ISSUES IN URBAN WATER RESOURCE MANAGEMENT: A STUDY OF DARJEELING TOWN

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BY

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DATE:

DECLARATION

I declare that the thesis entitled "**Issues in urban water resource management: a study of Darjeeling town"** submitted to Department of Economics, Sikkim University for the degree of Master of Philosophy. The research work brings the light to the results of an original investigation made by me and it is authentic in nature. The thesis is work of my own and has not submitted for any other degree of this or any other University.

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CERTIFICATE

This is to inform that the thesis entitled "**Issues in urban water resource management: a study of Darjeeling town"** submitted to Department of Economics, Sikkim University in partial fulfillment of the requirements for the degree of **Master of Philosophy in Economics**, embodies the result of bona fide research work carried out by **Miss. Alka Rai** under my guidance and supervision. She has fulfilled the requirements relating to the nature, period of research and presentation of seminar talk etc.

It is also being certified that the research work brings light to the results of an original investigation made by **Miss. Alka Rai** and no part of the thesis has been submitted for any degree, diploma, associate-ship and fellowship.

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Date: …………..   Alka Rai

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Dedications

This dissertation is dedicated to my father Lt. Dala Kishore Rai.

-The source of all my inspirations

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTORY VIEW

Water is a valuable natural resource and is necessity for socio-economic development, healthy ecosystems and for human existence itself. It has comprehensive roles as consumption good, as a production good and as an environmental good. Despite its importance, water is one of the most poorly managed natural resources. It is said to be abundant in nature as three quarters of the world is covered with water, but most of it is saline. The saline water present in the earth is 97%. Out of the rest 2% is ice and only 1% is potable. It is therefore essential to save water for the present and future generations. (Rawat and Sah 2007)[1]

Benjamin Franklin attributed value to scarcity; with the famous proverbial saying "It is not until the well turns dry that we know the worth of water".[2] The whole world is now paying attention to water resources that how the limited water resources could be better managed. The National Water Policy (2002) states that Water is one of the most crucial elements in developmental planning which has to be planned, developed, conserved and managed.

The World Bank reports that 80 countries now have water shortages and the World Health Organisation has reported that 1 billion people lack enough water for meeting their basic needs. In India water scarcity is a serious problem for both urban and rural communities. The per capita availability of water is declining as it has reduced from 5177m^3 **to** 1869m^3 in the year 1951 and 2011 respectively.[3] Moreover, this is not a new problem. It has been recognised for a long time, yet the efforts to solve it over the past three or four decades have been disappointing. This reality has increased the pressure on water conservation institutions and water resource planners to take appropriate measures.

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1 Ajay S Rawat & Reetesh Sah (2007), Traditional knowledge of water management in Kumaon Himalaya
2 Sonja S. Teelucksingh, Nesha C. beharry and dabo guan (2014); Water Economics
3 H.P. Singh, M.R. Sharma, Quamural Hasan and Naved Hasan (2011); Narrowing the demand and supply gap through roof water harvesting: A case study of Kutlehar area in Shiwalik hills of lower Himalayas

Water is becoming more and more a scarce and valuable resources in urban areas. The situation is getting worse as demand for water go up along with population growth, urbanisation and increases in household and industrial uses thus it is important to understand that urban water management and its conservation play a critical role in enabling a sustainable urban environment. In recent years, on account of the growing pressures upon urban water supplies due to rapidly increasing urban population, water scarcity has become a serious issue especially in Darjeeling hills which unlike plains lack the advantage of alternative sources. (Lepcha K. C. 2013)[4]. There is an urgent need to look into the issue of urban water resource management in Darjeeling town.

Therefore the present study assesses the water scarcity in Darjeeling town, looks into the causes of water scarcity, identifies the associated problems and put forward alternative measures.

1.2 PROFILE OF THE STUDY AREA:

Darjeeling, the headquarters of Darjeeling district is a town, situated on the northern most part of Darjeeling District of the state of West Bengal, India. The nearest neighbors of Darjeeling town are Kurseong (about 35 kms. away) and Kalimpong towns (about 55 kms. away). The town is located at an average elevation of 6710 Feet on the Darjeeling-Jalapahar range of Darjeeling Himalayan hill region with 27 º 13' N to 26 º27' N Latitude and 88º 53 'E to 87 º 59' E Longitudes. The Annual Mean Max. Temperature is 14.9 Degree Celsius and Annual Mean Min. Temperature is 8.9 Degree Celsius of the town. Average Annual Rainfall of the town is 3092 MM and Average Number of Rainy Days is 126. Darjeeling town is an area under Municipality which spreads over an area of 13.81 km^2 comprising 32 wards with population 120414 and around 21122 households[5] which is shown by the map of Darjeeling municipal area and is given by the following Figure1.2. Darjeeling municipality was established on 1850 and it maintains the public administration of the town.

4 *Neelee K. C. Lepcha (2013), Problems And Prospects Of Water Resource Of Kurseong Municipality, Darjeeling District, West Bengal*
5 Darjeeling Municipality (2011)

The name "Darjeeling" came from a combination of the Tibetan words ‘Dorje’ meaning thunderbolt and ‘ling’ is a land, translating to "the land of the thunderbolt". Darjeeling is known as the “Queen of the Hills” with attractive tourist attractions which results in inflow of large number of tourists every year. Darjeeling also has its name listed among the UNESCO World Heritage Sites for its Himalayan Railways. Darjeeling stands as one of the quality tea producer in the world. Darjeeling tea is one of the most exported items from India which occupies a place of pride in the entire world for its fresh aroma and taste.

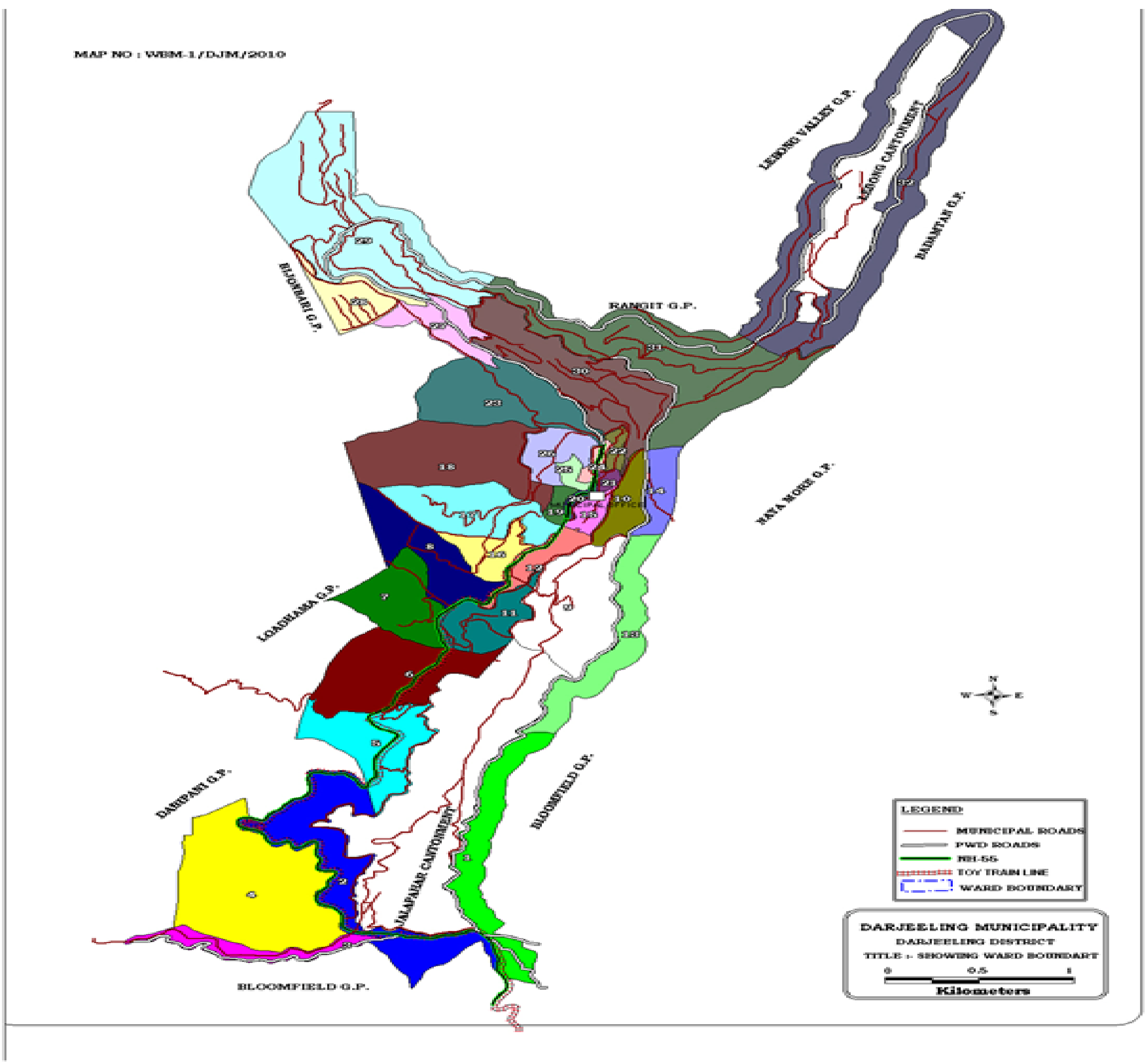

Figure 1.2: Map of Darjeeling Municipal Area

1.3 WATER RESOURCE MANAGEMENT IN THE STUDY AREA: CURRENT SCENARIO

Water resource management is the mistreated sector in Darjeeling hills. The disgraceful situation of water in the town is marked from its increasing deficit up to 42,55423 gallons/day. Senchal Lakes are the only sources to meet the water demands of Darjeeling which was constructed under British period and was designed for the population of about 10,000-15,000. Other local sources of drinking water such as springs and seepage are largely exploited for private earnings. The private water suppliers trade water in the town fetching from several nearby springs through the means like pipe lines, water tankers, manual water carts (Gorkhe jeep) and porters. Although the water supplied through such sources meet the basic water requirements in the town but it is limited only to the households or hotels who can afford its cost. A major section of the urban poor are unable to afford such costs and it is enhancing the water inequality rendering water crisis among them. It's not that there isn't enough water. The Town is blessed with adequate rainfall but is unable to make good use of rain water due to the lack of proper water resource management.

1.4 WATER SUPPLY SYSTEM OF THE STUDY AREA:

The types of water supply in Darjeeling town are pipelines, public taps, natural springs, rainwater, and water vendors. The supplied water is used for the personal and domestic uses. These uses generally include drinking, personal sanitation, washing of clothes, food preparation and personal and household hygiene.

People in the Darjeeling town get access to water either from public or private sources. The following table shows the classification of different types of water supply under public and private sources.

Table 1.4: Types of sources of water in Darjeeling Town

PUBLIC SOURCES	PRIVATE SOURCES
Piped water supply, Public taps and Public tanker supply	Natural spring water and Water vendors (Private tanker supply and Porters)

Source: Primary Survey

The public water supply systems are provided by Darjeeling Municipality. Municipal authorities supply water through pipelines and public taps. There is also provision for water tankers which serves certain section of population during dry seasons by municipality. However, public sources are unable to meet the urban water demands. Private sources of drinking water on the other hand, has emerged in the town as a major source of urban water needs thus people rely much on private sources than public sources. The private sources are handled by water vendors (private water tankers and porters) who take advantage of the vulnerable situation of the urban residents and supply untreated water and they do not take responsibility for its quality. These suppliers get water for sale from different jhoras (small streams).

At present, the town almost depends on supply of water from the three lakes on Senchal ridges. The lakes are fed by jhoras (springs). The water supply system of Darjeeling town consists of tapping of 26 springs from the catchment area of Senchal Forest and wildlife sanctuary located about 15 km away from main town. Water is collected from over 26 springs and is carried down to two lakes, namely, Senchal North Lake and South Lake, from where it is piped to the town after purification at the Jorebungalow filteration plant. From there water is conveyed through large water mains to reservoirs established at St. Paul Tank having capacity of 2,35,812 gallons and that of Rock Ville tank (or MS tank) being 56,651 gallons and 58,012 gallons (Masonry tank). From these main reservoirs at two places water is distributed over the town through subsidiary tanks located at various places and also directly through distribution mains of various diameters. There are about

19 nos. of distribution mains each from Rockville and St. Paul tank. (Darjeeling Munipality, Water works Department)[6].

The North Lake and South Lake at Senchal (which is shown in the Figure 1.4.a below) have storage capacities of 20 million gallons and 13 million gallons respectively. The Lakes were built in 1910 and 1932 under the British period and it was designed for the population approximately 10,000- 15,000 people. Besides, there is a third lake, Sindap, which has a capacity to store 8 million gallons of water, constructed by the P.H.E. (Public Health and Engineering) Department in 1984. During the lean period when the water supply of Senchal Lakes becomes short, water is pumped from the Khong Khola (which is shown in the Figure 1.4.b below). Khong Khola River is a small perennial river near the town.

6 Gaurav Ghimiray (Sub Assistant Engineer, water works department, Darjeeling Municipality), August 2015

Figure 1.4.a: Sinchel north and south lakes

Figure 1.4.b: khong khola

In addition, there is a small mountain streams namely Bokshi Jhora which covers the requirement of water of the people of Rajbari area and its surroundings to some extent.

However, Darjeeling town still faces deficiency of water supply and the per capita availability of water in the town is much low from the prescribed norms of 135 liters per day.[7]

1.4.1 STANDARD WATER REQUIREMENT AS PER NORMS:

According to the World Health Organization (WHO) and Bureau of Indian Standards (BIS), the value of standard requirement of water supply is 135 litres per head per day and the water source has to be within 1,000 metres of the home and collection time should not exceed 30 minutes.

The break-up of 135 litres water according to BIS is given as follows:

Bathing: 55 litres

Flushing: 30 litres

Washing of clothes: 10 litres

Washing utensils: 10 litres

Cooking: 5 litres

Drinking: 5 litres

The WHO classified the supply and access to water in four categories. These categories are,

(1) No access (water available below 5 lpcd),

(2) Basic access (average approximately 20 lpcd),

(3) Inter-mediate access (average approximately 50 lpcd), and

(4) Optimal access (average of 100–200 lpcd)

7 Bishal Chhetri and Lakpa Tamang (2013), Population Growth and Associated Problems: A Case Study of Darjeeling Town.

1.5 SCARCITY OF WATER IN DARJEELING MUNICIPAL AREA:

There are 32 wards in Darjeeling Municipal Area which have total population of 120414 and 21122 households according to the 2011 census report. Out of 21122 households, only 10.20 percent have domestic pipelines. From Table 2 as shown below, we can see that there are 2145 domestic pipelines, 144 commercial pipelines and 400 public taps provided by Municipal in 32 wards of the town.

Table 1.5: WATER COVERAGE BY MUNICIPALITY IN DARJEELING

WATER CONNECTION DETAILS IN MUNICIPALITY AREA (2011 CENSUS)					
Total Wards	Total population	Total households	Total Domestic pipe lines	Total Commercial pipe lines	Total Public Taps
32	120414	21122	2145 (10.20%)	144 (0.70%)	400 (1.90%)

Source: Darjeeling Municipality

Water scarcity is one of the foremost problems faced by the residents of Darjeeling town especially during the dry seasons. During the lean period (January to May), the region faces huge water stress. Maximum quantity of the total annual rainfall pours within June-September in the town. Most of the water in monsoon runs off without being collected across the steep slopes, and as a result, only a small percentage of it is available.

Shortage of drinking water in Darjeeling Town has been felt for the past thirty (30) years or more. The historic water supply problem has gone from bad to worse because of widening gap between supply and demand. The inflow of water from the springs of Sinchal Range has been gradually decreasing with time. The enormous deforestation around the sources is further distressing the problem. The present population of Darjeeling town is more than 1 lakh and with the opening of schools, colleges and the beginning of tourist season the total population is added by another 20 to 30 thousand resulting to a total population of about 1.30 Lakhs for which water has to be provided.

The town as a district head quarter is a centre of all types of economic activity, which attracts the inhabitants of rural areas of the district to migrate to the town for enhanced opportunity. Furthermore, the refreshing climatic attributes of the town compels the people from the neighboring states to migrate and settle permanently in the region. This has made the town more populated in recent decades. Density of population has increased by 68.5% from 1991 to 2011 and consequently demand of water is increasing. There is a widening gap between water supply and demand.

Due to water stress residents and hoteliers have to turn to tankers (trucks with storage containers) to bridge the shortfall. Darjeeling truck chalak sangathan have eighty tankers that supply water to homes and hotels in the town. A tanker supplies 6,000 liters of water. The water is brought from Rangbull and 3rd Mile areas, which are situated at a radius of about 12km from Darjeeling town. The trucks charge between Rs. 800 to Rs. 1200 depending on the location of a hotel and house in the town.

Figure 1.5: A private water truck in Darjeeling Town

1.6 INITIATIVE TAKEN TO MITIGATE THE CRISIS OF WATER TO SOME EXTENT:

High rainfall in Darjeeling town and the everlasting shortage of water supply in Darjeeling town has led to demonstrate the roof top rainwater harvesting at Raj Bhawan, Darjeeling in order to create consciousness among the population of the town. Roof top rainwater preservation structures at Raj Bhawan were constructed in 2005. At the Raj Bhawan, net annual rainwater accessible from the roof of the main building is 1959.06 m3, which can meet the necessity of 134 citizens yearly[8]. The roof top rainwater after filtration is collected in 2 storage tanks having capacity of each as 100 m3 but the availability of rainwater is 9.8 times more. This indicates that roof top rainwater preservation can modestly minimize this everlasting shortage of water supply in Darjeeling town.

1.7 DEVELOPMENT PLAN ADOPTED BY DARJEELING MUNICIPALITY:

The Darjeeling Municipality has been trying to solve the problem and for which it had proposed various water projects to the state government. Only few of these proposals got accepted while others are yet to take off. One of the famous projects is Balasun project.

Balasun water project was the expected as the solution to Darjeeling's water misery. It was estimated that the present lakes would receive about 2 million gallons of water daily from the Balasun River through pumping stations. Keeping view of severe water shortage in Darjeeling town, in 1995 Darjeeling municipality approached the Darjeeling Gorkha Hill Council (D.G.H.C.). They convinced the State Government for setting up a project to enhance the water collection and supply system. Thus in1995, a project to pump water from Balason river to Sinchal lake at an estimated cost of 39.5crores (395 million Indian Rupees) had been affirmed by the State Government. However, the Government hesitated to implement the project due to non-availability of funds. Thereafter, with the agreement of the State Government, Darjeeling Municipality tried to seek the financial assistance from the World Bank for the project. The project was duly submitted to the World Bank

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[8] **Bhu-Jal News** - Quarterly Journal of Central Ground Water Board (2009)

team which visited Darjeeling and was quite keen about the project. But the differences cropped up between the World Bank, State Government and D.G.H.C. which stopped the project from making any headway. Hence, the historic water problem of Darjeeling town still continues unsolved.

1.8 CONCEPTION OF WATER RESOURCE MANAGEMENT IN THE PRESENT STUDY:

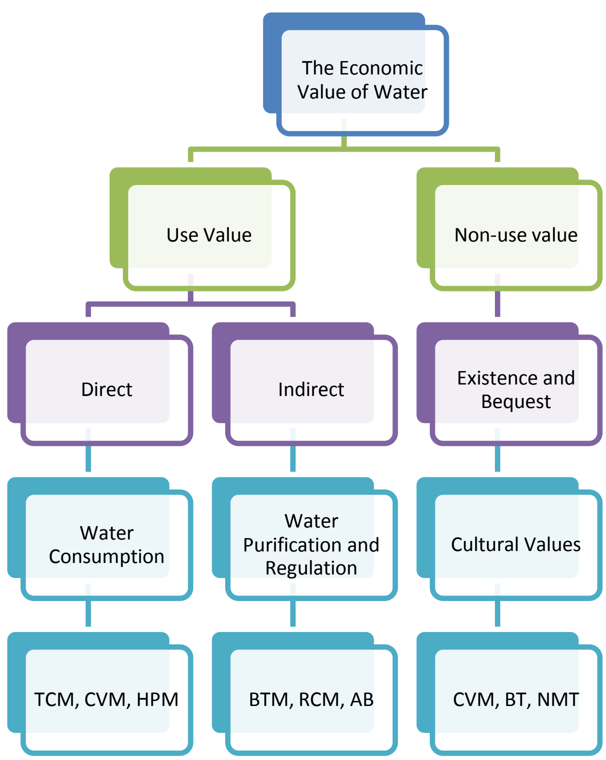
In the present study, water resource management is concerned with the management of provisions of water that could be beneficial to people. In Darjeeling Town there is neither proper management, nor reliable water supply in almost all the wards. From being the community's common property resource, water is gradually emerging as a scarce commodity which is bought and sold in the market. Rapid urbanisation and the growing population in the urban area are being considered as the primary reasons for increased water demand and deficit in water supply. There are two-three lakes to meet the water demand of the residents of Darjeeling Town which have less capacity to hold water. Most of the rainfall water is wasted and it goes useless due to the lack of proper infrastructure for managing water. Thus there is an emergence for the development of water harvesting facilities by constructing water reservoirs (artificial lakes) to assure reliable water supply to the residents of the town. Since, municipality has been failed to provide such facility therefore the present study estimates people's willingness to pay for better water resource management so that policy makers would come to know the willingness of the residents to pay for the water services.

The present study suggests how these problems could be addressed using the tools and techniques of environmental economics. A stated preference environmental valuation method, namely the contingent valuation method (CVM) has been employed for this purpose.

1.8.1 USE OF VALUATION TECHNIQUES IN THE MANAGEMENT OF WATER RESOURCES:

Considering the value of nature and its component, economists have defined the concept of value as Total Economic Value (TEV). It is further classified into various categories and sub-categories. The TEV of environmental goods consists of use value and non-use value. The use value is a value related to the present and future use by individuals and is subcategorised into direct and indirect use values. Direct use values are derived from the actual use of a resource (such as water consumption) while indirect values refer to the benefits derived from ecosystem functions (such as water purification and regulation). The non-use-value is related with the benefits derived from the knowledge that natural resources are maintained. It is subdivided into existence and bequest values. Existence values are not connected to the real use of the good but it reflects a value that is inherent in the fact that it will continue to exit independently from any possible present or future use by individuals. Bequest values are related with the benefits to individuals derived from the awareness that future generations may benefit from the use of the resources.

CHART 1.8.1: ECONOMIC VALUATION TECHNIQUES FOR WATER RESOURCES.



In the above chart 18.1.1, CVM denotes contingent valuation method, TCM signifies total cost method, HPM indicates hedonic pricing method, BTM represents benefit transfer method, RCM represents replacement cost method and AB stand for averting behavior (preventive expenditure) respectively.

There exists a method for the valuation of non-marketed environmental goods and services such as water resources. There are three two approaches to economic valuation: revealed preference and stated preference. In revealed preference approaches preferences are revealed by economic agents through their choices. In stated preference approaches consumers are asked to value environmental goods and services in carefully structured surveys. The two most commonly applied stated preference techniques are contingent valuation and choice experiment method (choice modeling). The present study uses contingent valuation method (CVM).

Contingent valuation method (CVM):

CVM has become one of the most widely used non-market valuation techniques. It is a survey-based method used for placing monetary values on environmental goods and services. It creates a hypothetical market where individuals reveal the values they would place on a resource. Individuals are either interviewed or given a questionnaire in which they are asked to state their maximum WTP or minimum willingness to accept (WTA) compensation. It is also one of the few techniques available for considering non-use values of a resource.

1.9 Objectives of the present Study

The following are the main objectives of the present study:

- To examine the empirical relationship between population growth and the water shortage of the study area.
- To estimate consumer’s willingness to pay (WTP) for better water resource management and to analyse the impact of various socio-economic factors such as gender, age, education, household size, family income, economic status (APL/BPL), employment status, house type (own house/rental house), different sources of water, water consumption, quantity of water purchased, price of water and distance of water source on WTP.
- To understand the effect of socio- economic factors on people’s perceptions towards water conservation for its sustainability.

CHAPTER 2

REVIEW OF LITERATURE .RESEARCH GAP AND JUSTIFICATION OF THE STUDY

2.1 REVIEW OF LITERATURE

Water is an essential requirement for human life but in recent decades human demand and misuse of water resource become major issue of humanity. Per capita availability of water is becoming less and less as the population is increasing at very fast rate where as the total availability of water continued to remain constant in India. Therefore, water security for human life has become a matter of principal concern for sustainable development in 21st century. The urban population faces demand supply gap of water.

Access to water in urban India is being paid more attention both by policy makers and academicians since the problem of water availability is more alarming in the urban areas of India. A series of literature is available regarding the different aspects and dimensions of urban water crisis. A general theme is ascertained through all the water resource management literatures that how water should be best allocated and conserved in order to utilise it efficiently between present and future generations.

There has been a significant amount of literature in this area of study. The findings from some of these have been summarised below.

2.1.1 The looming water scarcity:

In India, demand for water is growing both in urban and rural areas which may increase dispute over provision of water resources among the people. In order to manage water resources properly, it is essential to identify the information of actual water use on a household level. Therefore, Singh & Turkiya (2013) have studied the pattern of domestic water consumption in Dhani Mohabbatpur village of Hisar district in Haryana state of India. The study has examined the households daily and activity wise water consumption, sources, quality, duration, frequency of water supply, distance of different sources and the level of awareness about rainwater harvesting. Results of the study revealed that the daily average water consumption for the village was found to be 117.0 l per person per capita per day. Washing of clothes consumes the highest amount of water, whereas 85 % of the households are using government water supplies with very safe water quality. However, 77 % households are not satisfied with duration of water supply and 86 % do not have awareness about rainwater harvesting technology. The study finally recommends that such problems should be addressed immediately through media and by organizing public awareness programs.

According to Sharma(2007), supply led water deprivation prevails in major cities in India. The per capita water availability in the cities is near the standards lay down by the World Health Organisation or the Bureau of Indian Standards and it is also far lower than that in other large cities in the world. The availability of water in Indian cities varies with socio-economic groups and areas. Households with incomes below Rs 3,000 a month suffer a lot – about 72 per cent of such households in these cities lack sufficient water. He mentions that this is mainly because they have limited their desires and requirements of water in relation to available supply from the municipalities or water authorities. He too found that given appropriate and affordable technologies to save water in specified activities, the households would be willing to adopt them. He stated in his study that the supply of water in the large cities of India is going to be a serious challenge in the future. The rapid increase in the population in the cities, depleting water resources and enhanced consumer needs are going to create a difficult situation. Thus he recommended that an awareness campaign can play a big role in conserving water for cities.

LI, (2012) states that the expansion in population magnifies the problem of water security and water safety which in turn becomes a powerful restrictor of the urbanisation process and which poses the biggest challenge to the sustainable development of any urban region.

Chettri and Tamang (2013) have studied the growth of population in Darjeeling town and highlighted the problems associated with it. According to them shortage of water supply is one of the major problems caused by population growth.

2.1.2 Urban water resource management in different regions:

Ashbolt .J. Nicholas (2008) reviews how we have come to have unsustainable large centralized urban water services in developed countries, which clearly has ramifications for the rapidly developing regions. Population growth, particularly in the water scarce regions on every continent, makes water-based sanitation unsustainable for most of us. He suggests many options to manage household ‘wastes’ for nutrient and energy recovery, as well as to support water fit for purpose. In the short-term, household Grey water reuse could reduce water demand by over 70% and reduce the need for large sewers. Storm water drains too could be reduced if flows were reduced via rainwater tanks, wetlands and infiltration, all providing alternative urban water sources.

Jiang et al. (2008) introduces the main stages and the processes of implementing water quota management in China, analyzes the basic principles, and expounds the elements, information foundation, core module and operational model of the urban water quota management system. It has been demonstrated that urban water quota management has made some remarkable contribution not only in transforming the pattern of water mode and strengthening water management enforcement but also in integrating various management methods in saving water and preventing pollution.

2.1.3 Water as an economic good:

Rogers, et al.,(1998) addressed the concept of water as an economic good as well as a social good and explained, in practical terms, the economic tools that can be used to effect the environmentally, socially, and economically efficient use of water. They found that raising water tariffs, levying effluent charges and encouraging water markets can play significant roles in improving economic efficiency and environmental sustainability of water use.

Mehta (2003) have used the case of Kutch, Gujarat to highlight the complex nature of water scarcity and how it is socially and politically constructed to meet certain ends. She largely focused on how scarcity was used to legitimise the construction of large dams and create a 'scarcity' industry. The study witnessed a new twist in the water province. Her study reveals that here is a need to recognise water's economic value and water privatisation.

Hanemann (2004) explains the economic conception of water that how economists think about water. It consists of two main sections. First, it reviews the economic concept of value, explains how it is measured and discusses how this has been applied to water in various ways. Then it considers the debate regarding whether or not water can or should be treated as an economic commodity and discusses the ways in which water is the same as, or different than, other commodities from an economic point of view. While there are some distinctive emotive and symbolic features of water, there are also some distinctive economic features that make the demand and supply of water different and more complex than that of most other goods.

According to Ward & Michelsen (2002), the plan of institutions that maximizes water's favorable use in the face of growing demands for scarce and random supplies is the central policy issue in dry places. He mentions that information on water's economic value enables decision makers to make informed choices on water development, conservation and allocation. He further states that conceptually correct and empirically accurate estimates of the economic value of water are essential for rational allocation of scarce water across locations, uses, users, and time periods. His study raises several issues that must be considered in deriving accurate estimates of the economic value of water. These include establishing common denominators for water values in quantity, time, location and quality; identifying the point of view from which values are measured; distinguishing the period of adjustment over which values are estimated; and accounting for the difference between total, average, and incremental values of water. he illustrates values of water for agricultural use, based on a recent drought policy analysis of the Rio Grande Basin

2.1.4 Water markets:

Hadjigeorgalis Ereney (2009) evaluates the performance of established water markets. His study explains different challenges posed by water markets in developed and developing countries and discusses how countries can overcome these challenges. He mentions that water is being shifting from agriculture to municipal, industrial, and energy uses and thus construction of new dams and large-scale diversion projects are an expensive measure to meet these growing and changing needs. According to him the issue is not a physical deficiency of water but institutional and political failures in water management. Markets could address these failures as a demand-side approach to managing water scarcity. Raising the price of water to scarcity levels will also lead to changes in behavior as water users become better aware of the true costs of water provision.

The 2006 United Nations Human Development Report presents a miserable picture of global water scarcity and states that demand-side policies are more effective than supply-side approaches. The report too gave a doubtful remark regarding water markets as a means of managing scarce water supplies. However, the successful implementation of water markets within the United States and other countries contrasts with the statement. To clarify the debate, Hadjigeorgalis (2009) evaluates the performance of established water markets. He furthermore reflects on different challenges posed by water markets in developed and developing countries and discusses how countries can overcome these challenges. The results of his study suggest that water marketing is expected to be stretched out over the coming decades to correct institutional failure and will play an important role in the protection of in-stream flows and wildlife.

According to Rao (1988) since the beginning of the 80s, there has been a distinct decline in national spending for water resource development. He emphasises that the state and sub-state level agencies and users will have to find and develop additional resources. In his study, he mentioned that the present project developed by federal contributes to inefficient allocation of the resource thus there is an urgent need for financial and water management reform in order to avoid an impending water crisis. He proposes water pricing as a factor in water conservation efforts.

Bakker (2000) studied about the Yorkshire drought of 1995 and revealed that it was the most extreme climate event faced by the English and Welsh water industry since its privatization in 1989. As a symbol of crisis in privatized water management, and as a potential signal of climate change, the 1995 drought has motivated change in water regulation and management. In his study, he mentioned that 1995 water supply crisis as a natural hazard or as a result of managerial clumsiness. He further conceptualized drought as the production of scarcity and an outcome of three interrelated practices: meteorological modeling, demand forecasting, and corporate restructuring and the regulatory "game." These practices are situated within an analysis of the context of the regulatory implications of the privatization of the water industry in 1989. He explores the natural, social, and discursive elements of water scarcity and situates them within an analysis of privatization as reregulation, rather than deregulation. His analysis brings insights developed in debates over "real" regulation and regulation theory to bear on nature-society analysis. He emphasized the need to account for the role of the state and the particulars of "real" regulation in analyses of resource management

Abaza H. and McCraken (1998) have discussed the issue of groundwater pricing in Thailand. They demonstrated the role of groundwater pricing as a tool for the sustainable use and management of groundwater resources. They too discussed the design of the instrument in response to the observed environmental and socio economic issues.

2.1.5 Valuation technique (CVM) used for evaluating natural resources:

Jung, Kim, & Lee, (2015) have used the contingent valuation methodology (CVM) to determine the willingness to pay (WTP) of renewable energy and therby estimated its value. They also identified the direct and social factors that influence the WTP and studied the relationships between them through multiple regression analysis.

Danarifar et al. (2015) have uses the contingent valuation method and dual choice quesstionnare the recreational value of the tourist area in Mogarmon. They have incorporated 160 sample size in their study and estimation was made by using Logit analysing method on the basis of maximum likelihood estimation model. their results shows that 92 percent of people are ready to pay for visiting the tourist area and their average payment for recreational value was estimated as 2835 Rials per visit.

Meibodi et al. (2011) determined the existence value of drinking water for the households in Larestan, and measured individual’s willingness to pay (WTP) based on contingent valuation (CV) and dichotomous choice (DC). They used logit model for measuring the individuals' WTP based on the method of maximum likelihood (ML). They used data from 320 randomly selected households in Larestan, Iran. Their findings reveal that once drinking tap water is connected, the households are willing to pay an average of US$0.24 (per cubic meter) in addition to their monthly charge for the water consumed.

Bouchrika et al. (2014) have introduced contingent valuation method (CVM) in their paper as an efficient method in order to modify the utility level of an economic agent. They explained in their respective paper that in the absence of the market for natural assets, the CVM allows us to create hypothetical market to evaluate the economic value of those assets. Through the theoritical framework of their work they have shown that a change in utility function and consumer surplus at one side and on other side a change in price and profit of monopoly should keep the measures of economic efficiency and social equity.

2.1.6 Economic valuation of water resources management:

Nicola Smith, Garry McDonald, Susie Trinh (2009) have done various reviews of existing literatures on valuation of water demand management and have therefore concentrated on an examination of water values and the various economic theories and techniques applied in their valuation.

Smith et al. (2009) have concentrated on an examination of water values and the various economic theories and techniques applied in their valuation. They disclosed that economic valuation is often mistakenly conceptualised as the value of goods and services as determined by markets because many water values are not easily captured by regular market mechanisms and is often regarded as a common good.

Teelucksingh, Beharry-Borg, & Guan (2014) have explained the economic value of water resources and role of water in economic system. They have used concepts of environmental economics but with a focus on water as the environmental component of concern. Further, they have described different types of economic valution tecniques that can be applied to water resources such as direct market valuation, revealed preference and stated preference

2.1.7 Willingness to Pay for Water Supply and Sanitation:

Whitehead(1995) explains the variation function theory by examining the effects of changes in prices, quality, and income on willingness to pay for quality change. Comparative static effects are found for both on site users and nonusers of the resource. These results are used to interpret contingent valuation empirical models. For example, the substitution and complementary relationships between trips to natural resource sites can be identified. This paper also suggests tests for comparison of contingent valuation with recreation demand models and other tests of validity.

Brox, et al., (2003), in their study, deals with the contingent valuation surveys using a payment card method for estimating respondent's decision to answer a willingness to pay question. They found household income, number of children, education, and perception of existing water quality as major determinants of willingness to pay.

Moore .R. Michael (1999) develops a model of irrigator profit and ability to pay. The shadow price (marginal revenue) of water is employed to measure ability to pay per acre-foot of water. The model has been carried out with the analysation of data by using econometric tools. Annual data from thirteen districts in California have been used. Shadow price functions are derived for 1981-91 and compared to ability to pay. In estimating the ability of irrigators to pay for water, the total net productivity of water is computed after subtracting all other costs.

B. Moffat, et al., (2011) investigated the willingness of people to pay for an improved water quality and reliability in Chobe ward, Maun in Botswana. They found that on an average, 54% of the households were willing to pay for improved water quality. Those with a higher income were willing to pay for an improved water quality and reliability of supply. This finding corroborates the environmental economic theory which assumes that the demand for an improved environmental quality increases with income. According to the authors, water pricing is an important way of improving water allocation, encouraging optimal resource use and water conservation. However they were also of the view that pricing should take into account the fact that water is a basic need and a commodity with an economic value

2.1.8 Water Conservation Strategy:

Water scarcity has emerged as an important theme in discussions on India's future. Global discourse suggests that India, and other developing countries in Asia and Africa, can respond to water scarcity or water poverty by implementation of 'integrated water resources management which is a package of best practices for improved management of water resources with strong emphasis on direct demand-side management. Shah & Koppen (2006).

Guha and Kujur(2009) have found that crisis of water supply may be tackled with the help of rainwater harvesting. In Darjeeling town, annual rainfall is 2973mm and net annual rainwater available in Darjeeling town is 22 MCM (22000 million litre annually). They believed that availability of rainwater is 9 times more than the shortfall in supply. Thus they suggested that if this amount of rainfall is properly harvested than it can mitigate the crisis to some level. Further they have elucidated that Hydro geological condition of a hilly terrain like Darjeeling town does not support the artificial recharge to ground water but conservation of rainwater may be done at all level. In their study they have explained about the strategy adopted by the government of West Bengal to conserve rainwater from the roof of the Raj Bhawan main building. According to them the strategy is all about roof top rainwater harvesting which is implemented not only for the use of staffs of Raj Bhawan but also to create awareness among the people of Darjeeling.

Bartram, et al., (2014) states that International monitoring facilitates Millennium Development Goals (MDG) established global targets for drinking water and sanitation access and has contributed to reducing the global disease burden and increasing quality of life. Their study critically reviewed about JMP methods in detail. They mentioned that experiences of the MDG period generated significant lessons about the strengths and limitations of current approaches to defining and monitoring access to drinking water and sanitation. Further, their study exposes that in order to track access and progress of water; data from household surveys are analysed using linear regression modeling by the Joint Monitoring Programme (JMP) of WHO and UNICEF. They found that the method used by JMP provide nationally representative and internationally comparable insights into the drinking water and sanitation facilities used by populations worldwide but it have some limitations since it does not address water quality, equity of access, or extra-household services therefore they inform that improved statistical methods are needed to better model temporal trends.

Postel (2000) proposed a global effort to ensure that freshwater ecosystems receive the quantity, quality, and timing of flows needed for them to perform their ecological functions and to work toward a goal of doubling water productivity. He discusses that Developing and implementing these options will require new partnerships and alliances that draw upon the expertise of professionals from many disciplines including biology, ecology, engineering, hydrology, economics, anthropology, and demography. It will also require a willingness of professionals to cross not only disciplinary boundaries but professional boundaries; for academics to join with practitioners, and for both of these groups to interact with policy makers. Water management practices that protect natural capital rather than depleting it will be critical to the survival and sustainability of agricultural and economic activities. In the spirit of the new social contract for science called for by Lubchenco (1998), institutional reward mechanisms to encourage synergistic collaborations among scientists, practitioners, water users, and policy makers could greatly help advance the cause of ecologically sound and sustainable water use and management.

2.2 RESEARCH GAP AND JUSTIFICATION OF THE STUDY

A number of researchers from various fields have concentrated on the water crisis and its management. Many studies on economic valuation of natural resources like water have been carried out in different parts of the world but it seems there is hardly any study on economic valuation of water resource management in the Darjeeling area. There were numbers of studies on water resource management on agriculture side but very few on domestic water utilization in urban areas of the state. Thus the present study is an attempt to bridge the gap. The backwardness of the area in terms of water supply infrastructural facilities has called for a distinct study.

Furthermore, water scarcity is a major issue of concern in Darjeeling Town and its management is urgently required for an adequate and convenient supply to the residents. However, this particular aspect of water management has been overlooked in Darjeeling. Thus the study explores the causes of water scarcity, its associated problems, the need for economic analysis in the implementation of efficient and effective water resources management strategies and policies in the respective area. The study also deals with concept of water conservation and people's perception towards it. It has look into the impact of socio-economic status of the residents on willingness to pay for water management.

In several studies, environmental valuation techniques have significantly been implemented throughout the world for valuing various aspects of water resources, including their quality and quantity; ecological and recreational functions, as well as commercial uses but very few such experiment based studies have been implemented in India. Therefore this may be among the few applied methods in this area. The present study could be beneficial for policy makers as well as private agencies with useful information for enhancement of water resources management in Darjeeling

CHAPTER 3

Database and Methodology

3.1 Sampling Design

The study was carried out in Darjeeling Town of West Bengal. The total sample size is 120. In the respective area the respondents were chosen on the basis of convenience sampling and purposive sampling.

3.2 Data Collection

The data for the study were collected both from primary and secondary sources. The primary data were collected from 120 households of 32 wards under Darjeeling municipal area. Secondary data were collected from the Water works department of Darjeeling Municipality.

3.3 Data Analysis

The following analytical tools have been employed in order to fulfill the objectives provided in the present study:

(i) Descriptive statistics: Descriptive statistics are used to summarise data with the help of numerical and graphical methods. In the present study we have computed mean, maximum, minimum, standard deviation, frequencies. Also, we have drawn trend lines for revealing patterns/trends in our data. A trend line, often referred to as a line of best fit, is a line that is used to represent the behavior of a set of data to determine if there is a certain pattern.

(ii) Contingent Valuation Method (CVM): CVM has been applied in order to estimate people’s willingness to pay for water resource management in monetary terms. Also an attempt has made to explain the influence of various socio-economic factors on willingness to pay by using the Multiple Linear Regression Method.

Multiple Linear Regression Model: Multiple linear regression analysis is an extension of simple linear regression analysis, used to assess the association between two or more independent variables and a single continuous dependent variable. The multiple linear regression equation is as follows: $Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots\ldots\ldots + \beta_k X_{ki} + U_i$ ………. (1)

We conducted a Multiple Linear Regression on the amount of money the respondents are willing to pay for the reliable and sustainable supply of water that considered their gender, age, education, household size, family income, economic status (APL/BPL), employment status, house type (own house/rental house), different sources of water, water consumption, quantity of water purchased, price of water and distance of water source in order to investigate their impact on WTP. We employed the equation below:

$$WTP_i = \beta_0 + \beta_1(DGEN)_i + \beta_2(AGE)_i + \beta_3(EDU)_i + \beta_4(HSIZE)_i + \beta_5(FINC)_i + \beta_6(DSTAT)_i + \beta_7(DEMP)_i + \beta_8(DHT)_i + \beta_9(DMH)_i + \beta_{10}(DMP)_i + \beta_{11}(DFD)_i + \beta_{12}(DPVS)_i + \beta_{13}(DPW)_i + \beta_{14}(DRW)_i + \beta_{15}(WPCD)_i + \beta_{16}(QPW)_i + \beta_{17}(PWAT)_i + \beta_{18}(SRCD)_i + U_i$$

Where

WTP: Willingness of Darjeeling town residents to pay per month for the reliable and sustainable supply of water (in monetary terms, Rupees)

β_0: Constant

β_i: Coefficients where i= 1 to 18

DGEN: A dummy variable indicating gender of the respondent

Where DGEN= 1 if the respondent is female

= 0 otherwise

AGE: Age of the respondent

EDU: Educational Qualification of the respondent (in terms of years of schooling)

HSIZE: Household size of the respondent

FINC: Family Income of the respondent

DSTAT: A dummy variable indicating economic status (APL/BPL) of the respondent

Where DSTAT=1 if the family is above poverty line (APL)

= 0 otherwise

DEMP: A dummy variable indicating employment status of the respondent

Where DEMP = 1 if the respondent is employed

= 0 otherwise

DHT: A dummy variable indicating the type of house (own/rental house) of the respondent

Where DHT = 1 if the respondent has own house

= 0 otherwise

DMH: A dummy variable indicating whether the respondents have municipality's houseline water connection. DMH = 1 if the respondent has a houseline connection

= 0 otherwise

DMP: A dummy variable indicating whether the respondents have municipality's public high drain

Where DMP = 1 if the respondent has public high drain near his/her locality

= 0 otherwise

DFD: A dummy variable indicating whether the respondents fetch water from natural sources like spring water (dharas)

Where DFD = 1 if the respondent fetches water from dharas

= 0 otherwise

DPVS: A dummy variable indicating whether the respondents have private source of water

Where DPVS = 1 if the respondent has a private source of water

= 0 otherwise

DPW: A dummy variable indicating whether the respondents purchase water from any source

Where DPW= 1 if the respondent purchases water

= 0 otherwise

DRW: A dummy variable indicating if the respondents use rainwater for their basic water needs

Where DRW= 1 if the respondent uses rainwater

= 0 otherwise

WCPD: Total amount of water consumption per day in the household of the respondents

QWP: Quantity of water purchased by the respondents

PWAT: Price of water purchased by respondents (per litre in rupees)

SRCD: Distance of water source from respondent’s home

U_i: Error term

(iii) Logit Model: The logistic regression model is simply a non-linear transformation of the linear regression. It is a qualitative response regression model (often known as probability model) in which the regressand is qualitative in nature. It takes only two values, say 1 and 0. In other words, the regressand is a binary or dichotomous or dummy variable and hence the model is known as binary response regression model. The Logistic Regression Model is given by:

$$L_i = \ln\left(\frac{pi}{1-pi}\right) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots\ldots\ldots + \beta_k X_{ki} + \varepsilon_i \qquad \ldots\ldots\ldots\ldots\ldots(1)$$

Where ln is the natural logarithm

p is the probability that the event Y occurs, p(Y=1)

$\frac{pi}{1-pi}$ Is the "odds ratio" [the probability of the event divided by the probability of the non-event].

$\ln\left(\frac{pi}{1-pi}\right)$ is the log odds ratio, or "logit"

As pi, the probability goes from 0 to 1, the logit L_i goes from $-\infty$ to $+\infty$.That is, although the probabilities lie between 0 and 1, the logit values are unbounded.

In our study, logistic regression model has been conducted in order to examine the impact of the concerned explanatory variables on the dependent binary values. Here, we have taken people's perception towards water conservation for its sustainability (= 1, if the respondent is in favour otherwise 0) as a dependent variable and the independent variables taken are gender, age, education, household size, family income, economic status (APL/BPL), employment status, house type (own house/rental house), different sources of water, water consumption, quantity of water purchased, price of water and distance of water source. In the present case the estimated Logit model is as follows:

$$PWC_i = \beta_0 + \beta_1(DGEN)_i + \beta_2(AGE)_i + \beta_3(EDU)_i + \beta_4(HSIZE)_i + \beta_5(FINC)_i + \beta_6(DSTAT)_i + \beta_7(DEMP)_i + \beta_8(DHT)_i + \beta_9(DMH)_i + \beta_{10}(DMP)_i + \beta_{11}(DFD)_i + \beta_{12}(DPVS)_i + \beta_{13}(DPW)_i + \beta_{14}(DRW)_i + \beta_{15}(WPCD)_i + \beta_{16}(QPW)_i + \beta_{17}(PWAT)_i + \beta_{18}(SRCD)_i + \varepsilon_i$$

Where PWC = 1, if a respondent is in favour of water conservation for its sustainability

= 0 otherwise

β_0: Constant

β_i: Coefficients where i = 1 to 18

DGEN = 1, if the respondent is female

= 0 otherwise

AGE: Age of the respondent

EDU: Educational qualification of the respondent (in terms of years of schooling)

HSIZE: Household size of the respondent

FINC: Family Income of the respondent

DSTAT: 1, if the family is above poverty line (APL)

0 otherwise

DEMP: 1, if the respondent is employed

0 otherwise

DHT: 1, if the respondent has own house

0 otherwise

DMH: 1, if the respondent has houseline connection

0 otherwise

DMP: 1, if the respondent has public high drain near his/her locality

0 otherwise

DFD: 1, if the respondent fetches water from dharas

0 otherwise

DPVS: 1, if the respondent has private source of water

0 otherwise

DPW: 1, if the respondent purchases water

0 otherwise

DRW: 1 if the respondent uses rainwater

0 otherwise

WCPD: Total amount of water consumption per day in the household of the respondents

QWP: Quantity of water purchased by the respondents

PWAT: Price of water purchased by respondents (per litre in rupees)

SRCD: Distance of water source from respondent's home

ε_i is the error term or random disturbance term.

Here, Ds are the Dummy variables.

CHAPTER 4
RESULTS AND DISCUSSIONS

4.1. Descriptive Analysis:

Table 4.1.a: Frequencies (total 120 observations)

GENDER		**EMPLOYMENT STATUS**		**FAMILY STATUS**		**HOUSE**		**PUBLIC TAPS**	
MALE	FEMALE	EMP	NOT EMP	APL	BPL	OWN	RENTAL	YES	NO
57	63	79	41	35	85	77	43	35	85
HOUSELINES		**FETCH WATER**		**PVT. SOURCE**		**PURCHASE WATER**		**USES RAINWATER**	
YES	NO	YES	NO	YES	NO	YES	NO	YES	NO
52	68	66	54	18	102	63	57	111	9

Source: Author's calculation from primary data

From the above Table 4.1.a it is seen that, out of 120 observations there are 57 males and 63 females. 65.3 per cent of the respondents were found to be employed while 33.9 percent were not. Out of the 120 households surveyed, 77 were the respondents' own houses while the remaining 43 were rental houses. 70.2 percent of the surveyed households are above the poverty line whereas 29.8 percent are below the poverty line.

With regard to the source of water, 52 households (43.4%) receive water within the premises (pipelines provided by municipality) but only once or twice a week. 35 households (29.2%) get water near the premises from public taps provided by municipality. It has also been noted that 66 households (55%) have to fetch water from the natural sources (dharas) which are at least 500-800 meters away from the town. Only 18 households (15%) have private sources of water which means they have their own source of water like natural springs in their lands which they utilise as a source of income by selling water to other households. It has been found that 63 households (53%)

purchased water from water vendors. The figures suggest that usage of rainfall water in the region is high, with 92.5 percent of the population having access.

Table 4.1.b: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
WTP	120	.00	550.00	2.1225E2	181.74441
AGE	120	15	75	43.07	13.355
EDU	120	0	17	9.32	4.999
HSIZE	120	1	8	4.23	1.423
FINC	120	1000	9000	3183.33	1995.766
WCPD	120	30	1100	258.25	271.283
QWP	120	0	800	170.58	219.378
PWAT	120	0	3	.46	.512
SRCD	120	0	800	280.42	276.328

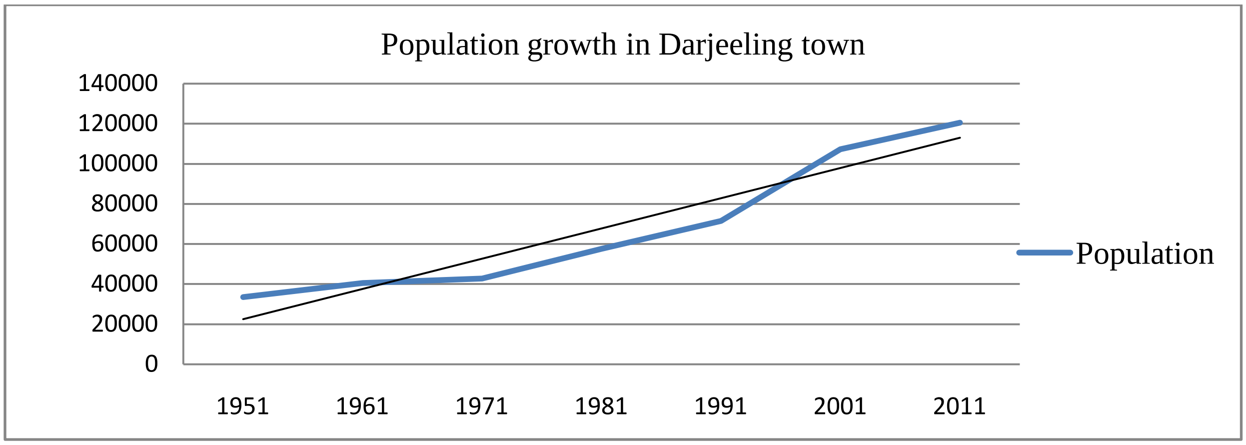
Source: Author's calculation from secondary data

From Table 4.1.b, it is observed that the minimum WTP is Rs 0 while the maximum value is Rs 550. The average age of the respondents is 43. Likewise the minimum education level is 0 and while the maximum level is 17. The minimum household size is 1 whereas maximum is 8. The average family income is 3184. Average water consumption per day is 272 litres. The minimum quantity of water purchased is 0 while the maximum is 800 and maximum price of per litre of water is Rs.3. The maximum distance of the source of water is 800 meters while the minimum is 0.

4.2. Graphical and Statistical representation to show the empirical relationship between population growth and the water deficit over the periods of the study area:

Here the study tries to show the relationship between population growth and water deficit with the help of graphical and statistical analysis. The population coverage in the past decades is shown in figure 4.2.a.

Figure 4.2.a. Trend of population growth

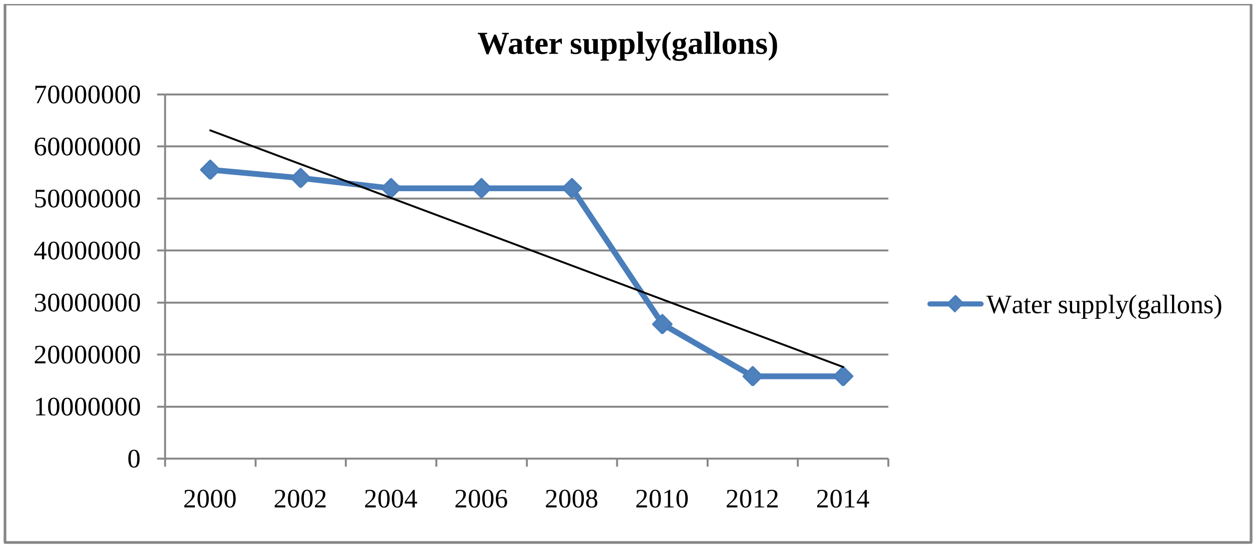


Source: author's calculation from secondary data.

According to the census report the population of Darjeeling town in 1951 was 33603 and today is 120414. The above figure represents the population density of Darjeeling town, which shows the trend of total urban population which has increased over the period. The town of Darjeeling has seen fluctuation in the growth of its population. However, at an average, the town has supported the growth rate of over 32% per decade. From 1970 onwards the growth rate of Darjeeling town has far exceeded the growth rate at the district level. In addition to this, the town has to support a floating population of 20500 in the form of tourists, students, visitors and wage earners (Darjeeling Municipality, 2001).

As the human population increases the demand of water resources also increases. The population is increasing more rapidly in the town resulting decreased water availability. The urban population faces a demand supply gap in case of water due to inadequate and unreliable supply of water in the town. The residents have much less access to water to meet the most basic human needs. The trend of water supply in the town over the decades is shown below in figure 4.2.b.

Figure 4.2.b. Trend of Water supply



Source: Author's calculation from secondary data

It is observed that the trend line is downward slopping indicating that over the decades the supply of water in Darjeeling town has decreased. The figure further shows that after 2008, water supply had fallen down drastically; the study revealed that this is a result of the drastic fall in the volume of water at natural springs of the catchment area due to monoculture plantations, massive felling of trees, and dramatic increase in population. (Darjeeling Municipality, Waterworks Department 2012).

Now, some gap between water demand and supply has been observed. Also, per head water deficit in Darjeeling town has been calculated. The following Table 1 shows the variation in water supply, demand and deficit over the decades.

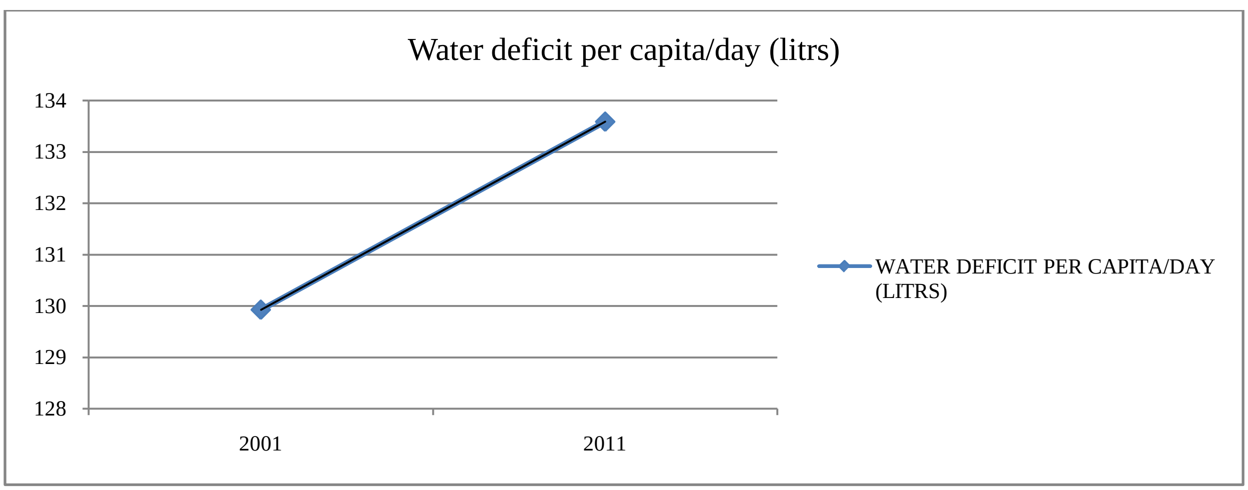
Table 4.2: Supply, Demand and Deficit of water

YEAR	POPULATION (CENSUS)	WATER SUPPLY (GALLONS)	WATER DEMAND/ DAY (GALLONS)	WATER DEMAND/ YEAR (GALLONS)	WATER DEFICIT/ YEAR (GALLONS)	WATER DEFICIT/ DAY (GALLONS)	WATER DEFICIT PER CAPITA /DAY (GALLONS)	WATER DEFICIT PER CAPITA /DAY (LITERS)
2001	107191	51947378	3826719	1396752326	1344804948	3684398	34.4	130
2011	120414	15825000	4298779	1569054627	1553229627	4255424	35.4	134

Source: Author's calculation from secondary data

From the above Table 4.2, the data reveals that in 2001, the population of Darjeeling town was 107191 while the supply of water was 51947378 gallons whereas in 2011, the population was 120414 and the supply of water was 15825000 gallons which shows the availability of water for that particular year. According to the World Health Organisation (WHO) and the Bureau of Indian Standards, the value of standard requirement of water supply is 135 litres per head per day. Thus the demand for water among the population has been calculated taking this into account and water deficit has been obtained by subtracting water supply from water demand figures. It is found from the analysis that in 2001, water deficit per head per day was 34.4 gallons (130 liters) while in 2011 it rose to 35.4 gallons (134 liters). Trend line is fitted below in the figure 4.2.c. to show the growing pattern of water deficit over the decade 2001-2011.

Figure 4.2.c: Trend of water deficit



Source: Author's calculation from secondary data

There was data with regard to water supply was inadequate for analysing water deficits over different decades. The area of concern is Darjeeling town and unfortunately the census data for the local population is not available for a continuous period. It is therefore not possible to determine fully the changes in water deficit over various periods.

From the above analysis, it has been found that there is a positive relationship between population and water deficit/water shortage. As we can clearly see from the above figures, the population has a positive trend while water supply has a negative trend which implies that the growth in population over the past decades has put tremendous pressure on the existing water resources. With greater population, demand for water increases and thus the water deficit increases across the years.

4.3. Results of the Multiple Regression Analysis:

Our estimated Multiple Linear Regression Model is given as:

WTP = -128.36 + 38.453(DGEN) -0.467(AGE) +14.389(EDU) +11.062(HSIZE) +0.0043(FINC) +66.459(DSTAT) +64.459(DEMP) +2.409(DHT) -16.078(DMH) +29.875(DMP) +28.195(DFD) +4.673(DPVS) -11.661(DPW)-28.815(DRW) +0.0435(WPCD) +0.0417(QPW) -67.225(PWAT) +0.021(SRCD)

Table 4.3: Results of regression analysis (Dependent variable: WTP)

VARIABLES	COEFFICIENTS
DGEN	38.46 (24.25)
AGE	-0.467 (1.032)
EDU	14.39*** (3.158)
HSIZE	11.07 (8.73)
FINC	0.004** (0.02)
DSTAT	66.46* (36.13)
DEMP	64.68** (26.66)
DHT	2.41 (27.81)
DMH	-16.08 (34.28)
DMP	29.03 (29.87)
DFD	28.19 (29.65)
DPVS	4.67 (37.36)
DPW	-11.66 (37.39)
DRW	-28.81 (47.49)
WCPD	0.042

	(0.04)
QWP	0.04 (0.03)
PWAT	-67.23* (37.09)
SRCD	0.02 (0.047)
F-VALUE	11.53***
R^2	0.67
No. of obs.	120
Note: ***, ** and * indicates 1%, 5% and 10% level of significance respectively; the figures in parentheses denotes standard errors.	

Source: Author's calculation from primary data

According to the results, the coefficient of determination for the model shows that 67 percent of the variations in WTP are attributed to the explanatory variables; the remaining 33 percent is unexplained. We know that R^2 is an overall measure of goodness of fit of the estimated regression which gives the proportion or percentage of the total variation in the dependent variable that is explained by all the regressors. A value of 0.67 for R^2 indicates that the above model gives a good fit. The value of F-stat is 11.53 with a p-value of 0.000 suggesting that overall regressors are statistically significant and have an impact on the dependent variable. The following regressors are found to be statistically significant:

Educational level (EDU) has a positive sign and is statistically significant at 1 percent level of significance. The education coefficient of 14.39 suggests that holding all other factors constant, for every additional year of schooling the average monthly WTP goes up by about Rs. 14.4. This means that the higher the number of years of schooling, the higher the WTP. The longer the years spent in formal schooling, the more people will be educated and hence understand the need to have reliable water supply. Therefore the educated people are more willing to pay than the illiterate.

Family income (FINC) has a positive sign and is statistically significant at 5 percent level of significance. This implies that with increased monthly income, the household WTP will increase. From the result, estimation coefficient of income suggests that a unit increase in family income will result in a 0.4 percent increase in WTP. This is because low income reduces the capability to contribute to the programme the family has to utilise a low income look after their daily requirements for sustaining their lives.

Economic status (DSTAT) is a dummy variable taken in order to categorise the economic status of people into APL (above poverty line) and BPL (below poverty line). Here DSTAT=1 if the respondent family's status is APL and 0 in case of BPL status. From the results it is clear that DSTAT has positive sign and is statistically significant at 10 percent level of significance. This implies that the average monthly WTP of APL people are higher by about Rs.66.5 as compared to the average WTP of BPL people, holding all other variables constant. Environmental economic theory states that the demand for an improved environmental quality increases with income. Those who are in APL category obviously have a higher income than those in BPL category and consequently people from higher status are willing to pay more than people from lower status.

Employment status (DEMP) is a dummy variable where employment status = 1 if a respondent is employed and is 0 otherwise. There is a positive relationship between DSTAT and WTP, which is statistically significant at 5 per cent level of significance. The average monthly WTP of a employed person is higher by about Rs.64.7 as compared to the average monthly WTP of a non-employed person, holding all other variables constant. Though almost every household is facing the problem of water shortage, all are not willing to pay for the improved water resource management; the reason behind this is that there are some sections in the society where people are unemployed. In many houses, it has been found that youths are unemployed and have no personal source of income; they are fully dependent on their parents. Therefore even if they are aware of the situation, their willingness to pay is less than that of employed ones.

Price of water (PWAT) is the amount paid by the households to purchase water for their daily use from different sources, which is found to be statistically significant at 10% level of significance and has a negative sign. The estimation of the coefficient of price of water implies that a unit increase in price of water will decrease WTP by Rs.67.3. This suggests that the more the price of water the people pay, the more will be the difficulties encountered in terms of budgetary constraints, hence the decreased WTP. Households are not willing to pay since they incur so many costs like purchasing water from different sources at different prices, paying the water bill to municipality, etc and hence cannot afford an extra burden.

4.4. Results of the Logistic Regression Analysis:

Our estimated Logistic Regression Model is given as:

PWC = -6.264 + .567(DGEN) + .016 (AGE) + .157(EDU) -0.097(HSIZE) + .0001(FINC) +1.62(DSTAT) +0.939(DEMP) -0.086(DHT) +1.133(DMH) +0.442(DMP) +2.44(DFD) +1.35(DPVS) +2.38(DPW) +.346(DRW) +3.79(WPCD) +0.002(QPW) -3.392(PWAT) +0.0023(SRCD)

Table 4.4: Results of Logistic Regression

Endogenous variable: (PWC) people's perception towards water conservation for its sustainability. =1, in favor. 0 otherwise		
VARIABLES	**ESTIMATED COEFFICIENTS**	**ODDS RATIO**
DGEN	.567 (.69)	1.768 (1.21)
AGE	.016 (.029)	1.016 (.029)
EDU	.157* (.089)	1.169* (.102)
HSIZE	-0.097 (.244)	.908 (.221)
FINC	.0001* (0.00006)	1.0002* (.00006)
DSTAT	1.62 (1.18)	5.025 (5.89)
DEMP	0.939 (.736)	2.558 (1.882)
DHT	-0.086 (.891)	.425 (.378)
DMH	1.133 (1.122)	3.11 (3.48)
DMP	0.442 (0.86)	1.556 (1.35)
DFD	2.44** (0.95)	11.43** (10.84)
DPVS	1.35 (1.09)	3.856 (4.21)
DPW	2.38* (1.34)	10.78* (14.43)

DRW	.346 (1.27)	1.413 (1.795)
WCPD	3.79 (0.01)	1.000 (.002)
QWP	0.002 (0.001)	1.001 (.001)
PWAT	-3.392*** (1.713)	.0336** (.057)
SRCD	0.0023 (0.001)	1.002 (.002)
Constant	-6.264** (2.79)	–
Pseudo R^2	0.4480	0.4480
No. of obs.	120	120
Note: ***, ** and * indicates 1%, 5% and 10% level of significance respectively; the figures in parentheses denotes standard errors.		

Source: Author's calculation from primary data

From the above estimated results it is seen that variables like education (EDU), family income (FINC), source of water9(DFD), source of water (DPW) and price of water (PWAT) are found to be statistically significant at 5 per cent and 10 per cent level respectively. Each slope coefficient measures the change in the estimated logit for a unit change in the value of the given regressor holding the other regressors constant.

The fact that education is statistically significant suggests that with other variables held constant, if education increases by one year the average logit value increases by 1.17. In other words, the log of odds in favor of people's perception towards water conservation rises 1.17 times. This result can be explained by the fact that people with greater education are more aware of the fact that water conservation has important implications for the sustainability of water resources for the current and future generations. Thus educated people are more concerned about urban water resource management.

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9 Sources of water: in the present study, several sources of water has been categorized into different dummys like:

Source1:municipality houseline (DMH)
Source2: municipality public taps (DMP)
Source3: fetching water from dharas, natural springs (DFD)
Source4: private source of water (DPVS)
Source5: purchasing water from different tankers, porters or any other means (DPW)
Source6: using rainwater (DRW)

Family income is found to be statistically significant, suggesting that holding other variables constant, a unit increase in the level of family income will increase the odds in favor of people's perception towards water conservation 1.01 times. This result can be explained by the fact that richer households with high family income are better educated than their poorer counterparts, and therefore they are more concerned about the situation. Also, with their high income they are capable of paying for any kind of management practices for water conservation. Thus we can say that people with high family income are in favor of water conservation.

In terms of source of water i.e. fetching water from dharas is statistically significant, suggesting that those respondents whose source of water is the dhara (natural springs) are in favor of water conservation 11.43 times more than those who do not do so. This can be explained by the fact that there are many households in the surveyed area where people carry water from natural springs, especially women and children. They spend more time and energy waiting for their turn and fetching water from dharas. Therefore the source of water has a positive and significant impact on the people's perception.

Source of water (i.e. purchasing water from tankers, porters or other means) is also found to be statistically significant, suggesting that those who purchase more water are in favor of water conservation by 10.78 times more than those who do not purchase it. This can be explained by the fact that in a water scarce area like Darjeeling, in order to meet the requirements of water, people purchase water from different sources like porters (water carrier), tankers (vehicle carrying water) and other means. All the households are not rich enough to afford the cost of water for their daily use. Therefore people are in favor of water conservation to sustain the availability of water.

Lastly, the overall fit of models, as measured by McFadden's ρ^2, is satisfactory. According to Hensher and Johnson10 (1981) values of ρ^2 between 0.2 and 0.4 are considered to be extremely good fits. According to this criterion the overall fit of the model is 0.44 which suggests a good fit; all the coefficients are statistically significant and intuitively correct.

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10 Hershan, D.A., Johnson, L.W., 1981. Applied Discrete Choice Modelling. London. Croom-Helm/New York: John Wiley

CHAPTER 5

CONCLUSIVE OBSERVATIONS AND RECOMMENDATIONS

5.1 CONCLUSIVE OBSERVATIONS:

The present study dealt with the issues in urban water resource management in Darjeeling town. During the study it was seen that the municipal water supply is unable to cope up with the increasing demand of the growing population of the town leading to a huge water deficit. The crisis in urban water supply on the other hand, is not because of the actual scarcity of water but due to poor management practices. Most of the water supply infrastructure in Darjeeling is outdated as it came into existence 85 years ago. The existing installations were meant for a population of about 15000 during the British period. At present the population of Darjeeling town is more than 1 lakh. Thus there exists a widening gap between supply and demand of water in the town.

The study estimated water deficit per day in the town at 42,55,424 gallons (approximately) which reveals that per capita water consumption is very low. It was also seen that during monsoon more than 90 percent of the total population uses rainwater for their basic purposes but during dry seasons, the town faces a huge crisis of water, forcing them to buy water at much higher rates from private sources. The following are the results which have been obtained from the study:

A study of 120 households in Darjeeling municipal area revealed that only 43.4 percent of total households have municipal water connection within the premises. 29.2 percent get water near the premises from public taps provided by the municipality. One tap is used by 15 to 20 households. Municipal water is not at all sufficient for the residents to meet their basic requirements. The unreliable and limited duration of supply of water in the town is a common trend. This has forced the residents to rely on other sources of water supply namely, natural spring water, porters who sell water and private vendors who supply water through tankers. This in turn is leading to emerging water markets in the town.

In addition, 15 percent of the total households are found to have private sources of water, i.e., they have their own source of water like natural springs in their property which they utilise as a source of income by selling water to other households. Moreover, in the present context, due to the commodification of water, people having higher purchasing power (socially wealthy and politically powerful people) have better access to water, while in the poorer sections there is lack of provision of adequate minimum water.

Some major observations drawn from the study are:

a) People have to travel from 20 meters to 1 km away from the town for fetching water.

b) Women and children are the main water collectors of the households.

c) The availability and mode of use of water varies across the various socio-economic classes. However, the differences are not very significant.

d) Per capita water consumption in Darjeeling town is far lower than the norms laid down by WHO (World Health Organisation) and BIS (Bureau of Indian Standards).

e) Twenty-four hour water supply through taps is a dream for a majority of households in the town. The study reveals that not a single household in the town receives such water supply.

f) People are compelled to rely on water markets (water vendors such as private tankers and porters) due to the unreliable supply of municipal water.

g) The present water system was constructed during British period for a population of around 10,000 to 15,000 while today's population is more than 1 lakh. However, till date there has been no improvement in the water supply system.

h) A festival like Holi has lost its charm in the hills over the past decade because of water scarcity. People cannot afford to waste water in celebrating Holi and then washing their clothes.

i) Darjeeling town requires about 15-18 lakh gallons of water daily but the municipality supplies only about 7-8 lakh gallons of water.

j) The water tankers charge differently for supplying water depending on the location of a hotel and house in the town.

Further, the study estimated people's willingness to pay (WTP) for better management of water resources with respect to their socioeconomic conditions. Economic valuation techniques like contingent valuation method (CVM) was applied to examine the monetary values that people are willing to pay for better water resource management in order to get reliable and sustainable water supply. The study's findings are summarised as follows. Firstly, on average, 88 percent of the surveyed households in Darjeeling town are willing to pay for better water resource management. The maximum WTP is Rs. 550 and the minimum is 0. Secondly variables such as education, family income, family status and employment have positive impacts on WTP for the proposed management plan. This suggests that residents of Darjeeling town in general regard water as an economic good as they are willing to pay for its provision. Thirdly, in Darjeeling town those households with a higher family income, who are above the poverty line, are willing to pay for improved water resource management. This finding supports the environmental economic theory which states that demand for an improved environmental quality increases with income. Again, educated people are more likely to pay than uneducated ones. The longer the years spent in formal schooling, the more people will be educated and hence understand the need to have reliable water supply. Therefore the educated people are more willing to pay than the illiterate. Likewise, the average monthly WTP of an employed person is higher by about Rs.64.7 as compared to the average monthly WTP of a non-employed person. Lastly, from being the community's common property resource, water emerged as a commodity to be bought and sold in the market. In such a situation, people have to pay a high price to commercial vendors for water. Thus those households who are currently paying for water are not willing to pay since they have already incur so many expenses that they cannot afford a new burden.

Finally, the study discusses how different people perceive water conservation differently. With the help of logistic regression analysis method people's perception regarding water conservation for future generations with respect to different socio-economic factors has been estimated. The findings are as follows:

It was found that people with higher education are more aware of the fact that water conservation has important implications for the sustainability of water resources for the current and future generations. Similarly, high income people are capable of paying for any kind of management practices for water conservation. Thus it was seen that people with high family income are in favor of water conservation. Lastly, sources of water are found to be significant in case of water conservation. This can be explained by the fact that there were many households in the surveyed area where people - especially women and children - carry water from natural springs that are outside the main town. They spend more time and energy waiting for their turn and fetching water from dharas. Likewise, in a water scarce area like Darjeeling, in order to meet the requirements of water, people purchase water from different sources like porters (water carriers), tankers (vehicles carrying water) and other means. Therefore it was found that households facing such problems are in favor of water conservation so as to sustain the water availability for the future generations. They do not want to make their upcoming generations suffer like themselves.

Water can pose a serious challenge to sustainable development but managed efficiently and equitably, it can play a key role in strengthening the social, economic and environmental systems. The study may be helpful for planning a water supply system for the rising urban population of the state. It gives insight into the various components of the water supply system and people's perception regarding sustainable water resource management. The research further shows the impact of various socio-economic factors on the payment decisions of the residents. The study also highlights awareness among people regarding the need for the conservation of water for future generations.

5.2 RECOMMENDATIONS:

Darjeeling town, being an important tourist spot and having several renowned education institutions as well as the tea industry, is becoming overpopulated day by day. The density of population has increased rapidly over the decades and consequently demand of water is increasing. At present there are only three lakes where water is being stored from different springs and is supplied to the town. There is a water deficit of 42,55423 gallons per day in the town; during the dry season it becomes worse. During the rainy season people get water once or twice in a week that too for a very limited period; but in the dry period water is supplied at an interval of six to thirteen or fourteen days.

Considering the current situation of the existing water supply systems and the fact that projects carried out in the past have not been able to resolve the water problems in Darjeeling town, recommendations can be made as follows:

- The corporations should organise awareness campaigns in order to educate people about proper water resource management as well as about the need for water conservation.

- Municipal water supply needs further improvement in terms of water duration and regularity.

- Municipal water coverage should be enhanced.

- Some repair and renovation work has to be implemented to improve the present water distribution system in the Darjeeling Municipal Area, as the twin lakes are the main water sources for Darjeeling town.

- The state government should allocate sufficient funds to Darjeeling Municipality so as to bring the existing water systems into proper functioning form.

- The other alternate way to mitigate this crisis is rainwater harvesting through roof top rainwater conservation as it is the best option for restricting the rainwater from runoff.

Lastly, it is obvious that one of the main problems of water scarcity is due to the shortage of reservoirs but a permanent solution of the water crisis is totally dependent on the willingness of the people. Till date, the responsibility of water management was only on Darjeeling Municipality but to really undertake proper urban water resource management, people's participation is very important. The town is blessed with adequate rainfall (avg. annual rainfall: 3092mm), one of the highest rates of annual rainfall in India. This rainwater, if properly harvested, can mitigate the crisis. Thus rain water harvesting can be done through the construction of reservoirs.

Through this research it has been found that people of Darjeeling town are ready to pay for better water resource management where they get reliable and sustainable supply of water. If water deficit could be met through the construction of more reservoirs, people are ready to pay for it thus it is a suggestion for the government or the local authorities to come forward with a long term project which can solve the water problem permanently. However, the project needs to priced and monthly bill should be charged from the consumers for its maintenance but there should be assurance of reliable supply of water.

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APPENDIX

SET 1

QUESTIONNAIRE FOR THE HOUSEHOLD LEVEL SURVEY

TOPIC OF THE STUDY: URBAN WATER MANAGEMENT IN DARJEELING TOWN

Elicitation of public preferences for water resource management:

Name of the Enumerator: ______________________
Date: _____________________________________
Time Started: ______________________________
Time Ended: _______________________________
Place: _______________________________

My name is Alka Rai and I am a research scholar, pursuing my M.phil degree from Sikkim University. I am carrying out this survey to examine how people live on the water scarce area like Darjeeling town and their views with regards to water resource management and water conservation. Understanding people's perceptions will provide useful insights to policy making towards the design of efficient and effective water resource management.

I would be most grateful if you could take about 15 minutes to complete this questionnaire. Responses are strictly confidential and there are no correct or wrong answers; I just want your opinion. Thank you in advance for your cooperation.

Part 1: Warm-up questions: Water resource management perceptions and actions taken

1. In your opinion, which of the following do you consider to be the most serious problems currently facing by the residence of Darjeeling Town? Choose three and rank them from 1 to 3 according to their importance to you

   a) Water scarcity |__|
   b) Lack of food |__|
   c) Sanitation problem |__|
   d) The spread of an infectious disease |__|
   e) A major economic downturn |__|
   f) The increasing population |__|

g) Other (spontaneous - specify) ___________ |__|
h) None |__|

2. What are the three environmental risks that you find most worrying for Darjeeling town? Choose three and rank them from 1 to 3 according to their importance to you

a) Depletion of water resources |__|
b) Water pollution |__|
c) Air pollution |__|
d) Deforestation |__|
e) Earthquake |__|
f) Landslides |__|
g) Other (spontaneous - specify) ___________ |__|
h) None

3. How severely do you believe the following goods and services are nowadays threatened because of water scarcity? (On a scale from 1 to 5 with 1 indicating least perceived risk and 5 strong risk)

Goods and Services	**1**	**2**	**3**	**4**	**5**	**DK/NA**
Safe Drinking water availability	☐	☐	☐	☐	☐	☐
Sanitation	☐	☐	☐	☐	☐	☐
Tourism	☐	☐	☐	☐	☐	☐
Human health	☐	☐	☐	☐	☐	☐

4. Could you please tell us on a scale from 1 (strongly disagree) to 5 (strongly agree) what you think about the following statements?

	1	**2**	**3**	**4**	**5**	**DK/NA**
There will be no water source in Darjeeling..						
...in the next 10 years	☐	☐	☐	☐	☐	☐
... in the next 30 years	☐	☐	☐	☐	☐	☐
... in the next 50 years	☐	☐	☐	☐	☐	☐
The price of water will rise in such a manner that one could hardly able to afford it...	☐	☐	☐	☐	☐	☐
...in the next 10 years	☐	☐	☐	☐	☐	☐
... in the next 30 years	☐	☐	☐	☐	☐	☐

... in the next 50 years						
Unless action is taken the sustainability of water in the town will be significantly reduced...						
... in the next 10 years	☐	☐	☐	☐	☐	☐
... in the next 30 years	☐	☐	☐	☐	☐	☐
... in the next 50 years	☐	☐	☐	☐	☐	☐

PART 2: VALUATION TASK

Current Scenario:

Darjeeling town spreads over an area of 10.7sq.km and comprises of 32 wards with the population 132,016 (census 2011). In the Town, a significant fraction of population has no access to proper water supply and hence water scarcity has become a serious issue over there. There are various reasons behind water scarcity in Darjeeling. The population of Darjeeling town has grown over the years, as it stands close to around 2 lakhs, but there are only Senchal South and North lakes to meet the water demands of Darjeeling residents. These were actually constructed to meet the demands of 25,000 – 30,000 citizens under the British period. Though the Town is blessed with adequate rainfall (avg. annual rainfall: 3092mm) one of the highest rates of annual rainfall in India, yet there is problem of water shortage. With such heavy rainfall, one would expect water to be easily harvested. Unfortunately, there is no water harvesting facilities. During the rainy season, water is seen flowing down huge drains. The Senchal South lake can hold a total capacity of 13 million gallons while the North lake can accommodate 20 million gallons after which it overflows. Millions of gallons of water go waste. This quantity of rainfall if properly stored could play an important role in solving the water crisis to some extent.
Now if any agency comes forward and designs an efficient water resource management project to mitigate water shortage then the implementation of the proposed programme is expected to influence the following characteristics:

- Water supply
- Water price
- Health Risks
- Sanitation
- Time consumed in water fetching

To cover the expenses of the relevant mitigation measures new municipal taxes on drinking water and waste water will be issued. The additional monthly cost to your household (minimum tax for water) for the next 5 years will be:

- 0 rs per month
- 50 rs per month
- 100 rs per month
- 200 rs per month
- 300 rs per month

The additional funds collected will be managed by the municipality and will be exclusively used for implementing the risk mitigation project.

The levels for all attributes correspond to the situation in Darjeeling in:

- 10 years
- 30 years
- 60 years

In what follows, we will present you with a sequence of cards displaying alternative risk mitigation/management plans. In each of these cards we ask you to choose the one that is most preferred to you. Option C always corresponds to the continuation of the current management, under no new policy response and no new taxes to your household.

Please keep in mind that in this kind of surveys people often tend to overstate their willingness to pay to contribute to the proposed project. You are kindly asked to consider the impact of the extra amount to your family budget and the reduction in your disposable income for other goods it implies before stating a choice.

Choice Cards

Choice Set	Option A	Option B	Option C
1	☐	☐	☐
2	☐	☐	☐
3	☐	☐	☐
4	☐	☐	☐
5	☐	☐	☐
6	☐	☐	☐

Debriefing questions

1. On a scale from 1 to 4 how difficult did you find the choice between the cards? (with one meaning very easy and 4 meaning highly difficult)

1 2 3 4 5 don’t know

2. Do you trust that all additional funds you will pay will be used for reducing the water shortage associated risks in Darjeeling? Yes ☐ No ☐

3. On a scale from 1 to 4 how efficient do you think a new risk mitigation strategy can be in tackling the problem of water shortage in the Darjeeling town? (with one meaning least efficient and 4 meaning highly efficient)

1 2 3 4 5 don’t know

4. On a scale from 1 to 4 how realistic you think the description of the status quo (option C: situation in Darjeeling in 10/30/60 years) (with one meaning totally unrealistic and 4 meaning very realistic)

1 2 3 4 5 don’t know

5. If you chose neither management programme (option C) in one of the choice sets above, could you please tell us why you are against any management strategy?

   a) I don’t believe that the proposed strategy would be successful ☐
   b) I do not have the financial capability to pay higher taxes ☐
   c) I would only pay higher taxes if other locals definitely do ☐
   d) I do not care for the water issues in the area ☐
   e) The government should pay ☐
   f) I do not think that the water management strategy is necessary, there is no risk ☐
   g) If problem increases, I will move elsewhere ☐
   h) The benefits of the measures are too distant/I don’t care for future generation ☐
   i) Other (please specify) _______ ☐
   j) I don t have enough information about the risk reduction measures ☐

PART 3: SOCIO-ECONOMIC INFORMATION

1. Age: ______

2. Gender: Female ☐ Male ☐

3. Nationality: ______

4. a) Permanent Resident ☐``
   b) Rental House ☐
   c) Tourist ☐

If a tourist: For what purpose have you visited Darjeeling (can tick more than one)

a) Cultural (museums, theatres, Castles, Churches) ☐
b) Recreational ☐
c) Swimming ☐
d) Natural parks ☐
e) Other (please specify) ______

5. Occupation

a) Full-time job ☐
b) Part-time job ☐
c) Unemployed ☐
d) Pensioner ☐
e) Student ☐
f) Farmer ☐
g) Housewife ☐
h) Other (please specify) ______ ☐

6. Number of people living in the house: ___________

7. Do you have children? Yes ☐ No ☐

8. Which is the higher level of education you have completed or you are in process of completing?

a) Less than primary school ☐
f) Primary school ☐
g) High school ☐
h) Technical school ☐
i) University ☐
j) Postgraduate ☐

9. In which one of the following categories of income brackets does your monthly net household income lie?

a) 0-5000 ☐
b) 5000-10000 ☐
c) 10000-15000 ☐
d) 15000-20000 ☐
e) 20000-25000 ☐
f) 25000-30000 ☐
g) Over 30000 ☐

10. Could you please tell us on a scale from 1 (strongly disagree) to 5 (strongly agree) what do you think about the following statements?

	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)	Don't know
Current generations should protect the environment to ensure that future generations can continue to enjoy the benefits of the goods it provides.						
Intergenerational equity should be an important consideration for policy-making.						
I would financially contribute						

to actions aiming to mitigate climate change even if benefits are to be received by future generations.						
I prefer enjoying the present and not spend a big part of my time worrying about the future						

PART 4: RISK PERCEPTION

11. In your current house, do you feel threatened by water shortage?

a) Yes, seriously ☐
b) Yes a little bit ☐
c) No, not too much ☐
d) No, not at all ☐
e) No answer ☐

12. Have been affected by water shortage in the last 10 years? Yes ☐ No ☐

If yes, have you been compensated for the financial losses suffered?

a) Yes, totally ☐
b) Yes, partially ☐
c) Yes, but only a few ☐
d) Not at all ☐

13. Are you privately affected due to water scarcity? Yes ☐ No ☐

If NO, would you consider get affected in the future? Yes ☐ No ☐

14. Do you expect to be deprived from basic need such as drinking water within the next 30 years? Yes ☐ No ☐

15. In order to manage water supply and its conservation, who do you trust the most? (Circle as appropriate)

1. The local government (Mayor etc)
2. Regional authorities
3. National authorities
4. Local NGOs
5. Private agencies
6. Other (please specify)
7. No answer.

INTERVIEW PROTOCOL

1. Respondent’s cooperation

   Excellent ☐ Fair ☐ Average ☐ Bad ☐

2. Respondent s understanding of the choice task

   Excellent ☐ Fair ☐ Average ☐ Bad ☐

3. Respondent being on a rush

   Very rushed☐ Somewhat☐ No rush☐

SET 2
QUESSTIONNARE

1. Name of the respondent:
2. Gender: F/M
3. Age:
4. Location:
5. Education qualification:

i.	Primary:
ii.	Secondary:
iii.	Higher secondary:
iv.	Graduation:
v.	Post-grad:
vi.	P.hd:

6. Religion status:

i.	Hindu:
ii.	Buddhist:
iii.	Christian:
iv.	Muslim:
v.	Others:

7. Job status: Working/not working

8. Occupation:

i.	**Govenment**
ii.	**private**
iii.	**Self employement**

9. Own house/ rental house

10. Household size:

11. Total no. of working members:

12. Family status: APL/BPL

13. Family's Monthly expenditure:

14. Family's Monthly income:

15. Municipality water connection: Y/N

If Yes		**If No**	
i.	Within premises/outside premises(Sharing):	i.	From which source do you fetch water:
ii.	No. of house using same connection given in your locality:	ii.	Distance from home:
iii.	How many days in a week do you get water from municipality connection:	iii.	Hours spent for collecting water:
iv.	For how many hours:	iv.	Who collects water:
v.	Municipal's water is Sufficient: Y/N	v.	Amount of water fetched in a day:
vi.	Do you purchase water: Y/N	vi.	Do you purchase water:

16. From where do you purchase water:

17. Water requirement per day(in Ltrs):

18. Water consumption per day (in Ltrs):

19. Water purchased per day (in Ltrs):

20. In favor of Water conservation: Y/N

21. Willingness to pay(WTP) for water management for reliable supply: Y/N:

22. WTP(in Rs)