE

1. LOCATION *(RURAL/URBAN)*:

2. OWNERSHIP *(WHETHER RENTED OR OWNED ETC.)*:

3. RENT PAID *(IF RENTED)*:

4. TYPE OF HOUSE:

5. DISTANCE FROM TOWN:

6. FOR HOW MANY YEARS HOUSEHOLD HAS BEEN THERE:

7. MONTHLY EXPENDITURE *(FOOD, BILLS, EDUCATION ETC.)*:

PART 3: WATER USAGE

I. DRINKING PURPOSE: (BOTH DRY AND WET SEASONS)

	DRY SEASON	**WET SEASON**
1. WATER SOURCE TYPE:		
2. TIME TAKEN TO COLLECT WATER:		
3. WHO COLLECTS WATER FROM HOUSEHOLD:		
4. VOLUME OF WATER COLLECTED:		
5. WATER CHARGES (MONTHLY):		
6. QUALITY OF WATER (GOOD OR BAD):		
7. TREAT WATER ***(please specify)***		

II. OTHER PURPOSES (EXCEPT DRINKING) (BOTH DRY AND WET SEASONS)

	DRY SEASON	**WET SEASON**
1. WATER SOURCE TYPE:		
2. TIME TAKEN TO COLLECT WATER:		
3. WHO COLLECTS WATER FROM HOUSEHOLD:		
4. VOLUME OF WATER COLLECTED:		
5. WATER CHARGES (MONTHLY):		
6. QUALITY OF WATER (GOOD OR BAD):		
7. TREAT WATER (please specify)		

PART 4: WATER REQUIREMENTS

1. PHYSICAL AVAILABILITY OF WATER IN YOUR HOUSE *(very poor/poor/good/acceptable/excellent)*

2. DO THE HOUSEHOLD STOCK WATER *(please mention how much): yes / no*

3. DOES THE HOUSEHOLD BUY WATER OR COLLECT OWNSELF:

4. IF PURCHASED THEN WHAT IS THE COST:

5. HOW REGULARLY WATER IS PURCHASED:

6. IS THERE ANY PROBLEM WITH MUNICIPAL CONNECTION *(IF ANY) (please specify):*

7. QUALITY OF WATER RECEIVED FROM MUNICIPAL CONNECTION *(very poor/poor/good/acceptable/excellent)*

8. HOW MUCH WATER IS USED IN LITRE*(for domestic and other purposes):*

9. WHAT IS THE PRECEPTION REGARDING WATER *(please specify):*

PART 5: WATER RELATED HEALTH PROBLEMS

1. HEALTH PROBLEMS *(like diarrhea/malaria/vomiting/skin problems etc.)*:

2. NO. OF HOUSEHOLD MEMBERS WHO SUFFER OR DEATHS *(if any):*

3. MEDICAL EXPENSES:

4. DOES THE HOUSEHOLD HAVE PROPER TOILET FACILITIES *(Mention type):*

5. HOW IS SOLID WASTE DISPOSED (Nearby Rivulet / Jhora – Khola / Septic Tank / Others):