Adaptation to Water Shortage: Analysis of Ward Number 7 and 8 in Kathmandu Metropolis

by

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Dedication

Dedicated to all professionals involved in supply and management of water endeavor to support people to meet their domestic water needs.

Abstract

Water is the essential resource for survival. However, residents of Kathmandu valley have been suffering a long from water shortage, since the water supply utility of Kathmandu Valley has not been able to meet water demands of growing population. Households have been using multiple water sources of varying characteristics. The government's effort to improve water supply has not been fruitful yet. In this context, there is need to identify essential measures that residents are putting up to adapt with water shortage in order to improve access and manage available water sources to minimize the problem. Hence, the study is about the causes, effect and mitigation measures employed by the residents of Kathmandu Metropolitan City ward number7 and 8to adapt with water shortage. The study adopted convenient sampling approach to gather quantitative data from the households. A total of determined 67 households disproportionately distributed over two selected wards were interviewed. In addition, key informants were also interviewed during the field work. The collected data was coded and entered into the computer for analysis using Microsoft Excel, and results are presented in respective bar-charts, tables and pie charts wherever necessary.

The study revealed that urbanization in the study areas is the major cause of water shortage as a result of which water is perceived to be extensively extracted from the groundwater leading to its depletion. With every pace of urbanization, the water demand has increased whereby each house in the areas own an individual dug wells. The local people were seen going deeper into the wells for the water. The local people revealed that the quality of water delivered by the utility has also been one of the causes of water shortage in the area which has led to the construction of dug wells in the houses.In addition, local people and the representative of both wards mentioned the water leakages in the distribution system which was contradicted by the Kathmandu Upatyaka Khanepani Limited (KUKL) representative. With this, people have lost the faith on the water utility and are reluctant to pay the water bills. Secondary causes were lack of water treatment plant, water pollution and leakage. Therefore, day to day life of the local people was more affected than health as they have to spend more hours during odd hours for water. Therefore, Mahankalchaur distribution center should reconsider the timing of water delivery so that every household get sufficient time to collect and store water in the study areas.

As a result, it was found that the majority of households were found to be dependent on multiple sources. A spectrum of water sources is being used in the study areas depending on the economic status of the households. In some cases, it was also influenced by the family size. Medium sized family were found to be using multiple water sources in compare to other. However, rainwater harvesting, a potential source of water, has been sporadically adapted by the households (8 households out of 67 surveyed households) in the study areas, which is attributed to limited awareness amongst the local people. Therefore, the government or non-government organization should break in and create awareness on rainwater harvesting system in the study areas.

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Finally, I would like to thank my family for moral support and inspiration throughout this study.

Declaration

I hereby declare that this study entitled **"Adaptation to Water Shortage: Analysis of Ward Number 7 and 8 in Kathmandu Metropolis"** is based on my original research work. Related works on the topic, by other researchers, have been duly acknowledged. I owe all the liabilitiesrelating to accuracy and authenticity of the data or any other information included hereunder.

Signature:
Name of Student: Binaya Kharel
Date:

Recommendation

This is to certify that this thesis entitled **"Adaptation to Water Shortage: Analysis of Ward Number 7 and 8 in Kathmandu Metropolis**" prepared and submitted by Binaya Kharel, in partial fulfillment of the requirements of the degree **of Master of Science (M.Sc.) in Interdisciplinary Water Resources Management** awarded by Pokhara University, has been completed under my supervision. I recommend the same for acceptance by Pokhara University.

Signature:
Name of the Supervisor: Robert Dongol
Organization: Nepal Engineering College
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Certificate

This thesis entitled "**Adaptation to Water Shortage: Analysis of Ward Number 7 and 8 in Kathmandu Metropolis**" prepared and submitted by **Binaya Kharel**, has been examined by us and is accepted for the award of the degree of **Master of Sciences (M.Sc.) in Interdisciplinary Water Resources Management** by Pokhara University.

Ram Prasad Kharel External Examiner	…… Signature	……. Date Signed
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Table of Contents

Title **Page**

List of Tables

Title **Page**

List of Figures

Title **Page**

Abbreviation

BL	Billion liters
CBS	Central Bureau of Statistics
GEQ	Gorkha Earthquake
HHs	House holds
ICIMOD	International Center for Integrated Mountain Development
IUCN	International Union for Conservation of Nature
KII	Key Informant Interviews
KMC	Kathmandu Metropolitan City
KUKL	Kathmandu Upatyaka Khanepani Limited
KVDA	Kathmandu Valley Development Authority
MLD	Million Liters per Day
MOUD	Ministry of Urban Development
MWSP	Melamchi Water Supply Project
NDWQS	National Drinking Water Quality Standard
NWSC	Nepal Water Supply Corporation
SLC	School Leaving Certificate
SDGs	Sustainable Development Goals
SSCWSS	Small Scale Community Water Supply System
UNICEF	United Nations International Children's Emergency Fund
UN DESA	United Nations Department of Economic and Social Affairs
WHO	World Health Organization
WTPs	Water Treatment Plants

Chapter – 1

INTRODUCTION

1.1 Background

Water is the life giving as well as life maintaining element. It is essential for all sorts of living as well as non-living elements and is an indispensable factor. It is a fundamental natural resource and vital to the society (Pandey, 2012).Anthropological studies reveal that human civilizations sprouted alongside riverbanks and water has worked as a promoter and protector of human life and civilization. Thus, the presence of safe and reliable source of water is an essential prerequisite for the establishment of stable community. Two third of the earth is occupied by water and only 0.3% is safe for drinking purpose. Safe drinking water is defined as water with microbial, chemical and physical characteristics that meet World Health Organization (WHO,2007) guidelines or National Standards on Drinking Water Quality (NDWQS, 2005).Watershortage is the lack of sufficient available water resources to meet the demands of water usage within a region. More than 1.2 billion people lack access to clean drinking water (Hussain, et al., 2003).Nepal has abundant water resources, despite this, the potable water supply in most of the areas especially urban areas of Nepal is still reeling under bad and inadequate water supply. The urban areas, especially in Kathmandu Valley there is a constant short supply of water due to unprecedented population growth, changing lifestyle and poor water management (Gautam, et al.,2013).

There are several causes of water shortage. Some of the contributing factors to water shortage are climate change, water overuse, drought, governmental access including chemical and microbiological pollution. The biggest problem that happens when there is water shortage is that people are not able to get fresh, clean drinking water. The human body can only go so long without water and a lack of drinking water can result in a number of other problems like hunger, disease, lack of education, sanitation issues. About 844 million people do not have clean water (WHO&UNICEF, 2017). Access to quality water is fundamental to better living standard and economic growth. Schools, restaurants, hospitals, hotels and other businesses need to stay clean for operations to run effectively - manufacturing and industrial processes, mining activities, and commercial businesses all need large quantities of water to flourish. Without economic activities led by the lack of water means higher poverty levels and poor living standards. Water, health and poverty are closely linked to each other. Health and poverty have two-way relationship: good health brings prosperity and prosperity brings improvements in health or conversely poor health may create and perpetuate poverty and poverty may lead to poor health. Water is at the center and contributes to both health and poverty. Water also contributes to livelihoods of the poor as a key input in the production process in agricultural and non-agricultural uses and in the environment in which poor people live and depend on. Good human health and environmental health contributes to poverty reduction and vice versa with water being at the center for both. Poverty causes natural resources degradation, influencing environmental health, which in turn creates more poverty (Hussain, et al., 2002).

There are several coping strategies to combat water shortage such as recharging ground water, adopting treatment technologies, re-using water, water conservation, infrastructure repair and maintenance. In addition, clean water initiatives, improved practice related to farming, awareness through education etc. play vital role to solve the issues related to

water. Many residents of the Middle Mountains in the Hindu Kush–Himalaya face shortage of water for domestic and agricultural use. Improved supply, demand, and quality management of water resources must take into consideration the current situation, with active local participation and creation of awareness with respect to preventive and curative methods. Locally based organizations should be strengthened and fully involved in the discussion of water resources management. More studies need to be undertaken in this context to further support local groups in integrated water management (Merz, et al., 2003).

1.2 Statement of the problem

Nepal is characterized by rapid population growth, unplanned urbanization, and a high rate of rural out-migration to urban centers. The urban population has increased from 1 million (6.5%) in 1981 to 4.52 million (17%) in 2011 and still in the rise, and as a result, water demand has been identified as a major challenge for the rapidly increasing urban population(IUCN, 2013).The total population of the Kathmandu Valley is more than 2.38 million (CBS, 2014). The annual population growth rate of the Kathmandu Valley is about 4.63%(KDVA, 2015).Over the last few decades, water security has emerged as a major issue in the Kathmandu Valley due to the increasing population. Natural springs and traditional stone spouts have dried up and as a result obtaining sufficient clean water has become a daily struggle(ICIMOD, 2014). The average water demand and supply in the Kathmandu Valley between 2010 and 2014 increased from 320 to 360 Million Liters per Day (MLD) whereas the supply only increased from 111 to 124 MLD. The average water deficit remains more than 200 MLD (KUKL, 2014). The average demand for water is 360 MLD, and Kathmandu Upatyaka Khanepani Limited (KUKL) is able to supply only an average of 125 MLD, which is 35% of the total demand (KUKL, 2014). The supply and demand situation demonstrates that there is a huge shortage of water in the valley. KUKL was established in 2008 by the Government of Nepal to manage drinking water and sanitation services in the Kathmandu Valley which is capable of supplying only 33% of total water demand while the remaining 67% comes from traditional water resources such as stone spouts, wells, private boreholes, and private water tankers, which deliver household water from rivers and springs (Jha, 2012). Over-extraction of groundwater in the valley has resulted in groundwater depletion; therefore, both the quantity and quality of groundwater in the valley are in immense threat(Pradhanang et al., 2012).Hence, a lack of water has become a common problem for households and businesses in the Kathmandu Valley turning water security into a burning issue.

There is lack of document which provides the information on extent of water shortage in Kathmandu Metropolitan City especially in ward level and how people are meeting their water demand despite acute shortage. Most of the previous studies in Kathmandu valley have focused on surface water and groundwater quality (Koju et al., 2014; Chapagain et al., 2010) but there is lack of studies on adaptation strategies adopted by households in ward level.

1.3 Research Questions

In this ground the following research questions have been formulated to seek the answers which are as follows:

1. What are the local perceptions on the causes and effect of water shortage in ward number 7 and 8 of Kathmandu Metropolitan City?

2. What are the existing water use strategies adopted by the people of ward number 7 and 8 in the Kathmandu Metropolitan City?
3. How socio-demographic characteristics of respondents affects the strategies they adopt to cope with water shortage?

1.4 Research Objectives

The broad objective of the study was to document water shortage, its effect and adaptation strategies of the residents of ward number 7 and 8 of Kathmandu Metropolitan city.
The main objective was addressed through a set of three objectives:

1. To analyze the local residents' perception on the causes and effects of water shortage in ward number 7 and 8 of Kathmandu Metropolitan City.
2. To investigate the existing water use adaptation strategies adopted by the local residents of ward number 7 and 8 of Kathmandu Metropolitan City.
3. To compare the association between socio-demographic characteristics of respondents and the strategies they adapt to cope with water shortage.

1.5 Significance of the study

The study tried to generate knowledge on causes-effect and coping mechanisms against water shortage in the selected ward of Kathmandu Metropolitan City. This information should help policy makers and intervention agencies understand the various dimensions to the water shortage problem which should help in the formulation of policies geared up towards sustainable water supply so as to reduce the sufferings of the people. This is also equally important to other city governments to manage water where demands exceed supply.

1.6 Scope and limitations of the study

The study was conducted in two wards of Kathmandu Metropolitan City (ward number 7 and 8) only, which fall under the service area of Mahankalchaur of Kathmandu Upatayaka Khanepani Limited (KUKL). The particular wards were selected as the effect of Gorkha Earthquake 2015 is severe in Mahankalchaur service area (Thapa, et., 2016).Since, it did not adequately reveal holistic information on causes and effect of water shortage in the study area in overall. The survey wasbased on convenient sampling. Hence, it did not possess the power of generalization of the results to whole; however, the study documented the various causes and effect of water shortage of the particular area.

Chapter – 2

LITERATURE REVIEW

2.1 Urbanization and Water Supply in Kathmandu

Nepal is one of the ten least urbanized countries in the world. However, it is also one of the top ten fastest urbanizing countries. In 2014, the level of urbanization was 18.2 %, with an urban population of 5,130,000, and a rate of urbanization of 3 %(UN DESA, 2014). For the period 2014- 2050, Nepal will remain amongst the top ten fastest urbanizing countries in the world with a projected annual urbanization rate of 1.9 %. The Kathmandu Valley is the most populated urban region and one of the fastest-growing urban agglomerations in South Asia. Kathmandu Valley accounts for 24 % of the total urban population, with Kathmandu Metropolitan City alone accounting for 9.7 %(MOUD, 2015).

In Kathmandu Valley, 72 % of households have access to piped water. Water demand is around 350 MLD but KUKL only provides 90 MLD in dry season and 150 MLD in wet season. Kathmandu dwellers meet their insufficient water demand from private vendors (over 400 tankers), deep boring (about 500 deep wells used) and other sources. In 2006, 382 stone spouts were reported and 237 stone spouts still serve as independent water sources catering to approximately 10 % of population. Of them, 41 sources have dried up, 104 spouts are connected to the Nepal Water Supply Corporation (NWSC) system, and 237 stone spouts still serve as independent water sources catering to approximately 10% of Kathmandu's population. The Melamchi Water Supply Project is expected to meet the increasing demand for drinking water in the Valley (Uprety, 2017).

Drinking water in Kathmandu Valley is supplied from in-valley sources of water that include a number of small storage facilities, river sources, springs and spouts, and groundwater. There are 20 water treatment plants (WTPs) in Kathmandu Valley with the total treatment capacity of 117 m^3/day and distribute water through 7 water distribution systems (Pasakhala, 2014). A study for evaluation of physico-chemical characteristics of drinking water supply in Kathmandu was carried out in order to understand the quality of drinking water in Kathmandu Metropolitan City. Various physico-chemical parameters, such as turbidity, water temperature, pH, conductivity, total alkalinity, total hardness, calcium, magnesium, chloride, iron and total ammonia were studied and compared with National Drinking Water Quality Standard (NDWQS) of Nepal and WHO water quality guidelines. The results revealed that most of the parameters were in normal range and indicated suitability for drinking purposes (Tamrakar, 2014).

The residents at various parts of Kathmandu Valley are forming their own Small-Scale Community Water Supply System (SSCWSS). Under this system, the traditional sources of water, mostly the springs, dug wells and stone-spouts, are improved and the efficiency of the collection and distribution system is enhanced by cooperative type of management. The SSCWSS includes collecting water from the sources in the evening/night and distributing/selling the water to the local users at affordable fee. This system has been able to improve the access to water for thousands of households where the public supply system has failed utterly and the newly formed private agency (KUKL) is finding difficulty in improving the situation (Shrestha, 2010).

2.2 Sector Development Plan(2016)

Sector Development Plan (SDP) was prepared for a period of fifteen years (2016- 2030) by Ministry of Water Supply and Sewerage (MoWSS) following the recommendations made by the Joint Sector Review in 2014. The primary focus of the SDP is to improve the public health and living standard of the Nepali through the provision of safe, sufficient, accessible, acceptable and affordable Water, Sanitation and Hygiene (WASH) services. The unique rolling SDP (updated every five years at the end of each phase) foresees to provide WASH services in three phases:

- Phase I: Short Term (2016 - 2020) Universal access to basic WASH services; improved service levels (medium 25 %, high 15 % population, Reconstruction)
- Phase II: Medium Term (2021 - 2025) Improved service levels (medium 40 %, high 30 % population), Functionality & Sustainability improvement
- Phase III: Long Term (2026 - 2030) Improved service levels (medium 50 %, high 50 % population), Impact assessment

Eleven areas of development have been identified under SDP. Accessibility and utilization (availability) of WASH services has been of the major concern followed by the functionality and sustainability. These two area require 66 percent (601 Billion NRs) of the total budget for all the areas. SDP intends to review, refine and adapt its programming, approaches and technologies to make sure that the work is sustainable, innovative, relevant and effective and without discrimination between urban and rural and continuous quality improvement. SDP emphasizes on establishment of sector MIS and national sector review to be carried annually. SDP assumes that 25 percent of the SDP cost is contributed by the users, 27 percent by development partners and rest by government budget along with private water entrepreneurs. SDP also defines water supply service level as standard, basic, medium and high based on quantity, quality, accessibility, reliability (duration and continuity) and service satisfaction. Similarly, service level of sanitation has been defined as no service, limited, basic and improved based on accessibility, facilities, use, reliability and environmental protection. The development of WASH SDP presents a unique opportunity for the sector in a coherent and strategic programming and management for sector development by providing a shared vision and coherent strategy around national priorities, the Plan provides a clear programming framework and direction for action to all stakeholders in the realization of universal access to safe water and sanitation services (GoN,2016).

2.3 Water Supply Service Levels

National Urban Water Supply and Sanitation Sector Policy (2008) defines water service levels in accordance with the daily amount of water consumption, quality of supplied water, time period of daily supply and its reliability as follows:

Table 2.1 Water Supply Service Levels

Service Level	High	Medium	Basic
Quantity	112-150	65	20-45
Quality	WHO Standards	National Standards	Potable
Accessibility	Within the house (fully plumbed)	Within the house (fully plumbed)	Within 20 min. walking distance (stand-post supply)
Duration of supply (hrs./day)	24		4
Continuity(months/per)	12		12

(Sapkota,2019)

2.4Causes of water Shortage

Winpenny (1996) defined water shortage as an imbalance of supply and demand under prevailing institutional arrangements and or prices; an excess of demand over available supply; a high rate of utilization compared with available supply, especially if the remaining supply potential is difficult or costly to tap. Such a definition has the advantage of having the explicit recognition that water shortage is a relative concept.

Building on the definition proposed by Winpenny (1996) the World Water Development Report Magrath (2007) defined water shortage as:"The point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully, a relative concept that can occur at any level of supply or demand. Shortage may be a social construct (a product of affluence, expectations and customary behavior) or the consequence of altered supply patterns stemming from climate change. Shortage has various causes, most of which are capable of being remedied or alleviated."

According to Chapagain, (2014) there are several causes behind the water shortage in Kathmandu Valley such as lack of stakeholders accountability, lack of political will or instability, uncontrolled rapid urbanization, weak institutional structure in terms of inadequate organizational resources, lack of regulation and monitoring from regulatory bodies, deteriorating & non-scientific infrastructure, unclear supply standard & norms, unsustainable water resources, lack of effective human resource management and conflicts over water resources.

However, the study on the drawdown and dynamics of groundwater table in Kathmandu Valley shows that water shortage has been well represented through the drawdown of groundwater table in Kathmandu Valley, thus concluding the central groundwater district is facing the highest rate of drawdown. The northern groundwater district has relatively less drawdown rate, it is due to less population density, potential recharge zone lying here and even the good vegetation cover as well, and however, recent trend in this district is also altered along with the urbanization, water supply companies, and removal of

vegetation cover. Low permeability in the central and southern groundwater districts are also contributing in the rapid drawdown, however, the northern groundwater district is composed of relatively permeable sediments thus facilitating the recharge as well. Concentration of population in central groundwater district is the highest compared to any other parts of Kathmandu, because this district constitutes the two metropolitan city, thus increased water demand has triggered the overexploitation from household to commercial level(Gautam & Prajapati, 2014).

Gautam et al., (2013) found that in Kathmandu Valley there is a constant short supply of water because until last three decades, Bagmati and its tributaries, traditional stone spouts and natural springs were able to fulfill the drinking, irrigation and various other needs of the valley but now they are used as sewage dumping sites.

Thapa et al., (2016) has shown that the valley's water supply infrastructure suffered a reduction in the capacity of water distribution pipe networks of 28%, 30% and 18% in the Lalitpur, Kathmandu, and Bhaktapur Districts respectively and also concluded that the limited water supplied by the Kathmandu Upatyaka Khanepani Limited (KUKL) in Kathmandu is highly polluted and cannot be consumed without proper filtering and boiling. Environmental,political, economic,technical and anthropogenic causes along with climate change are behind the severe water problem in Kathmandu. Similarly, another study carried out to assess impacts of Gorkha Earthquake 2015 by analyzing situation of potable water supply, demand and water availability in the area before and after earthquake revealed that due to the earthquake, additional 0.15 and 0.24 million are under water stress; 87% and 81% peoples are not getting water during dry and wet seasons respectively (Thapa et al., 2016).

However, according to Jha (2012) lack of stakeholders' accountability for the common goal and lack of interest, collaborating problems among the actors and institutions, rapid population growth, misuse of water, poor supply system, limited supply of water hasworsened water problems. In addition, traditional water resources such as stone spouts and wells were playing an important role in meeting the increasing water demand in the Kathmandu Valley are drying up (Shrestha, 2016).

The study on traditional water resource use and adaptation efforts in Nepal carried out by Shrestha & Maharjan (2016)reveals inadequate attention given by the state and non-state authorities to the conservation of traditional water resources such as stone spouts and wells which were playing an important role in meeting the increasing water demand for several years. Therefore, rapid population growth, unplanned urbanization and the drying up of traditional water resources have caused water shortage in the Kathmandu Valley. The impact of climate change has further exacerbated the increasing problem of water shortage.

Similarly, the discontinuation of the *guthi* system has disintegrated community network, social support and a sense of ownership over water infrastructures, while random installation of public utilities and construction of non-engineering buildings has destroyed the rajkulos and its distribution system and failure to regulate rapid urbanization, socio-economic modernization and changes in people's lifestyles (since the last two decades) has not only further ruined the traditional water infrastructures but also created water stress (Shrestha &Shrestha, 2013).

2.5 Effect of water shortage

Shortages of water could become a major obstacle to public health and development. The United Nations International Children's Emergency Fund (UNICEF) and the World Health Organization (WHO) estimated that 1.1 billion people lack access to a water supply and 2.6 billion people lack adequate sanitation. The global health burden associated with these conditions is staggering with an estimated 1.6 million deaths every year from diseases associated with lack of access to safe drinking water, inadequate sanitation and poor hygiene (Tarrass and Benjelloun, 2012).

Some of the effects of poor water services in Kathmandu Valley are that the residents have to travel longer distances in search of water, spend more time and pay high prices for water, they are also forced to find alternative sources of water, increase in water related diseases and insufficient clean water for domestic use which leads to poor economic productivity (Chapagain, 2014).

The problem of drinking water crisis in Kathmandu has brought about many consequences along with it. Water shortage leads to serious health, environmental as well as socio-economic consequences. Health risks for millions of people has increased due to significant reduction in low flow or extreme rainfall events(Jha, 2012). In addition to this, the unmatchable ratio of population, and quantity of water, people of valley extremely depend on groundwater. Bacteriological contamination in most groundwater has contributed to the rise of water-borne diseases (Valley et al., 2018). About one-third of the water samples of deep tube wells and 44 % of shallow tube wells were found contaminated with coli form and non-compliant with the National Drinking Water Quality Standards (2006). Polluted water and poor sanitation has accelerated diarrhea, dysenteries, typhoid and paratyphoid with occasional loss of life (Uprety, 2017). Similarly, study demonstrate that households with partial access to improved water were at greater risk of diarrhea than those with full access because of intermittent water supply and having an intermittent water supply requires users to store water, which increases the risk of contamination (Shrestha et al., 2013).

The study on ground water use on Kathmandu Valley found that the traditional culture of using public well and sharing and optimizing groundwater resource is gradually fading due to shortage of water. Private deep wells are being constructed inside house for household use altering traditional social setting of a public well and culture of sharing public resource is declining. Hence, this increasing number of groundwater extraction, uncontrolled and unregulated use for private and commercial use has contested the use of common pool resource and traditional social setting (Shrestha, 2017).

Udmale et al., (2016) stated that water shortages and poor water quality in the Kathmandu Valley lead to serious health, environmental and socioeconomic consequences. The time and distance to fetch water will cause extra pressure on women’s household activities, and may also result in water-related societal conflicts. Poor households are expected to suffer water shortages, resulting in a reduction in water consumption, which subsequently will cause health and sanitation issues.

Water shortage has been well represented through the drawdown of groundwater table in Kathmandu valley as water demand has triggered the overexploitation from household to

hotel level. The annual dynamics of groundwater table has been found to be shifting towards the southwestern region of Kathmandu valley (Gautam and Prajapati, 2014).

A study was conducted to evaluate the quality of drinking water of the valley. A total of 132 drinking water samples were randomly collected from 49 tube wells, 57 wells, 17 taps and 9 stone spouts in different places of Kathmandu valley. The samples were analyzed for microbiological parameters. Heterotrophic Plate Counts (HPC) and Coliform counts have been used extensively as a basis for regulating the microbial quality of drinking-water. In this study, both regulatory parameters were excessively above the WHO guideline values. Study results clearly indicated that most of the natural water sources are highly contaminated. The detection of pathogenic enteric bacteria in different sources of drinking water in Kathmandu valley also reveals the alarming situation for water borne epidemics in the valley (Prasai et al., 2007).

Another study on access to improved water and its relationship with diarrhea in Kathmandu Valley shows that family members of 179 households (7.8%) reported having developed diarrhea during the previous month. For households in which family members consumed less than 100 L of water per capita per day (L/c/d), which is the minimum quantity recommended by WHO, the risk of contracting diarrhea doubled (1.56-fold to 2.92-fold). In households that used alternative water sources (such as wells, stone spouts and springs) in addition to improved water (provided by a water management authority), the likelihood of contracting diarrhea was 1.81-fold higher (95% CI 1.00 to 3.29) than in those that used only improved water. However, access to an improved water source was not associated with a lower risk of developing diarrhea if optimal quantities of water were not consumed (i.e., <100 L/c/d).The lack of water impedes personal hygiene, such as washing, resulting in bacterial accumulation on the skinfindings of the study demonstrate that households with partial access to improved water were at greater risk of diarrhea than those with full access (Shrestha et al., 2013).

The increasing water shortage in the Kathmandu Valley has led the conflicts in the study area. The conflicts were mainly due to water sharing between households and business purposes, dispute among water users, destruction of water resources due to building constructions, encroachment of land that belongs to *stone spoutguthi*, wastes disposal to water sources. Water conflict will be aggravated due to growing water shortage problem in the Kathmandu Valley (Shrestha & Maharjan, 2016).

2.6 Adaptation strategies for water shortage

Coping with water shortage means living in harmony with the environmental conditions specific to and dictated by limited available water resources (Pereira, et al., 2009).It involves employing diverse measures or techniques to meet the water needs of the people. Ishaku, et al.(2011), advocates the need for a paradigm shift from public monopoly of water supply to innovative approaches such as rainwater harvesting. Shipek (2007) suggest that people should be educated on how to use technology and to shape landscape to harvest water. Similarly, community participation in water provision has also been advocated as a way out of the water shortage problem which involves people pooling resources together to provide water projects (Kholisa, 2006). In addition, water right institutions, market-based approaches, and capacity building should be the government's top priority to address the water shortage issues (Jiang, 2009).

Alternative options to minimize the demand-supply deficit of the valley and decrease the stress on groundwater resources can be done by the development of urban centers outside the valley, optimum planning of land use for potential recharge, introducing micro-to macro-level rainwater harvesting structures, and water demand management. The water from the mountainous region, which is also of sufficient quality for drinking purposes, can be harvested with community-based water resources management and used in conjunction with surface and groundwater in the valley. Strategies to save and reuse water and avoid wastage, should be implemented at the household level (Shrestha, et al., 2012).

According to Jha (2012) a combination of strategies such as roof top rain water harvesting, artificial groundwater recharge,leakage reduction, grey water recycling and completion of MWSP would meet water demand until 2050 only, thereafter full recycling and population control would be the only available solution as sharp reduction (up to 95%) in the capacity of precipitation dependent sources.

In the study on water management at household level in Kathmandu Valley carried out by Pasakhala, (2014) found that households used multiple water supply sources.The majority of households were dependent on private pipe connection followed by private well. Due to insufficient piped water supply and poor water quality, significant number of households was dependent on alternative water supply sources. During dry season, private pipe connection and private well users shifted to use tanker, vendor and bottled water due to decline in piped water supply and drying of ground water. Furthermore, he found that household income was a major factor influencing the selection of coping measures. To cope with water shortage, the low-income group reduced their water consumption for bathing and laundry while maintaining their consumption for more essential activities such as hygiene and cooking.

Similarly, majority of households depend on more than two sources of water. On average, households depend on 2.4 sources of water. These sources of water can be KUKL, water tankers, groundwater (dug wells, tube wells), and springs (stone spouts, springs). The survey also found that municipal pipeline,groundwater and purchased water are the most important sources of water. When it comes to groundwater, one in every two households have access to it (Gamao, 2013).

Another study conducted on dynamics of domestic water consumption in urban areas of Kathmandu Valley pre- and post-GEQ showed that multiple water sources are being used with increasing reliance on the water market- jar water and tanker water as adaptation strategies to water shortage(Thapa et al., 2015).

Similarly, SSCWSS in the local scale within limited areas are viable alternative to the centralized water supply system in Kathmandu as they are very flexible in rapidly changing the supply as per the demand as long as water is available and due to their negligible overhead cost, the water can be supplied to the local residents at affordable cost. Furthermore, it also promotes water conservation and avoid conflict because of knowledge of the volume of water available and the feeling of ownership (Shrestha, 2010).

However, a study conducted by Jha and Shrestha, (2013) highlighted the need to reframe the relationship between citizens, policy-makers and scientists to bring about effective solutions to the problem of urban water supply in a changing climate. The vulnerability can be minimized by diversifying the water supply sources, improving governance of the

institutions, having visionary leadership and adopting the principles of adaptive management. Thus, existing practice of depending on a single solution such as the MWSP and the government only need to be replaced by multiple solutions and multiple actors.

United Nations Economic and Social Commission for Asia and the Pacific Strategy paper revealed that there is need for conserving traditional water systems and promoting rainwater harvesting, groundwater conservation, faecal sludge management, including capacity building and mobilization of resources to enable integrated implementation of SDGs in Kathmandu Valley (Uprety, 2017).

A study was carried out to assess impacts of Gorkha Earthquake 2015 by analyzing situation of portable water supply in Kathmandu, demand and water availability in the area before and after the event and recommend possible development options for sustainable water allocation. Results showed almost 40% reductions in the amount of water supply after the earthquake affecting additional 0.15 and 0.24 million people under water deficit condition. Harnessing of only 48% and 65% of available surface water during dry and wet seasons, respectively, reveals the potentiality of developing additional water supply projects. However, even with optimal development of surface sources is inadequate to meet the valley's water demand and therefore projects on conjunctive use of surface and groundwater resources, with due care of potential areas for groundwater storage, may be required as a short-term solution to ensure water supply security in the post-GE2015(Thapa et al., 2016)**.**

The majority of the households widely rely on alternative sources due to the limited availability of piped-water and ground water is the major alternative source that people rely on (Yoden, 2012).

2.7 Existing Water Uses and Perceptions

The major sources of water for Kathmandu households include private water connections, water from neigh-bores, private wells, public taps, and public wells.

About 70% of the sample collected by Pattanayak (2005) is connected to the private water network, 43% of which has a metered connection. Only about 1% of the connected households share a connection with other households. Almost 80% of the non-poor households were connected to the network, whereas only about 50% of the poor had connections. About 90% of the connected households pay National Water Supply Corporation (NWSC) for water on a monthly basis. The average water bill of a household with a metered connection that was working was about US$ 2.19 per month. The average monthly water bill of a household with an unmetered main connection was US$ 2.45 and branch connection (i.e., a connection to a tertiary to the main water line) was US$ 0.90. Given the poor reliability of the piped water supply, many households with private connections supplement the water they receive from the piped distribution network with water from other sources. An average household can access at least three sources and uses two of these. They asked connected households what they liked least about their water service. Considering that water was available from their connection on average about 2 hours per day in the wet season and 1 hour per day in the dry season, it is not surprising that 67% said unreliability. The approximately 30% of households without private connections to the piped distribution system obtained their water from a variety of sources, including private wells, public taps, stone spouts, and water vendors. About 25% of all the

households relied exclusively on some combination of free community sources: neighbors, public taps, stone spouts, public wells, ponds, and streams.

In this study they also asked households about their perceptions of taste, color, health risk, and reliability of water from the various sources water and they found that water from the piped distribution system was rated negatively across the board, households reported that the taste was poor, the water was dirty or very dirty, the water posed some or serious health risk, and the supply was irregular or unreliable. In contrast, water from private wells was rated positively in terms of taste, color, and reliability. Households also seemed to think favorably of water from stone spouts (these *dunge-dhara)* constitute an ancient system of stone conduits), although a much smaller group of households (approximately 220) uses this source. Regarding taste and color, households viewed water from public taps and neighbors to be of poor quality and from public wells to be of reasonable quality. In terms of reliability, households considered water from public taps and public wells to be regular and dependable.
However, a study carried out by Gamao (2013) shows that residents were more reliable to water from KUKL. This study also shows that coping strategies popularly employed by households are buying water, utilizing alternative water sources and storing water and the respondent's perception of a water source's insufficiency are poor quality, unreliability and high cost andpurchasing water from the water tankers is seen to be the most expensive alternative water source.

Another study by Pasakhala,(2014) found that households perceived bottled water and public standpipe as good although coli form were detected on bottled water, while public well and private well as poor quality water supply sources.

2.8 Influence of Socio economic Characteristics on Water Shortage Adaptation Strategies

The study on access to improved water and its relationship with diarrhea in Kathmandu Valley shows that socioeconomic status, particularly the level of education attained by the household head was associated with diarrhea risk among family members. The level of education attained may reflect health literacy (i.e., competence in acquiring, understanding and using health information), which is important in maintaining a hygienic household environment and good health (Shrestha et al., 2013).

Access to multiple sources of water is partly mediated through income. Of the 15% HHs (households) with access to only one source, 1/5th belong to the lowest income group. HHs in the highest income group are more likely to have access to four sources of water and households in higher income groups are more likely to use groundwater and tanker water while households in the lower income groups are more likely to use springs. Interestingly enough, access to KUKL water is income neutral (Gamao, 2013).

Similarly, household income was found to be a major factor influencing the selection of coping measure. The average water consumption was 36.9 ± 11.1 l/capita/day and to cope with water shortage the low income group reduced their water consumption for bathing and laundry while maintaining their consumption for more essential activities such as hygiene and cooking (Pasakhala et al., 2014).

Chapter – 3

METHODOLOGY

3.1 Research Design

The entire research design began with the field based real problem identification through frequent site visits and existing literatures. Few research questions were formulated to address the identified research issue within the selected wards of the metropolis. The research questions and objectives were refined with each visit and literature reviews. Once the research questions and subsequent research objectives are refined and finalized, the field work was planned for the collection of primary data and information. The tools used for the collection of primary data were Field observation, Key Informant Interviews with nine Key informants and Questionnaire Survey with a total of 67 households. Secondary data and information were also collected through both published and unpublished literatures, books, reports, articles to substantiate the primary information. This final stages comprised of data analysis and interpretation, preparation of thesis draft, oral presentation, incorporating comments and suggestions prior to submission of the final thesis to the university. The entire research steps carried out during the study is shown in figure 3.1.

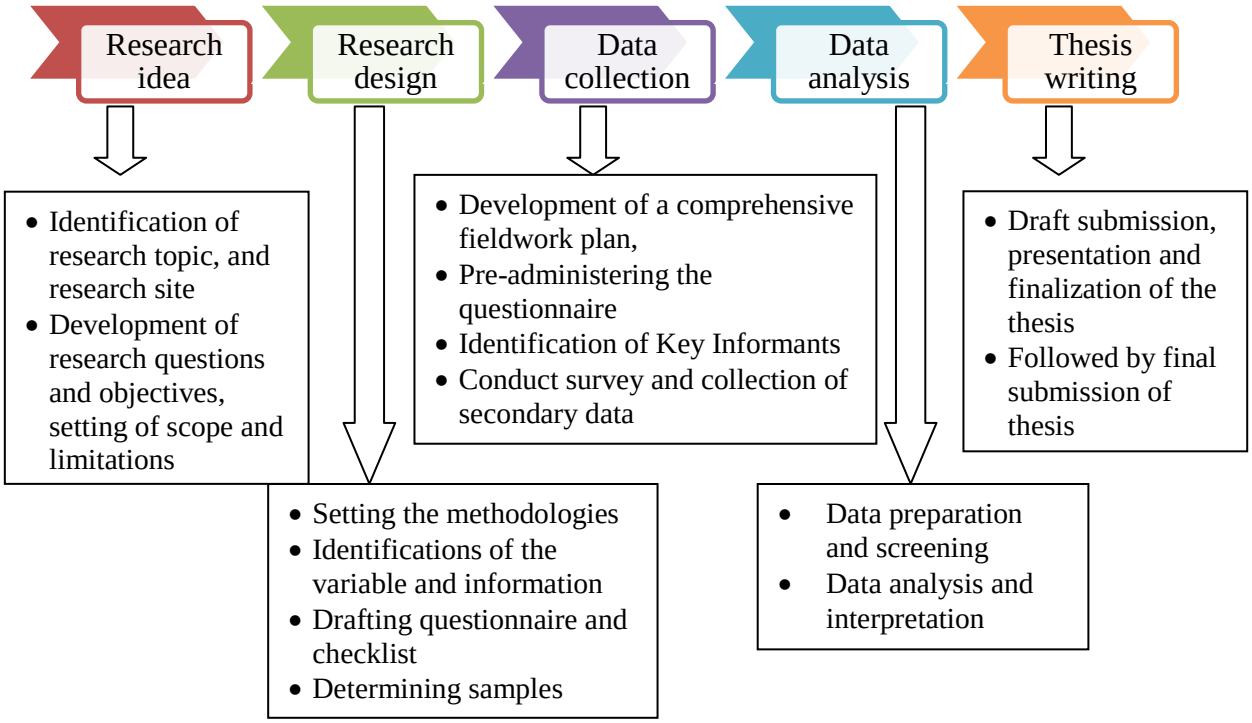
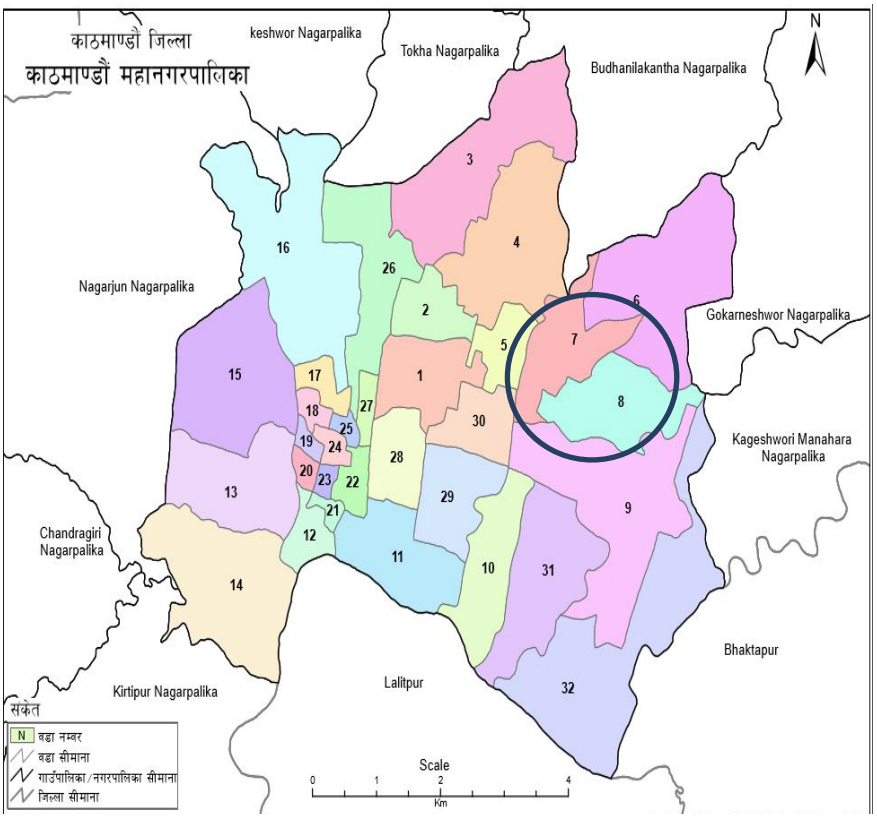


Figure 3.1Researchsteps carried out during the study

3.2 Study Area

Kathmandu Valley is a densely inhabited urban center. The study was conducted in ward number 7 and 8 of Kathmandu Metropolitan City. Drinking water supply from water supply authority is irregular in these selected wards. Out of the total combined area of both wards, 15 % of the households is not connected to piped water supply. Both the wards are

characterized by 12 public taps and 4 stone water spouts.However, among total, only 4 public taps and 1 stone spout were in good condition as per KMC (2005). Among identified five serious problems of the wards, drinking water problem ranks the first. Piped water in ward 7 and 8 is supplied by Kathmandu Upatyaka Khanepani Limited (KUKL) through its Mahankalchaur distribution station(Thapa, et. al., 2016).



Source: Google map

Figure 3.2Map of Kathmandu Metropolitan City

3.3 Study Population and Sample Size

The selected wards of Kathmandu Metropolis (ward 7 and 8) are not untouched with the rapid rate of urbanization. The total population of ward number 7 is 51,581 with male and female population of 26,561 and 25,020 respectively, residing in 13,559 households. Likewise, 10,738 individuals inclusive of 5,519 males and 5,219 female resides in 2,772 households in ward number 8 (CBS, 2012).

The required number of sample size was determined using equation (i). The sample was selected for confidence level 90% and 10% of error. Since the total number of household in the study area is known the calculated sample size was 67. The required number of samples was selected conveniently.

$$Samplesize = \frac{\frac{Z^2 \times p\,(p-1)}{e^2}}{1+\left(\frac{Z^2 \times p\,(p-1)}{e^2 \times N}\right)} = 67 \ldots\ldots. \text{(i)}$$

Where, p is proportion (50%),

z is score corresponding to 90% confidence level = 1.65,

N is the total number of households of ward 7 and 8

e is error = 10%

3.3.1 Sources of data

Water resource data at lower spatial scale i.e. ward level is non-existence for Kathmandu Metropolitan City. In this context, secondary data available for Kathmandu Valley and municipalities was used as reference for ward level analysis beside field survey. The major sources of data comprisedboth primary and secondary data. Primary data was collected from field using various tools of data collection whereas the secondary was extracted from the various literatures review.

3.3.2Primary Data

The major tools of inquiry for collecting primary data were field observations, Key informant interviews (KII) and Questionnaire survey.

i. Questionnaire Survey

A set of semi-structured questionnaire was developed to collect the data in order to achieve the research objectives. Questionnaires were pre-administered to few households to assess the completeness and of the questions to address the foreseen research objectives.

The questionnaire was used as a guide in household questionnaire survey so as to attain the set objectives. The administered questionnaire for the household survey is attached in annex 1. The list of households interviewed is provided in annex 2.

ii. Key Informant Interview

Only top management such as deputy manager of KUKL branch office Mahankalchaur, ward chairperson, ward member and valve operatorwere interviewed with a help of a questionnaires. Secondary data was used to provide information on what has already been done in relation to the study and to relate the findings based on the study objectives. The checklist and name-list of the KII are attached in annex 3 and 4 respectively.

3.3.3Secondary Data

Books, journals, articles, reports, documentaries were reviewed. The literatures both published and unpublished were taken into consideration for review. Literature was reviewed continuously throughout the period of study.

3.4 Data Analysis

All the collected data were analyzed qualitatively and quantitatively. The collected data through questionnaire survey, field observation and key informant interview was coded and entered into the computer for analysis using the Microsoft Excel. Regression statistical tool was used to analyze the relationship between the number of adaptation measures and various socio economic factors that influence it.

3.3 Research Matrix

The table 3.1 presents the various tools of inquiry, sources of data and method of data analysis for each of the research objective.

Table 3.1 Research Matrix

Objective	Tools	Sources of data	Method of Analysis
To analyze resident's perception on the causes of water shortage in the study area.	Questionnaire, KII	Individuals from thehouseholds	Quantitative and qualitative analysis
To investigate the existing water use adaptation strategies in ward number 7 and 8 of Kathmandu Metropolis.	Questionnaire Survey	Households, KUKL	Quantitative and qualitative analysis
To compare the association between socio-demographic characteristics of respondents and the strategies they adapt to cope with water shortage.	Questionnaire, KII	Individuals from the households, KUKL	Quantitative and qualitative analysis

Chapter 4

RESULTS AND DISCUSSION

4.1Socio-economic Characteristics of Respondents

Socio-economic descriptions of households such as respondent's gender, age, income, family size, education and religion are presented in the table 4.1.The interview was conducted with one member of each household. The respondents during the household survey were mainly the people aged above 21 years (77.61 %) this was purposively done to see the changes in water demand and supply scenario along with the adaptation measures taken over by the households over the period of time in response to water shortage. Higher proportion of respondents (22.39%) were in range of 21 - 30 and 51-60 years old age group,followed by 41-50 and above 60 years old age group i.e. (22.39%) and lowest was in range 31-40 (16.42%) as shown in table 4.1.The higher proportion of respondents was male (65.67%) in the study area because the female family members were either busy or were reluctant to respond to the questions. 35.82% of the interviewed respondent has income level more than NRs. 51,000 per month and only about 1.49% have their earning below NRS 20,000 per month. It was also found that only 1.49% of people interviewed have their family size 1-2 and above 10, whereas, highest 74.39% have 3-5 family members in their household in the study area. Similarly, data was collected about their level of education which shows that majority of the interviewed people were university graduates and 8.6 % respondent were below SLC. According to the survey, the total household interviewed indicated that at most 94.03% resident was Hindu followed by 4.48 % Buddhist and 1.49% Kirat.

Table 4.1Socio-economic Characteristics of Respondents

Gender		%	**Monthly Income (Rs)**		%	**Education**		%
Male	44	65.67	<20,000	1	1.49	Below SLC	6	8.96
Female	23	34.33	21,000-30,000	7	10.45	SLC	12	17.91
Total	67	100	31,000-40,000	25	37.31	+2	6	8.96
Age		%	41,000-50,000	10	14.93	Bachelor	30	44.78
<20	0	0	Above 51,000	24	35.82	Master's& Above	13	19.4
21-30	15	22.39	Total	67	100	Total		100
31-40	11	16.42	**Family Size**		%	**Religion**		%
41-50	13	19.4	1-2	1	1.49	Hindu	63	94.03
51-60	15	22.39	3-5	50	74.63	Buddhism	3	4.48
Above 60	13	19.4	6- 9	15	22.39	Kirat	1	1.49
Total	67	100	10 +	1	1.49	Others	0	0
			Total	67	100	Total	67	100

4.2 Resident's Perception Regarding Piped Water Supply

Almost all the respondent households are connected with the pipeline from KUKL, only 2 % of the households are out of connection in the study area. The respondents were asked initially about their experiences about water shortage in this ward. This was necessary to find out resident's perception on the causes of water shortage in the study area. The results

show that 94.03% responded to the affirmative while 5.97% said they had not experienced water shortage. Those who said “not experienced” were mostly those who depend on their own water source. This indicates that there is water shortage in KMC.

Figure 4.1summaries the perception of residents regarding piped water supply provide by KUKL, results shows that majority of the respondents about 77% believes that piped water supplied by KUKL is not enough. Similarly, 11% of people said that water is quite expensive and 6% replied that quality of water provided by KUKL is poor. However, 3% respondent took part in interview felt that water supplied is not reliable and another 3% believed piped water in their area is of low pressure.

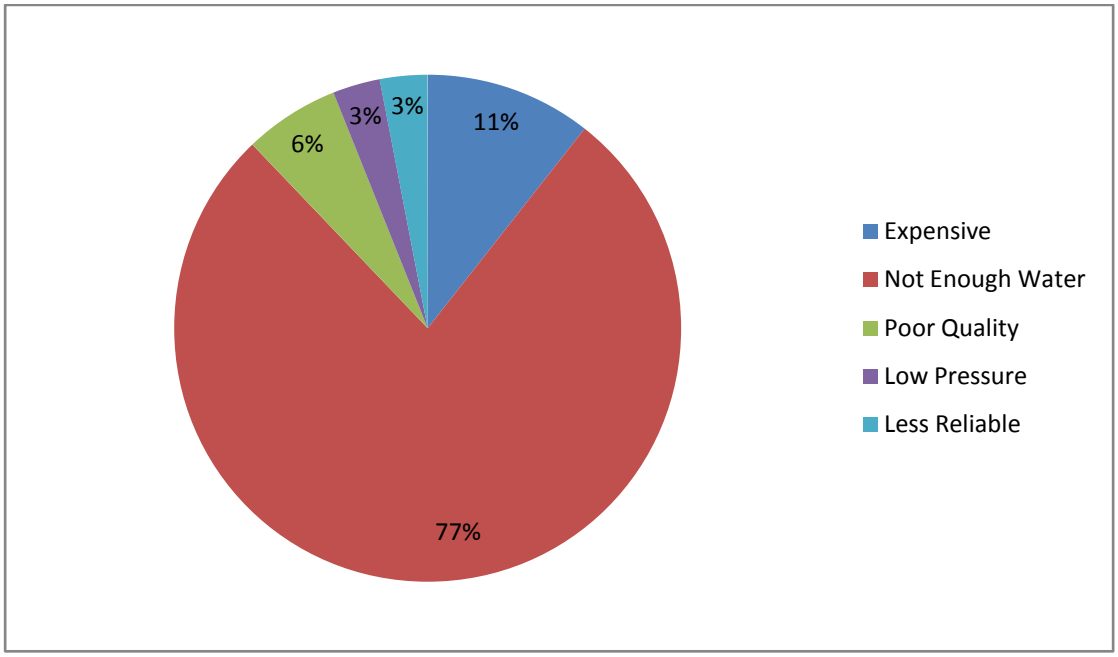


Figure 4.1Resident’s Perception Regarding Piped Water Supply

Mahankal water distribution of KUKL distributes water to Boudha, Tusal, Maijubahal,Budhanilkantha,Hadigaun, Kalopul, Pashupati areas. This water distribution center provides 30 MLD of water through piped connection (KII, 2018), according to the representative of the distribution system, those areas unserved with the piped connection are reached through water tankers. Surface water sources from Sundarijal area are the main source of water and also dependent on the groundwater sources to augment the supply system. The representative himself emphasized on the inadequacy of the distributed water volume to meet the demand of the local people of the study area, however denied any sort of water leakages in the distribution networks. The water shortage is mainly due to low amount of water available from the sources. Contrarily to no leakages as mentioned by the KUKL representative, the representatives of both the wards expressed water leakages in the distribution networks which has led to insufficient water distribution to the local people. Upon inquiry about the actions taken by the ward against water shortage, it came to know that the ward has been constantly informing KUKL about the leakage.Another reason mentioned by the ward representative is the problem of water pollution. Local people of the study area are dependent on various sources for water to meet their demand. The sources that are being used in the areas were dug well, deep tube wells, local traditional sources and water tankers. Those people who can afford are using

these available sources but those people who could not afford are dependent on the other neighbors.

Kathmandu Upatyaka Khanepani Limited provides 30 MLD water for four hours on alternate days and he was convinced that people are not satisfied by the volume of water provided. According to him there is lack of co-ordination among different stakeholders such as Department of Road (DoR),KUKL etc. which imposed difficulty to KUKL while supplying water. The KUKL representative also believes that ongoing Melamchi Project after completion will resolve water shortage problem.

It was also disclosed during the interview with the ward representative that they are planning to concentrate the collected rainwater on the surface to recharge groundwater through the installation of gutters in the household level. The reasons expressed by the representative of ward number eight behind this initiation was his belief that the much awaited mega project Melamchi alone cannot meet the water demand. Similarly, the representative of ward number seven opined that the government should increase the water cost and tighten water metering system as well as should focus on rain water harvesting and water recharging as water level has depleted more in few years.

4.2.1 Water distribution frequency in the study area

Local people were found to have a spectrum of opinion on the frequency of water supply from the responsible water utility. 38 respondents expressed that they get water only once per week and 16 respondents twice a week. 9 respondents said they receive water three times per week while one respondent said they access water once in fifteen days. Two people responded to be receiving water daily but at awkward times, for example, when they are out of their house. Unlike these responses, the KUKL water distribution representative said that the utility supply water for a total of four-hour duration on every alternate day. Similarly, the ward representative echoed with the local people on the frequency and regularities of water supply in the study area. The frequency of water supply is perceived to be irregular as most people access water only once per week in rainy season but frequency fluctuates during dry season and may reach once per month.

4.2.2 Current Water Supply Compared to Previous Years

The questionnaire constituted a question which prompted the opinions of the respondents on the current water supply compared to the supply over the previous years. 60 respondents answered with a “YES” that implies the current water supply has worsen as compared to the previous years. They also pointed that, previously, there used to be water every day for more hours a day. However, 5 respondents answered “NO” implying no changes in the current water supply than previous years, previously they used to get water once or twice per month but now they have once or twice a week. This view highly contradicted with the earlier. Therefore, the query was put forth to the key informant (representative of the water distribution system), where it was cleared that the water supply has become more stressful these days as water is being supplied to a limited hour a day and is provided every alternative day. However, those people who said the water supply now has become better were not satisfied with the supply. Their verdict was based on the quality of water being supplied thesedays.Similar results were obtained through a research carried out by Gamao in Kathmandu Valley where respondents were asked to compare the quantity of water they availed from all the water sources they had from 5

years ago, more than half of them (63%) responded that there was a decrease of water available while a third did not notice any change in available water. It was vivid with the opinion of most of the respondents that the quality of water being supplied is questionable these days. The water being supplied is relatively foul odour and turbid. The amount of water that the local people are getting these days is below the required volume of water under basic water service level, which states 20-45 liter per day, every household is connected to water supply but the frequency of getting water is very irregular, the local people hardly receive water for an hour, therefor the water is unreliable. This supply signifies the water service level analyzed through their local perception is below the basic service level. On the other hand, the country has been planning to reach the unreached population with potable water (GoN, 2016).

4.2.3Onset and continuation of water problem in the study area

The respondents were asked when they started experiencing the problem of water shortage,about 38 % replied that they had been facing problem since five years, 34% replied since 10 years and 13 % replied 15 years. The findings show that the area has been experiencing water problems for a long time as about eight percent respondents experienced this problem for up to twenty years.

During survey respondents were also asked whether water shortage they are facing now is going to be severe in coming days or not, in response 71.64% respondents said that it will become severe in future dayswith the increment in population leading to massive extraction of groundwater. The respondents were also found to be aware about the impacts and consequences of climate change which alters the rainfall pattern, and opined that the rainfall pattern has already changed, in addition lack of any effective alternative plans from government side is also aggravating the situation. But, other 19% respondent was very hopeful that ongoing Melamchi project after completion will resolve the problem up to some extent. The Melamchi Project is expected to transfer 14 crore liters/day in first phase and 240 MLD in second phase. With the uniform demand of 135 lpcd in the valley, the total demand of the water becomes 415.5 MLD which is expected to increase to 540.3 MLD by 2021 (Udmale, et. al., 2016). Therefore, Melamchi alone is not sufficient to quench the thirst of the valley. Every available options for water within the valley, alternate mitigation options, such as planning land use for potential recharge, introducing micro- to macro-level rainwater harvesting structures, conjunctive use of surface and groundwater resources, and water demand-side management, would also be helpful.

4.3 Resident’s Perception on Water Management

Management of water is vital as it helps to improve efficiency of water supply. So in this regard an attempt was carried out to document user’s view about who should manage water supply for efficient and adequate supply. The figure 4.2depicts that 72% people strongly believe that Government/Municipality should be engaged in supply of water which is similar to the result obtained by Gamao,(2013) where majority of households replied that Government/Municipality should manage. Similarly, about 11% people think that private sector should be responsible for the management and supply of piped water and only 1% respondent replied that community should supply water. However, 9% respondent emphasizes for both community and Private sectors and other 7% believe both government and community should engage in water supply.

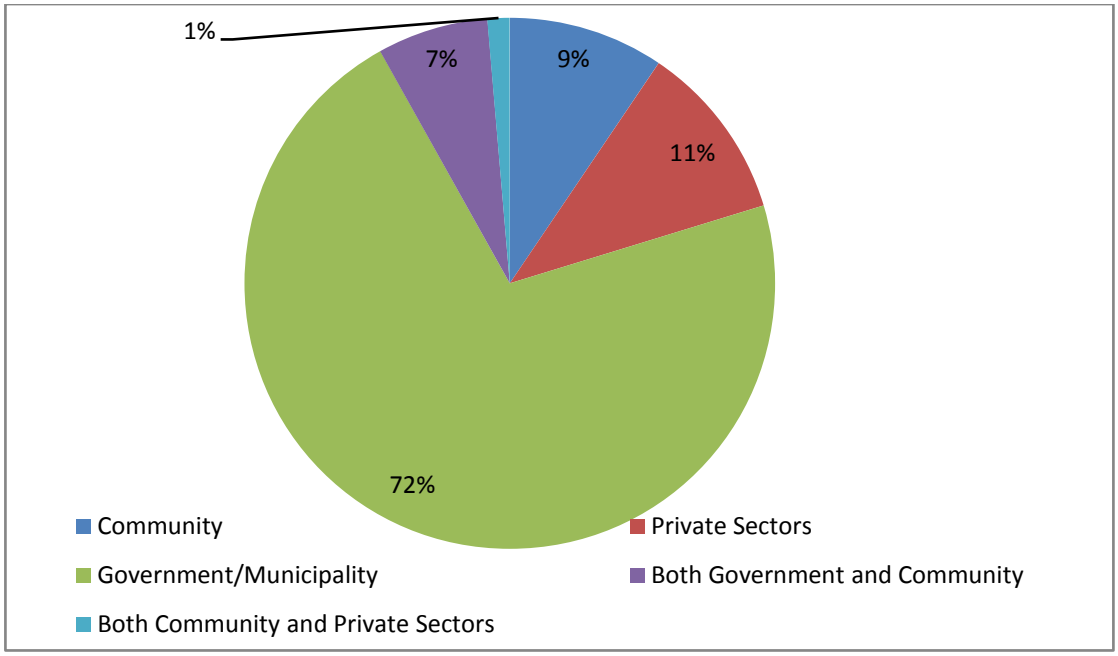


Figure 4.2Resident's Perception on Management of Water Supply

4.4 Causes of Water Shortage in selected wards of Kathmandu Metropolitan City

Respondents came up with an assortment of possible causes of water shortage in the area which is mentioned in table 4.2. Some respondents are on record as saying population growth coupled with respect to stagnant water infrastructures is the main cause of water shortages. About 56% of the respondents affirmed that urbanization is the prime cause of water shortage while around 13 % said decreased groundwater level as the major cause. The key informants also confirmed that the urbanization is the prime concern for the shortages of water. Similarly, according to 10.45% respondent there is scarce water due to presence of polluted water in the nearby rivers or public stand posts. Similarly, 7.46% respondents said water is scarce due to lack of treatment plant, 5.97% said it is due to leakages, 4.48% said due to lack of government's effort and 1.49% said poor management of KUKL are the causes of water shortage in the study area.

Table 4.2Perception on the Causes of Water Shortage in Kathmandu Metropolitan City

Causes	**Findings**	**%**
Urbanization	38	56.72
Decreased groundwater levels	9	13.43
Water pollution	7	10.45
Lack of treatment plant	5	7.46
Leakage	4	5.97
Lack of government effort	3	4.48
Poor management of KUKL	1	1.49
Total	67	100

The study conducted on Bulawayo, Zimbabwe's second largest city also shows urbanization as the major factor for water shortage. Continuous rural-urban migration had been one of the major drivers in Bulawayo with people migrating from surrounding provinces such as Matabeleland North and South with people coming in search of employment. This massive rate of urbanization had tremendous effect on the water supply. They increased water demand leading to the water stress that the city is facing. Thus, it can be concluded that urbanization has worsen the water problems in the various parts of the world. The isdue to hugely inhabited by the people from outside the valley. The land used to an agricultural land a long ago, now those agricultural lands have been rapidly converted into the human settlements within a short period of time.

4.5 Effects of water shortagein the study area

The degree of effect due to shortage of water on households was categorized as moderate (those family members who spent one-tenth of their monthly income on good quality water and whose day to day life activities such as bathing, washing etc. is affected occasionally), severely (those family members who spent more than one-tenth of their monthly income on good quality water and whose day to day life activities is affected rarely) and extremely (those family members who spent less than one-tenth of their monthly income on good quality water and whose day to day life activities is affected frequently) to find the effect on households and recorded during the study.It was found that 46% were affected moderately, 39 % were affected severely and 15% were affected extremely as show in figure 4.3 below.

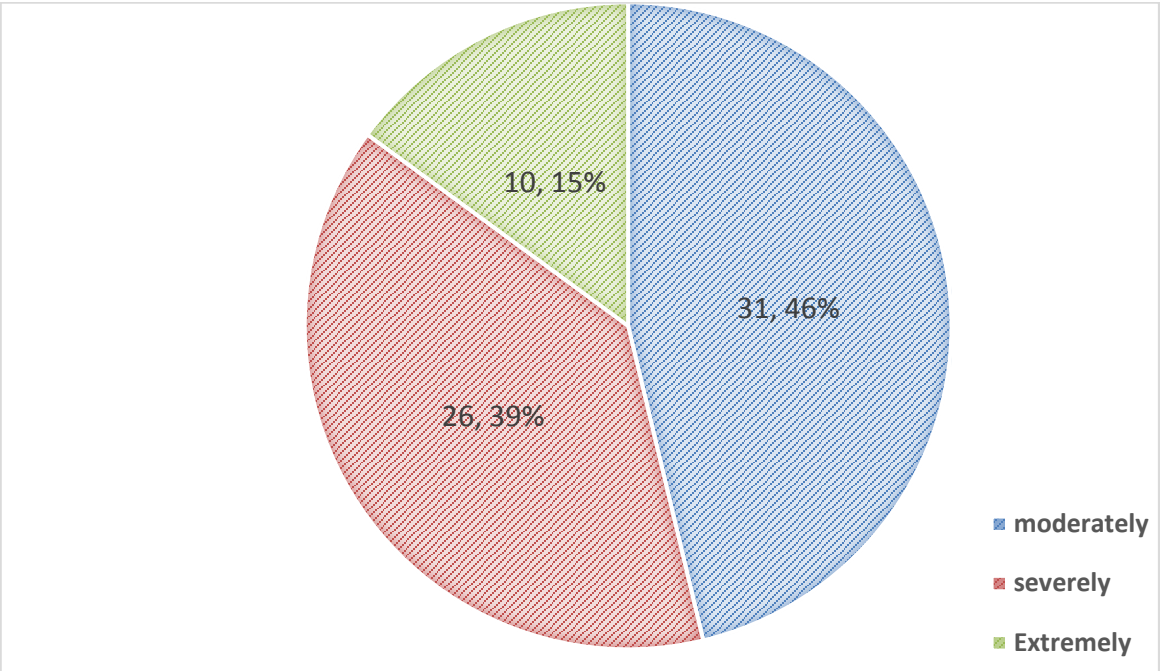


Figure 4.3 Degree of effect on households due to shortage of water

Table 4.3 shows degree of effect due to shortage of water on the households of various income level. It was found that only one household whose income is less than 20,000 per month and it was affected extremely. Similarwas the case in income level 21,000-30,000 households, where all of seven were affected extremely. However, in income level 31,000-40,000, out of 25 households, 3 were affected moderately, 20 were affected severely and 2

were affected extremely. Similarly, 10 households were found in income level 41,000-50,000 where 5 were affected moderately and another 5 households were affected severely.
And 23 households were affected moderately and 1 severely as their income level was above 51,000. Hence, it can be concluded that those households whose monthly income is relatively low were affected extremely than those having monthly income high.

Table 4.3Relationship between the degree of effect and monthly income of the households

Degree of effect /IncomeNRs.	**Moderately**	**Severely**	**Extremely**	**Total number of households**
<20,000	0	0	1	1
21,000-30,000	0	0	7	7
31,000-40,000	3	20	2	25
41,000-50,000	5	5	0	10
Above 51,000	23	1	0	24
Total	**31**	**26**	**10**	**67**

Upon identification of perceived causes of water shortage in the study areas, it was attempted to document the effects of water shortage at the householdlevel. Water shortage is viewed from both quality and quantity perspective.Those people who depend on water tankers for their daily water needs, responded that they have been spending more every time to buy water(jar water or water from tanker) to meet deficit water due to limited supply of water from the utility, while others responded that water they get is impure so their cost of water per months has got increased as they have to either filter or boil before drinking. Respondents also saidinsufficient water has negatively affecttheir cooking, bathing, washing, and flushing toilets. It was expressed that residents were forced to take bath once a week only; they were also compelled to wash their clothes hardly once a week. Similarly, people were rarely using commode as it consumes more water than ordinary pan in their bathrooms and almost all people said they do not use bathtubs.

Similarly, they were also inquired about the sickness attributed to poor water quality. Major response was “NO”. Sixty-three respondents said that they did not face any health related problem while only four people responded they felt cough and cold, minor headache and sometimes diarrhea but they were not sure whether it is due to insufficient water or not. It was found that their day to day life was more affected than health as they have to spend more hours during night to get water without sleeping. The respondents expressed that the utility distributes water during the odd hours, since most of the family members are job holders, the timing of water delivery by the utility does not match with their time, and therefore they are compelled to choose water tankers for their needs. Similarly, the utility distributes water at early morning which is also considered to be unsuitable for the local people. Almost 40 % of the respondents own deep boring or wells within their peripheries, those people expressed that they have been depending on the groundwater when the water from the taps is not sufficient to meet their needs. They also highlighted the fact that they have been going deeper to extract groundwater almost every year, which implies that the water table of the shallow aquifer has been decreasing gradually every year. It was found out that local people have been gradually losing their hopes on KUKL that it will supply water to them. This was substantiated by the repeated

request made to the utility for the timely and sufficient delivery of water to the areas, which are frequently put down by the utility. It seems people have lost the trust and reluctant to pay the water tariff. Therefore, the ward representatives have affirmed that they are in the process of initiating the recharging of the groundwater through rainwater in the areas. This could be a better initiative for securing water for a better living. The ward number 8 has approached to one organizations for conducting a training on recharging the groundwater.

4.6 Measures taken to address water shortage

Respondents, who felt water shortage issue in the study area were further inquired whether they have any measures adopted to cope with water shortage problem, all of them responded that they have adopted different strategies to cope with water shortage. The measures adopted by the households are ground water pumping, increasing storage capacity, buying water from tanker, collecting and storing rain water.The finding is similar to the findings of Gamao,(2013) in the study carried out in Kathmandu which reveals that majority of households depend on more than two sources of water. On an average, households depend on 2.4 water sources. These sources of water are water tankers, groundwater (dug wells, tube wells), and springs (*dhunge dhara*, springs) in addition to KUKL supply which is very much irregular in the study areas.

Water shortage is not unique to Kathmandu and its residents. Hence, people havedevised strategies to cope with the situation. Figure 4.3 shows the number of strategies employed by households to cope with water shortage in the study area. The results reveal that 40% of the respondents usually pump groundwater through wells. These wells dry up as the dry season sets in, forcing people to dig further to get water that will serve them for a while. The findings also show that 16% of the respondents buy water from tankers and about 14% store water either in big containers or by digging underground storage tanks. This strategy is adopted both in dry and rainy season. Only small fraction about 8% respondents (i.e. 5 households) who adopted coping mechanism involved in collecting rain water and use for other than drinking purpose and only 5% involved in other activities like neighbor water, bottled water, jar water etc. The use of rainwater for the domestic purposes in the households in the study areas is found to be very less. They are not aware of such system and have not installed the system in their houses. Those who owns rainwater harvesting at their houses got the information from various organizations and relatives. There are also other strategies such as buying jar water, getting water from neighbor etc.

People in both the wards under study expressed that they have increased the capacity of their water storage in their households. The households are found installing the waters storage tanks either on the roofs or at the ground floor. This study excludes the underground reservoir tanks. They are also harvesting the rainwater in these storage tanks following safety measures that remove the contaminants from this water. They flush the first harvest for sometimes and collect the later harvest in the tanks.

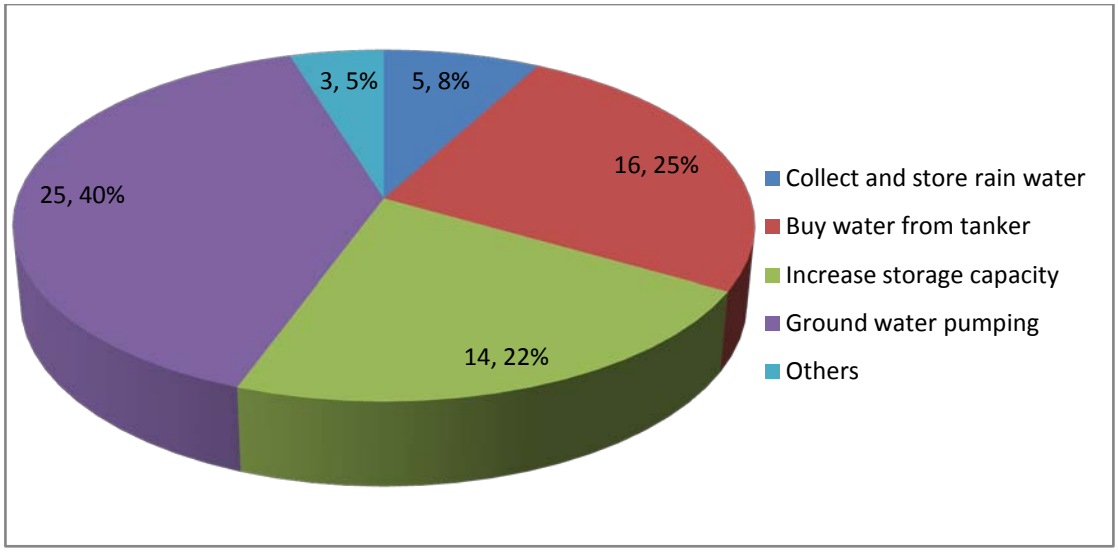


Figure 4.4Adaptation Strategies

Different households in the study area have varying size of water storage to cope with water shortage. Table 4.4shows size of water storage of sampled households according to their monthly family income. It was found that out of 24 households having monthly income in Nepali rupees greater than 51,000, 18 households have storage of above 5000 L, 5 households have 4000L and only one have 3000L. Similarly, 10 households have family income 41,000-50,000, out of which one have 5000L storage, 8 have 4000L and only one have 3000L. In income level between 31,000-40,000 there are 25 households among which 5 have 4000L storage, 15 have 3000L and another 5 have 2000L storage. Similarly, there are 7 households whose monthly income is in between 21,000-30,000 out of which 6 have 2000L storage and 1 have 1000L storage. However, there is only 1 household whose income is less than 20,000 and having storage of 1000L.

Thus, households having relatively more monthly family income are having large size of storage than those having relatively less income. An attempt was made to determine the relationship between these two variables (monthly family income and size of the water storage).The correlation coefficient (r)between the income level and size of water storage was found to be 0.87, which indicates that there is strong relation between the monthly family income and size of storage. The study finding also resembles the findings of Pasakhala (2014) in Kathmandu where the size of the water storage tanks showed strong positive correlation with the household income level.

Table 4.4 Relationship between the family income and size of storage in liters(L)

Monthly Family Income(NRs.)	Size of storage in liters(L)					
	1000	2000	3000	4000	Above 5000	Total number of households
Above 51,000	0	0	1	5	18	24
41,000-50,000	0	0	1	8	1	10
31,000-40,000	0	5	15	5	0	25
21,000-30,000	1	6	0	0	0	7
0-20,000	1	0	0	0	0	1
Total number of households	2	11	17	18	19	67

4.7 Influence of Socio-demographic factors in strategies adopted by residents for water shortage

The study found that socio-demographic characteristics has great influence on the adaptation strategies taken by the residents against water shortage as shown in figure 4.4. Residents having their monthly income level higher i.e. above 21,000are using more than one strategy to meet their demand and those having lower are compelled to use only one measure (below 21,000). This finding is similar to the study of unreliable water supplies and household coping strategies in peri-urban South Africa. Out of 63 respondents, 21 were having their income level above NRs. 51,000 per month and among them 8 household's dependent on water tankers, 8 households pumping groundwater, 3 has increased the water storage capacity at their households and 2 has installed rain water harvesting. Similarly, 10 households have income level in between NRs. 41,000 – 50,000. Out of those 10 households, 2 depend on water tankers, 5 households pump the groundwater, 2 households have increased the water storage capacity at their households and 1 household has installed rainwater harvesting. 25 households were found to have income level in between NRs. 31,000 -40,000 per month, out of which 5 households depend on water vendors, 10 preferred pumping groundwater, 9 households have increased the water storage capacity at their households and 1 household collects rain water. Similarly, the number of households whose income level is in the range of NRs. 21,000-30,000 is found to be 7, 3 households depend on water vendors, 2 households depend on groundwater and two households have increased the water storage capacity and collecting rain water. However, results found those households whose income level is below 20,000 were quite different from other high income level households as they opt pumping groundwater through wells only, they tend to use single measure though they are small in number in comparison to other. Hence, it can be observed that those having family income level high use multiple strategies to cope with water shortage in comparison to those having low income. Similar results were obtained on a study carried out by Pasakhala et al.,(2014) it reveals that households were found to use multiple water sources to cope with the shortage and household income was the most influential factor in selecting the coping measures.

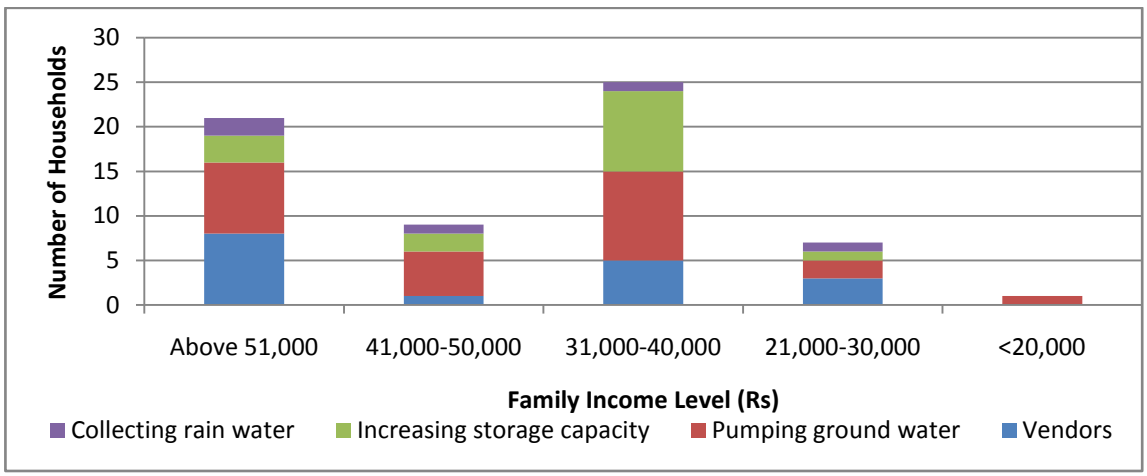


Figure 4.5Influence of family income level of respondents in strategies adopted for water shortage

The figure 4.5 shows how family size influence the strategies adopted by the respondents to the water shortage. It was found that highest number of respondents were in family size three to five and lowest in one to two. Out of 45 respondents in family size three to five, 13 have been using water tankers, 19 households have been pumping groundwater, 10 has increased the water storage capacity of the tanks at their households and three collected rain water. Similarly, in family size six to nine, only one is using vendors, eight got involved in pumping ground water, four in increasing storage capacity and two in collecting rain water. In family size one to two only one respondent lies and they opt vendors only. Similarly, in family where members exceed ten opt rain water collection only. This shows that respondents having very few members and very high members engaged in only one adaptation measures whereas medium size family were using multiple measures during adaptation process. It also can be concluded that largest nineteen respondents were engaged in pumping ground water and that lies in family size three to five lowest one respondent was found using only vendors which lie is family size one to two.

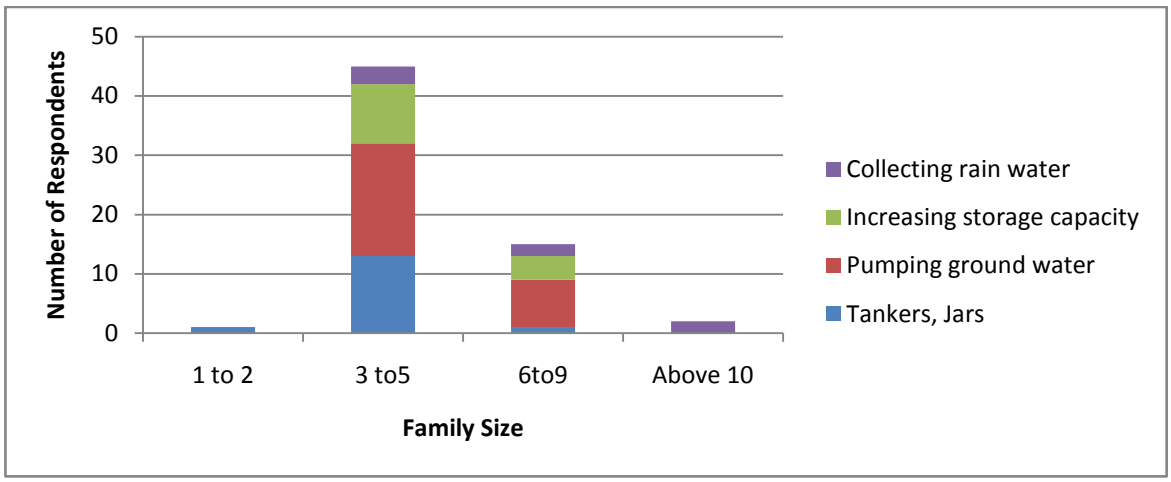


Figure 4.6Influence of family size in strategies adopted for water shortage

In order to examine the relationship between number of adaptation practices deployed by households and various socio-demographic characteristics (family size, income and education) of a household, the regression analysis was carried out. Number of adaptation practices is dependent on family size, family income and education. The regression analysis for two different wards under study was conducted separately and is shown in respective tables. The result of regression analysis for ward number 7 is shown in table 4.4 and 4.5.

Table 4.5Summary Output of Regression Analysis for ward seven

Regression Statistics	
Multiple R	0.234935092
R Square	0.055194498
Adjusted R Square	0.033381018
Standard Error	0.71995194
Observations	36

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.926395035	0.77662873	1.192841571	0.241701291

Income	1.31969E-05	1.18869E-05	1.110206505	0.275183217
Education	0.051470223	0.100278893	0.513270756	0.611287624
Family Size	0.059392613	0.099268548	0.598302429	0.553849721

Multiple R is the correlation coefficient, it shows how strong the linear relationship is i.e. a value of 1 means a perfect positive relationships and a value of zero means no relationship at all and a correlation of R = 0.9 suggests a strong, positive association between two variables, whereas a correlation of r = -0.2 suggest a weak, negative association. However, the value of multiple R in this case is 0.23which is very less than 0.9, therefore, itreflects that there is no strong relationship between dependent variable (number of adaptation practices) and independent variable (family size, income and education).

Regression output indicates that only 3.3% of variation in adaptation practice is explained by family size, income and education while 96.7%(100 %-3.3%) of the variation is caused by the factors other than family size, income and education.

Regression Equation is:

Number of adaptation practice = 0.92 + 0.051 X Education + $1.31X10^{5}$ Income + 0.059 X Family Size

The coefficient of income has estimated standard error of 1.18869E-05, t-statistics of 1.11 and p-value of 0.27. It is therefore statistically insignificant at significance level α=0.05. The coefficient of education has estimated standard error of 0.10, t-statistics of 0.51 and p-value of 0.61. It is therefore statistically insignificant at significance level α=0.05.The coefficient of family size has estimated standard error of 0.09, t-statistics of 0.59 and p-value of 0.551. It is therefore statistically insignificant at significance level α=0.05.

Table 4.6Summary Output of Regression Analysis for ward eight

Regression Statistics	
Multiple R	0.312492443
R Square	0.097651527
Adjusted R Square	-0.002609414
Standard Error	0.617768907
Observations	31

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	1.152531154	0.807861013	1.426645346	0.165144316
Education	0.111199043	0.066694089	1.66729984	0.107014403
Income	5.18339E-07	1.0534E-05	0.049206218	0.961117158
Family Size	0.006143157	0.088329663	0.069548058	0.945065926

However, the value of multiple R is 0.31which reflects that there is no strong relationship between dependent variable (number of adaptation practices) and independent variable (family size, income and education).

Regression output indicates that only 9.7% of variation in adaptation practice is explained by family size, income and education while 90.3%(100 %-9.7%) of the variation is caused by the factors other than family size, income and education.

Number of adaptation practice = 1.15 + 0.11 X Education + 5.1 $X10^5$ Income + 0.006 X Family Size

The coefficient of education has estimated standard error of 0.066, t-statistics of 1.66 and p-value of 0.10. It is therefore statistically insignificant at significance level $\alpha=0.05$. Coefficient of income has estimated standard error of 1.05*10^5, t-statistics of 0.049 and p-value of 0.96. It is therefore statistically insignificant at significance level $\alpha=0.05$. The coefficient of family size has estimated standard error of 0.08, t-statistics of 0.069 and p-value of 0.94. It is therefore statistically insignificant at significance level $\alpha=0.05$.

CHAPTER-5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study attempted to look on to the perceived causes and effects of water shortage along with the adaptation strategies of the local residents of ward number 7 and 8 of KMC. Various tools of inquiry were administered for the data collection both from the field and the literatures.

It can be concluded that there is a water shortage problem in the study areas of KMC. The study revealed that the primary causes of water shortageas perceived by the local respondents are urbanization and decreased groundwater level, lack of consolidated effort from the government and poor management of KUKL. Likewise, the secondary causes are lack of water treatment plant, water pollution and leakage. The water quality issue was also of prime concern in the study areas. Due to this day to day life of local people was found to be more affected than health as they have to spend more times during odd hours to collect water.It was concluded that those households whose monthly income is relatively low were affected extremely than those having high monthly income.

In addition, the water supply from the KUKL distribution system, is confirmed to be irregular in the study areas. Therefore, the residents have developed strategies such as groundwater pumping, buying water from vendors, increasing storage capacity and harvesting rain waterto cope with the water shortage issues in the study areas.Local people are found to be going deeper for the groundwater as it is the only reliable source for most of the households. Ironically, the rainwater harvesting is found to be installed in very few households, which may be attributable to limited awareness within the study areas or the investment required at first for the installation of the system. It could be concluded that awareness on the potential of rain water harvesting is lagging or limited in the study areas. People are also found aware that the Melamchi Water Supply alone cannot fulfill the entire demand of the valley, therefore, each and every available water sources within the valley, especially in the case of study areas, need to be conserved.

The existing water supply sources and socio-economic factors has influence the selection sources. The majority of households were found to be dependent on multiple sources, since, piped water supply is inadequate to fulfill their needs. Wells, water tankers and vendors and jar water were major alternative sources, which reduced severity of water shortage. Different sources were used by different respondents, family size and family income level are found to have greater influence in choosing adaptation strategies, generally it was found medium size family were using multiple sources than low and high. It was also found that respondents having high family income were using multiple sources than with lower. Those households who can afford, are spending more money on alternative sources whereas others are solely dependent on pipe water supply, and sometimes depend on neighbor households.However, from regression analysis output of both the wards, it is concluded that there is no influence of socio-demographic characteristics (family size, income and education) of the households on the number of adaptation practices at the household level this might be due to the small number of samples taken for the analysis.

5.2 Recommendations

Based on the above conclusions of the study, the following recommendations are put forth.

- ✓ People are found to have huge expectations on the much awaited Melamchi Water Supply Project, however are also aware that it alone cannot fulfill the demand of the local people, therefore, the government along with the local people should conserve the local water sources available within the jurisdiction of the lower level local administrative units.

- ✓ To meet the demand of rapidly increasing population in the study areas, it is recommended to focus on the possibilities of conjunctive use of surface water, groundwater and rain water harvesting options with quick recovery and maintenance of the damaged infrastructures based on assessment of actual freshwater available in the upper catchment area, sustainable harvesting.

- ✓ Since very few households have rainwater harvesting system in place, an effective rainwater harvesting awareness campaign should be launched in both the study areas either through the concerned governmental units or non-governmental organization.

- ✓ Rain water harvesting system design along with building design should be ensured at the time of approval of building construction by Metropolitan City.

- ✓ The local water distribution center (Mahankalchaur distribution center) should reconsider the timing of water delivery, though for a limited duration, so that every household get time to collect and store water in the study areas.

- ✓ Kathmandu Upatyaka Khanepani Limited needs to recover the lost faith that the residents have in their system by using the money to rehabilitate and improve the existing water system, embarking on a marketing and sensitization that will conscientize the residents about the benefits of paying their bills on time and constantly.

The study recommends the following points to be considered while carrying out further studies.

- ✓ Consideration of the amount of water consumption and piped water supply in different seasons.

- ✓ The effectiveness of adaptation measures under varying water consumption conditions.

- ✓ Study on the urgency of groundwater recharge and sustainable use.

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ANNEX 1: Semi Structured Household Interview

A. General Information:

Name: …….
Sex: Male/Female
Age of the respondents: ……
Religion: Hindu/ Buddhism / Muslims /Christians /Other
Size of the household …….
Ward number……
House number…….
Name of street /Tole …….

Name of the family members	Sex	Age	Education

1. What is your monthly family income in NR?

0-20,000	21,000-30,000	31,000-40,000	41,000-50,000	51,0000 +

B. Water shortage

Is there enough water in your area? Yes /No
1. Do you have piped water connection provided by KUKL? Yes or No
If "NO", what are the water sources being used by the family?
……
If "YES", is the supplied water is adequate enough for the various purposes?
Yes or No
2. What is your perception regarding piped water supply?

- Expensive
- No enough water
- Inconvenient
- Poor quality
- Low pressure
- Less reliable

3. What is the frequency of water supply in your area?
……

4. Do you think that current water supply by KUKL in your area is worse compared to the previous years? Yes or No

If YES, can you mention some of the evidences?
……
5. When did your area start experiencing water shortages?
……
6. Do you think that water shortage is going to be severe in coming days and why?
…….

7. In your views who should manage water supply?

- Community
- Private sector
- NGO'S
- Government/Municipalities
- Self
- I don't know

C. Causes and effects of water shortage

1. What do you think are the causes of water shortage in your area?

……
……

2. How affected is your household by water quantity and quality problems?

- Moderately
- Severely
- Extremely

3. Did anyone in the household get sick due to drinking water?
Yes, or No

D. Adaptation strategies for Water shortage

1. Have you taken any measures to cope with water shortage? Yes or No
2. What are the adaptive measures taken by the local people or individual households?

……

3. Which coping mechanisms that you engage in alleviating water problems?

I. Collect and store rainwater (Cost)
II. Buy water from tankers
III. Increase storage capacity of tanks
IV. Ground water pumping (wells)
V. Others ……...

4. Please rank your preferences for adoption of any these measures to resolve water shortage problems at household level 1 for most preferred.

Options/ Age	
Collect and store rain water	
By water from tankers	
Increase storage capacity	
Pump ground water(wells)	
Reduce water consumption	

5.What is the size of storage in liters(L) on your household?

…….

6. Which water sources do you have close to your house?

vendors	springs	wells	Stone spouts	river	pond

ANNEX 2: List of Household members interviewed

List of Respondents

S.N	Name of participants	Gender	Age	Education
1	Hari Bhakta Shresth	M	61	Master
2	Bishnu Maya Sangat	F	56	Bachelor
3	Usha Devi Shahi	F	58	SLC
4	Laxmi Pandey	F	56	Below SLC
5	Mohan Ratna Shakya	M	65	SLC
6	Tilak Bhattrai	M	29	PLUS 2
7	Niroj Dahal	M	32	Bachelor
8	Laxman Mainali	M	44	Bachelor
9	Shekhar Deula	M	38	SLC
10	Gajendra Shakya	M	64	Below SLC
11	Chandra Prasad Chaulagain	M	35	SLC
12	Basudev Kattel	M	48	Bachelor
13	Bhaba Nath Dhital	M	58	SLC
14	Rocky Krishna Tandulkar	M	42	Bachelor
15	Sanjay Manandhar	M	45	SLC
16	Sudeep Shrestha	M	41	Bachelor
17	Yagya P Kharel	M	62	SLC
18	Sita Thapaliya	F	40	SLC
19	Neeta Bhattrai	F	50	PLUS 2
20	Sanjok Khakurel	M	27	Bachelor
21	Ambhu khakurel	F	45	Bachelor
22	Annon Chaulagai	M	30	Master
23	Pramila devkota	F	50	PLUS 2
24	Barsad bahadue devkota	M	53	PLUS 2
25	Urmila Mainali	F	56	Below SLC
26	Ram Raja Dangol	M	40	Bachelor
27	Gokul Das Pakwan	M	63	MASTER
28	Sudarsan Thapa	M	28	SLC
29	Veena Karki	F	55	Master
30	Bandana Thapaliya	F	48	Master
31	Prabha Panta	F	50	Bachelor
32	Urmila kharel	F	52	Bachelor
33	Keshav Joshi	M	54	Bachelor
34	Ashok Adhikari	M	40	Master
35	Sunita Katwal	F	38	Master
36	Dharti Ghimere	F	26	Bachelor
37	Hira lal Sedhai	M	82	Bachelor
38	Vaama Tiwari	F	67	Below SLC
39	Mahesh kharel	M	75	Bachelor
40	Bhola Prasad Silwal	M	76	PLUS 2
41	Rishi Thapaliya	M	70	Master

42	Meera Tripathi	F	37	Bachelor
43	Ashim Rai	M	29	SLC
44	Perma Tshring Sherpa	M	30	Master
45	Roshan Tripathi	M	28	Bachelor
46	Usha Tripathi	F	36	Master
47	Nipesh Ghimere	M	37	Master
48	Kajal Pradhan	F	26	Bachelor
49	Mahesh Munakarmi	M	31	Bachelor
50	Aayush Shrestha	M	30	Bachelor
51	Sonwor Dangol	M	29	Bachelor
52	Razan Dangol	M	30	Bachelor
53	Nishant Gatauda	M	29	Bachelor
54	Yam Prasad Mainali	M	58	Bachelor
55	Yam Bahadur Chhetri	M	57	Bachelor
56	Bikal Malla	M	65	Bachelor
57	Kalika Pathak	F	70	Bachelor
58	Shiva Mainali	M	50	Below SLC
59	Guru Prasad Sitaula	M	63	Bachelor
60	Lalita Khanal	F	50	Master
61	Narendra Pathak	M	55	SLC
62	Sani Nani Tripathi	F	58	Bachelor
63	Bhagawati Tripathi	F	53	Below SLC
64	Shiva Krishan Mainali	M	49	SLC
65	Danda Pani Poudel	M	57	Plus 2
66	Ranju Chapagai	F	29	Bachelor
67	Subash Shrestha	M	29	Master

ANNEX 3: Checklist for the KII

Name:
Gender:
Organization:
Position:

1. Which area does your distribution unit supply water?
2. How does your department provide water in your service area?
3. How much does it collect and distribute water?
4. What are the main available sources of water for the distribution?
5. Is the water provided by KUKL is sufficient to meet daily water requirement of people in the service area?

YES	NO

If" No" Do you think leakage is the one of the cause behind the shortage of water? % leakage???

Site specific:

6. How the water is being distributed in ward no seven and eight?
7. How much water is required to meet daily water demand of people in ward no seven and eight? Volume /frequency????
8. Are people satisfied by the volume of water supplied by KUKL?
9. What are some problems your department face in supply?
10. What does your department do to resolve water shortage?
11. Do you have any collaboration with other organizations regarding water shortage?
12. Do you believe that ongoing Melamchi Project will be able to solve water shortage problem completely?
13. What would be your suggestions for the improvement of water management strategies at government and household levels?

ANNEX4: List of Key Informants

SN	Name of Key Informants	Gender	Organization	Position
1	Suddha Kumar Dangol	Male	Ward -7	Ward Chairperson
2	Dinesh Kumar Dangol	Male	ward -8	Ward Chairperson
3	Umesh Babu Marahatta	Male	KUKL , Mahankal Chaur	Deputy Manager
4	Shekhar Deula		Ward-8	Ward Member
5	Chandra Prasad Chaulagai	Male	KUKL, Mahankal Chaur	Valve Operator
6	Govinda Shrestha	Male	KUKL, Mahankal Chaur	Valve Operator
7	Ganesh Shrestha	Male	KUKL, Mahankal Chaur	Valve Operator
8`	Kedaar Raut	Male	KUKL, Mahankal Chaur	Valve Operator
9	Purna Bahadur Shrestha	Male	KUKL, Mahankal Chaur	Valve Operator

ANNEX 5: Summary Output of Regression Analysis for ward seven

Regression Statistics								
Multiple R	0.234935092							
R Square	0.055194498							
Adjusted R Square	-0.033381018							
Standard Error	0.71995194							
Observations	36							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.96897007	0.322990023	0.623134928	0.605250318			
Residual	32	16.58658549	0.518330796					
Total	35	17.55555556						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.926395035	0.77662873	1.192841571	0.241701291	-0.655545921	2.508335991	-0.655545921	2.508335991
Income	1.31969E-05	1.18869E-05	1.110206505	0.275183217	-1.10159E-05	3.74096E-05	-1.10159E-05	3.74096E-05
Education	0.051470223	0.100278893	0.513270756	0.611287624	-0.152791197	0.255731644	-0.152791197	0.255731644
Family Size	0.059392613	0.099268548	0.598302429	0.553849721	-0.142810802	0.261596029	-0.142810802	0.261596029

ANNEX 6: Summary Output of Regression Analysis for ward eight

Regression Statistics	
Multiple R	0.312492443
R Square	0.097651527
Adjusted R Square	-0.002609414
Standard Error	0.617768907
Observations	31

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	1.115117439	0.371705813	0.97397377	0.419477605
Residual	27	10.3042374	0.381638422		
Total	30	11.41935484			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.152531154	0.807861013	1.426645346	0.165144316	-0.505062725	2.810125034	-0.505062725	2.810125034
Education	0.111199043	0.066694089	1.66729984	0.107014403	-0.025645923	0.24804401	-0.025645923	0.24804401
Income	5.18339E-07	1.0534E-05	0.049206218	0.961117158	-2.10957E-05	2.21323E-05	-2.10957E-05	2.21323E-05
Family Size	0.006143157	0.088329663	0.069548058	0.945065926	-0.175094342	0.187380655	-0.175094342	0.187380655