Chapter 1
INTRODUCTION

1.1 BACKGROUND

Water is essential for life. Water is the most precious natural resource and something that most of us take for free. Water plays a central role in all aspects of life - public and private, at all levels from international waters to the household level; it plays a critical role in the natural environment, in economies, and in politics. The governing of how water is used, who uses it and how much is used is consequently very complex and is the substance of a substantial body of law at local, national and international levels.

We are now increasingly becoming aware of the importance of water to our survival and its limited supply. For that very reason it can turn us against each other, or it can be a formidable tool for cooperation. Water has the potential of becoming the quintessential tool for overcoming cultural, ethical, and political differences.

Water forms the lifeline of any society. Water is essential for the environment, food security and sustainable development. All the known civilization have flourished with water source as the base and it is true in the present context too. Availability of drinking water and provision of sanitation facilities are the basic minimum requirements for healthy living. Water supply and sanitation, being the two most important urban services, have wide ranging impact on human health, quality of life, environment and productivity. Despite the technological advancement, the global scenario still remains grim, as al the inhabitants of the world do not have access to safe drinking and adequate sanitation.

In the urban areas, the population is increasing rapidly and the issue of supplying adequate water to meet societal needs and to ensure equity in access to water is the most urgent and significant challenges faced by the policy makers.

With respect to the physical alternatives to fulfill sustainable management of fresh water, there are two solutions: finding alternate or additional water resources using conventional centralized approaches; or utilizing the limited amount of water resources available in a more efficient way. To date, much attention has been given to the first option and limited attention has been given to optimizing water management systems. Among the various to augment freshwater resources, rainwater harvesting and utilization is a decentralized, environmentally sound solution, which can provide many environment problems often caused by conventional large-scale projects using centralized approaches.

Rainwater harvesting, in its broadest sense, is a technology used for collecting and storing rainwater for human use from rooftops, land surfaces or rock catchments using simple technique such as jars and pots as well as engineered technique. Rainwater harvesting has been practiced for more than 4000 years, owing to the temporal and spatial variability of rainfall. It is an important water source in many areas with significant rainfall but lacking any kind of conventional, centralized supply supply system. It is also a god option in areas where good quality fresh water or ground water is lacking. The application of appropriate rainwater harvesting technology is important for the utilization of rainwater as a water resource

1.1.1 The World Water Crisis

Rapid population growth, combined with industrialization, urbanization, agriculture intensification and water intensive lifestyles is resulting in a global water crisis. In 2000, at least 1.1 billion of the world's people-about one in five- did not access to safe water. Asia contains 65 percent of the population without safe water and Africa 28 percent. During the 1990s, there were some positive developments: about 438 million people in developing countries gained access to safe water but due to rapid population growth, the number of urban dwellers lacking access to safe water increased by nearly 62 million.

Falling water tables are widespread and cause serious problems, both because they lead to water shortage and, in coastal areas, to salt intrusion. Both contamination of drinking water and nitrate and heavy metal pollution of rivers, lakes and reservoirs are common problem throughout the world. The world supply of fresh water cannot be increased. More and more people are becoming dependent on limited supplies of freshwater that is becoming more polluted. Water security, like food security, is becoming a major national and regional a in many areas of the world.

1.2 INTRODUCTION

Rainwater harvesting is the accumulating and storing, of rainwater. It has been used to provide drinking water, water for livestock, water for irrigation or to refill aquifers in a process called groundwater recharge. Rainwater collected from the roofs of houses, tents and local institutions, can make an important contribution to the availability of drinking water. Water collected from the ground, sometimes from areas which are especially prepared for this purpose, is called Stormwater harvesting. In some cases, rainwater may be the only available, or economical, water source. Rainwater harvesting systems can be simple to construct from inexpensive local materials, and are potentially successful in most habitable locations. Roof rainwater can be of good quality and may not require treatment before consumption. Although some rooftop materials may produce rainwater that is harmful to human health, it can be useful in flushing toilets, washing clothes, watering the garden and washing cars; these uses alone halve the amount of water used by a typical home. Household rainfall catchment systems are appropriate in areas with an average rainfall greater than 200 mm (7.9 in) per year, and no other accessible water sources (Skinner and Cotton, 1992).

Rainwater harvesting appears to be one of the most promising alternatives for supplying freshwater in the face of increasing water scarcity and escalating demand. The pressures on rural water supplies, greater environmental impacts associated with new projects, and increased opposition from NGOs to the development of new surface water sources, as well as deteriorating water quality in surface reservoirs already constructed, constrain the ability of communities to meet the demand for freshwater from traditional sources, and present an opportunity for augmentation of water supplies using this technology.

1.2.1 The Role Of RWH In Rural Development

Given the condition of rural communities rainwater harvesting can find a place in rural water supply if the following could be considered;

- RWH can be an effective way of water supply in the land areas. The government does not supply water to these places and it's up to the farmers to find ways of getting it. Since the same only stay there during the rainy season, the harvested water can be their water supply.
- Integration of RWH with traditional moisture conservation methods will bring breakthrough in rain fed agriculture resulting improved yield, better income and better life for the people.
- The unemployed living in villages, who cannot afford fruits and vegetables, could embark on growing these.People could harvest water from their house roofs and use it for gardening. Owing to the limited amount of water available, coupled with the walking distance to the water point gardening is impossible. Once rainwater has made this possible, healthy eating will be the result.
- Water and sanitation are inseparable. More water will definitely result in improved sanitation and a healthier population.
- Sanitation problems at rural schools can better be solved by this simple technology. Proper and timely maintenance of the tanks to ensure reliable operation and water quality, optimum utilization of the roof to increase the quantity could go a long way in transforming the school grounds, landscaping, gardening and savings on water bills

1.3 STATEMENT OF THE PROBLEM

Scientists have already predicted that by the year 2025 two thirds of humanity will face a shortage of fresh water. At present one thirds of the global population is facing water stress. Because of excessive extraction of ground water, drinking water is not available during the critical summer months. Urban development is already putting considerable strains on existing water resources which are struggling to keep pace with steadily rising demands. The lives of women and children as well as the environment have seriously been threatened by water problems in the country. Problems associated with fresh water and drinking water can be summarized.

- Rural population does not have access to regular safe drinking water and many more are threatened by less and less access to safe drinking water. Water shortages in cities and villages have led to large volumes of water being collected and transported over great distances by tankers and pipelines.
- High levels of fluoride, arsenic & iron lead to major environmental health problems and in the case of iron, people simply do not like to drink the water because of its appearance.
- Pollution of ground and surface waters from agro-chemicals (fertilizers and pesticides) and from industry poses a major environmental health hazard, with potentially significant costs to the country.
- Ground water is being over exploited; surface water is utilized inefficiently, as is water used for irrigation and urban water supply and water pollution is escalating at exponential rates, not least because of poor sanitation. The poor in rural and urban areas, particularly women and children, continue to be hard hit by these emerging problems.

1.4 OBJECTIVES OF THE STUDY

The main objective of the study is to access technical status and impact of rain water harvesting in rural area.

The specific objectives are as follows:

1. To assess technical status of rainwater harvesting systems
2. To explore a usage from available resources in the rural livelihood.
3. To assess the impact of RWH in rural life.
4. To explore the impact of RWH in water use.
5. To explore socio-economic condition including health and water quality of rural people and community.

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1.5 RATIONAL OF THE STUDY

The study assess to impact of RWH systems implemented by the different NGO with a view to get feedback for making the program more effective in the coming days and disseminate the lessons learnt. The RWH systems are selected from implemented RWH systems only. Necessary information on RWH and their owners was collected from the implementing NGOs. Exhaustive list of RWH systems was prepared. Selection was made from the prepared list so as to cover different systems and types of RWH as well as various regions and districts. Data sheet and structured questionnaire and employed in the survey. The impact assessment was largely focused on contents of the questionnaires.

1.6 ORGANIZATION OF THE STUDY

This study about the improved Rainwater Harvesting For Rural Water Demand is organized in five various Chapters and the chapters are as follows.

Chapter 1: This first chapter describes about 6-sub chapter and it is as follows. Introduction, Background of the study, Statement of problem, Objective of the study, Rational of the study area, Limitation and the scope of the study, Research question, Importance of the study.

Chapter 2: In this chapter, literature, which is related to this study, is reviewed here. The dissertation, related article and research work is reviewed here in this chapter.

Chapter 3: This topic describe about the method and the tools of data analysis for the research study.

Chapter 4: Chapter 4 describes about the information, which was collected from the field, and here we interpret data by different method like by tabulation, percentage method etc. with the various tools and technique here we describe the data in this chapter.

Chapter 5: Last chapter of this research describe about the summary, conclusion and recommendation of the study.

Chapter 2

LITERATURE REVIEW

Review of literature is an important part of the all studies. This study, Rainwater harvesting for rural water demand, I have reviewed the literature related to this research. From different aspects that is, in theoretical or practical attachment with this research, like several planners, researcher and implementers expressed their views in the field of research, and participation of the people. Several governmental and non-governmental agencies have been established for development and promotion of the Rainwater harvesting. Whatever available literature related to this topic is reviewed here.

2.1 NEPAL WATER SCENARIO

Nepal is the largest storehouse of freshwater. The presence of more than 6000 rivers and rivulet and many lakes are the evidences of richness in water resources water (Dixit 2002). The major source of water is precipitation. Nepal receives precipitation of around 220 km3 /year, 22 km3 /year as snowfall and remaining 198km3/ year as rainfall. However, to get sufficient water all the year around is a problem since the country receives too much water during the monsoon and too little water rest of the year as per the climatologically record of Nepal, 1971-2000 (Limbu 2005).

Nearly 80% of all precipitation occurs during the monsoon (June – September), with 8% falling during the post-monsoon (October – January) and 12% during the pre-monsoon periods (Chalise & Khanal 1996; Chyurlia 1984). Nearly 80% of the people live in rural area depend on agriculture, which in turn depend on rainfall. To combat the problem, rainwater harvesting practices is being used in the rural and urban areas.

2.1.1 Water Demand, Supply System And Scarcity In Nepal

Despite the fact that the Nepal is the largest storehouse of freshwater for many of their inhabitants getting sufficient water all year round is a problem. The region receives either too much water during the monsoon or too little the rest of the year (Climatological records of Nepal, 1971-2000). Management of water resources is becoming one of the biggest challenges for Nepal, where nearly 80 percent of the people live in rural areas and depend on agriculture, which in turn basically depends upon rainfall. Several organizations are actively involved in implementing water supply projects but very few could make notable contribution in the field of water management (UNCED, 1992).

Water supply through pipelines provides high level of service than point source properly managed. However, due to the leakage and pressure difference in the system, there is high possibility of contamination. Over exploitation of ground water causes subsidence of aquifer, and ground water pollution & depletion. The presence of Arsenic in ground water may cause health hazards. Thus over exploitation of ground water should be restricted which is not possible unless there is adequate supply of water. So the only solution is to replenish it, known as ground water recharge. The degree to which groundwater is recharged depends on the rate of recharge and rate of extraction of water. This explains the importance of alternative source of water supply. Population blooming, subsequent increase in demand, absence of source, inability of government and unequal distribution, plus the inability of civic authorities to resolve the problem are main causes of water scarcity.

Water demand of a single person is defined as per capita demand and demand is the function of access, price behavior, policy and technology. In case of Nepal, the household demand in urban region is 80 to 100 lit/day (lpd). Kathmandu Valley needs 190 MLD supply during dry season and 180 MLD in wet season. 60% of population has access to drinking water and 40% depend on tube wells, stone spouts, underground water and private water tankers (Singh 2003).
Water leakage from pipelines, reservoirs and illegal connection further increases the water scarcity.

2.1.2 Historical Development Of Rainwater Harvesting And Utilisation

Rainwater collection is one of the oldest means of collecting water for domestic purposes. Hundreds of years before the birth of Christ, rainwater collections were already a common technique throughout the Mediterranean and Middle East, used by Egyptians, Palestinians, Iranians, Iraqis, Yemenis, Greeks and Romans. Water was collected from roofs and other hard surfaces and stored in underground tanks, or excavated reservoirs (cisterns) with masonry domes (Movahed Danesh 1997 cited in; Smet & Moriarty 2001). In some parts of the Middle East, rainwater was collected from hard surface areas and channeled through vertical shafts to horizontal tunnels (*qanars*),that in turn led the water to underground reservoirs (Smet & Moriarty 2001).

In Western Europe, historical records show that in many places rainwater was the primary source of drinking water, the same applies to the Americas and Australia. In all three continents, rainwater continues to be an important source for isolated homesteads and farms. Gould and Nissen-Petersen (1999) had given a good summary of the history of rainwater harvesting. Rainwater collection and storage for agricultural purposes has equally been widely practiced for thousands of years. Agarwal and Narain (1997) had given a good historical overview of such practices in India. In sub-Saharan Africa, the collection of rainwater was practiced using small containers, in among others, most of Southern Africa, Ghana, Kenya and Tanzania (Smet and Moriarty (2001).

Limbu (2005) had discussed about the evidences of roof catchment of roman villages that explain the RHW system. Roman villages and cities were designed to take advantage of rainwater since 2000 B.C. In Negev desert of Israel, tanks were built to collect water for storing runoff from hillside for domestic and agricultural purposes.

The history of rainwater harvesting in Asia can be traced back to about the 9th or 10th century and the small-scale collection of rainwater from roofs and simple brush dam constructions in the rural areas of South and South-east Asia. Rainwater collection from the eaves of roofs or via simple gutters into traditional jars and pots has been traced back almost 2000 years in Thailand. Rainwater harvesting has long been used in the Loess Plateau regions of China. More recently, however, about 40000 well storage tanks, in a variety of different forms, were constructed between 1970 and 1974 using a technology that stores rainwater and storm water runoff in ponds of various sizes. A thin layer of red clay is generally laid on the bottom of the ponds to minimize seepage losses. Trees, planted at the edges of the ponds, help to minimize evaporative loss from the ponds (United Nation Environment Programme 1982).

In the last two decades however, the interest in rainwater harvesting and use is once again growing, driven by environmental concerns (particularly the increasing strain on other sources of water) and a renewed interest in small scale distributed and appropriate technologies of all kinds.

Such water provides an ideal source for a number of household and agricultural activities where high bacteriological quality is not an issue, including laundry, toilet flushing, car washing, and garden irrigation. Rainwater is of particular importance and relevance for arid and semi-arid lands, small coral and volcanic islands, and remote or scattered human settlements (Agarwal & Narain 1997; Smet & Moriarty 2001).

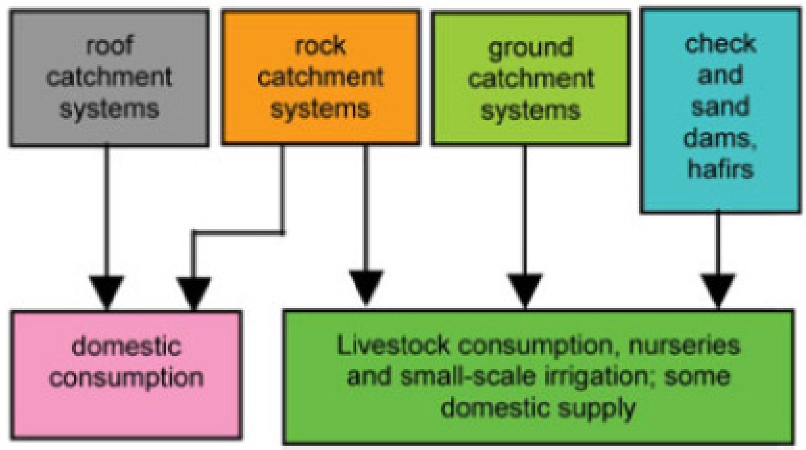
Rainwater harvesting and utilisation systems have been used since ancient times and evidence of roof catchment systems date back to early Roman times. Roman villas and even whole cities were designed to take advantage of rainwater as the principal water source for drinking and domestic purposes since at least 2000 B.C. In the Negev desert in Israel, tanks for storing runoff from hillsides for both domestic and agricultural purposes have allowed habitation and cultivation in areas with as little as 100mm of rain per year. The earliest known evidence of the use of the technology in Africa comes from northern Egypt, where tanks ranging from 200-2000m3 have been used for at least 2000 years – many are still operational today.

The technology also has a long history in Asia, where rainwater collection practices have been traced back almost 2000 years in Thailand. The small-scale collection of rainwater from the eaves of roofs or via simple gutters into traditional jars and pots has been practiced in Africa and Asia for thousands of years. In many remote rural areas, this is still the method used today. The world's largest rainwater tank is probably the Yerebatan Sarayi in Istanbul, Turkey. This was constructed during the rule of Caesar Justinian (A.D. 527- 565). It measures 140m by 70m and has a capacity of 80,000 cubic metres.

2.2 AN OVERVIEW ON RAINWATER HARVESTING

Rainwater harvesting is a technology used to collect, convey and store rain for later use from relatively clean surfaces such as a roof, land surface or rock catchment. The water is generally stored in a rainwater tank or directed to recharge groundwater. Rainwater infiltration is another aspect of rainwater harvesting playing an important role in stormwater management and in the replenishment of the groundwater levels. Rainwater harvesting has been practiced for over 4,000 years throughout the world, acticed for over 4,000 years throughout the world, traditionally in arid and semi-arid areas, and has provided drinking water, domestic water and water for livestock and small irrigation. Today, rainwater harvesting has gained much on significance as a modern, water-saving and simple technology.

The practice of collecting rainwater from rainfall events can be classified into two broad categories: land-based and roof-based. Land-based rainwater harvesting occurs when runoff from land surfaces is collected in furrow dikes, ponds, tanks and reservoirs. Roof-based rainwater harvesting refers to collecting rainwater runoff from roof surfaces which usually provides a much cleaner source of water that can be also used for drinking. Gould and Nissen-Petersen (1999) categorised rainwater harvesting according to the type of catchment surface used and the scale of activity.



Rooftop rainwater harvesting at the household level is most commonly used for domestic purposes. It is popular as a household option as the water source is close to people and thus requires a minimum of energy to collect it. An added advantage is that users own, maintain and control their system without the need to rely on other community members.

2.2.1 Why Rainwater Harvesting?

In many regions of the world, clean drinking water is not always available and this is only possible with tremendous investment costs and expenditure. Rainwater is a free source and relatively clean and with proper treatment it can be even used as a potable water source. Rainwater harvesting saves high-quality drinking water sources and relieves the pressure on sewers and the environment by mitigating floods, soil erosions and replenishing groundwater levels. In addition, rainwater harvesting reduces the potable water consumption and consequently, the volume of generated wastewater.

2.2.2 Application Areas

Rainwater harvesting systems can be installed in both new and existing buildings and harvested rainwater used for different applications that do not require drinking water quality such as toilet flushing, garden watering, irrigation, cleaning and laundry washing. Harvested rainwater is also used in many parts of the world as a drinking water source. As rainwater is very soft there is also less consumption of washing and cleaning powder. With rainwater harvesting, the savings in potable water could amount up to 50% of the total household consumption.

2.2.3 Criteria For Selection Of Rainwater Harvesting Technologies

Several factors should be considered when selecting rainwater harvesting systems for domestic use:

- type and size of catchment area
- local rainfall data and weather patterns
- family size
- length of the drought period
- alternative water sources
- cost of the rainwater harvesting system.

When rainwater harvesting is mainly considered for irrigation, several factors should be taken into consideration. These include:

- rainfall amounts, intensities, and evapo-transpiration rates
- soil infiltration rate, water holding capacity, fertility and depth of soil
- crop characteristics such as water requirement and length of growing period
- hydrogeology of the site
- socio-economic factors such as population density, labour, costs of materials and regulations governing water resources use.

2.3 APPROACHES ON RAINWATER HARVESTING

With an ever-growing population and increasing agricultural intensification, water demand has drastically increased in the middle hills of Nepal. As there exist no clear-cut regulations with regard to proper distribution of water, farmers in this region are now facing serious social conflicts. Farmers feel that proper pricing of water should be initiated for equal and efficient distribution of water. As the potential availability of water within a watershed is limited and subject to climatic conditions, efficient utilisation, conservation and equitable distribution are essential. There is a need for integrated management incorporating water quality, quantity and socio-cultural issues in middle hill watersheds of Nepal.

Provision of good quality water and sanitation facilities to all residents including the poor, is a basic responsibility of service providers. Moreover, it forms a critical component in achieving the Millennium Development Goals (MDGs).

Infrastructure capacity, seen as the "Wheels of Economic Activity" can deliver major benefits in economic growth, poverty alleviation and environmental sustainability - only when it provides services that respond to demand and does so effectively. Presently, the water and sanitation service levels in urban areas of many Asian countries are inadequate and financially unsustainable, particularly for the urban poor. For cities to achieve a world-class public health status, it is imperative that they move from an intermittent water supply system to continuous (24/7) water supply. 24-hours water supply, 7-days a week is an accepted global norm and is prevalent not only in the cities of developed countries but also in many cities in less developed countries. It is significant that along with Europe, African and Asian cities like Kampala (Uganda), Singapore, Phnom Penh (Cambodia) and Dhulikel (Nepal) also have ready access to clean, potable water available 24-hours/day and with less expense than currently available in most other cities of Asia.

The Water for Asian Cities Programme of UN-HABITAT in partnership with the NGO Forum for Urban Water and Sanitation (NGOFUWS), Ministry of Physical Planning and Works and Water Aid, Nepal has initiated a Rainwater Harvesting Promotion Programme (RWHPP) in Kathmandu Valley in five municipalities and a nearby town, Banepa, with a view to ensure uprooting of water scarcity, mitigate the present water crisis of the valley and with a vision for long-term impact that sustains free rain water for bulk of its water needs. The Programme seeks to familiarize people with the rainwater harvesting technology of tapping nature's gift and popularize its use at the household, community and municipal levels.

Organisations such as the Centre for Science and Environment (CSE), International Rainwater Harvesting Alliance, RAIN Foundation and others have been promoting the RWH as an option to contribute to the mitigation of water scarcity around the world. The use of rainwater to recharge the ground water and to augment the water supplies for purposes other than drinking has also come up vibrantly. In the past decades, various international RWH conferences have been organised throughout the world, the latest being the 5th World Congress of the International Water Association held in September 2006, with an international workshop on rainwater harvesting and management.

RWH has been successfully established for managing drinking water scarcity in many countries, including South Asian nations. But the use of rainwater and its storage for drinking purpose is not practised in Nepal probably because of the prevalent practice of regarding stored water as impure and flowing water as pure. However, local systems, called the Panyalo, made of bamboo supports to harvest rainwater, were used for livestock. These traditional methods today have, however, become extinct, as piped water supply has come in as an easier alternative.

In the developing world, societies have addressed the water scarcity problems mostly through technology innovation such as tapping ground water and harvesting rainwater. The RWH option is increasingly gaining popularity as a means to ensuring a reliable and sustainable source of water. It entails a decentralised mode of water supply. The challenge within the RWH movement is the propagation of its knowledge and management experiences to the targeted communities.

2.3.1 Historical Development of Rainwater Harvesting In Nepal Scenario

Water harvesting systems have been designated in Nepal from the periods of Lichhavi. On the top of the hills and mountains of Nepal, ponds were dug in ancient times to collect rainwater for livestock use. Stone spouts, ponds were constructed in urban areas to collect water for dry season and to recharge the spring and increased soil moisture.

Farmers in villages use traces land with bounded fields to capture rainwater from sloping hills. Ancient rainwater harvesting systems are dying out and gradually losing their importance. It needs to be revived at present situation. The first known use of a modern RWH system in Nepal was at a mission hospital in Pokhara in the 1960s (Shakya B *et al.* 2007) is functioning well (www.rainfoundation.org, 2006).

2.3.2 Status Of Rainwater Harvesting In Nepal

Although Nepal lies in the monsoon rainfall zone, adequate supply of water in rural and urban settlement areas has become a national concern at present. Major reasons of initiating RWH in the country are lack of water sources in the vicinity in hill rural areas, seasonal scarcity, unreliable water supply systems and scattered or isolated settlements

In recent years collection of rainwater for domestic use has been promoted in Nepal by various agencies. The Department for Water Supply and Sewerage has produced some technical guidance on application and construction of rainwater systems, and several other sector agencies and NGO partners have followed suit (RWSSP-Finnida, Helvetas, NEWAH, Rural Water Supply and Sanitation Fund Board, Biogas Support Programme and the NGO Forum for Urban Water Supply and Sanitation). In the process, experience has been gained in suitable technical, social and financial aspects of rainwater harvesting.

Figure 1: Ferro Cement Tank For RWH

Currently it is estimated that over 11000 systems are in use in the hill districts of Nepal. A recent survey reported that around 78% of the users were satisfied with the service (Laia Domenech, MPPW & WHO-Nepal, November 2008). It can be concluded therefore that some 47’000 people are getting a satisfactory service out of rainwater harvesting, often in water stress areas (uphill areas in Kaski, Tanhu, Doti, etc.

Implementing Organizations	No. of projects	Percentage	% of grand total
1.HELVETAS/ Nepal:	8	100.00	53.33
a) Individual ownership:	8	100.00	-
b) Institutional ownership:	0	00.00	-
2 .NEWAH:	2	100.00	13.33
a) Individual ownership:	0	00.00	-
b) Institutional ownership	2	100.00	-
3. NRCS:	1	100.00	6.67
a) Individual ownership:	0	00.00	-
b) Institutional ownership	1	100.00	-
3 BSP-NEPAL:	4	100.00	26.67
a) Individual ownership:	0	00.00	
b) Institutional ownership:	4	100.00	
Total	15	100.00	100.00
a) Individual ownership:	8	53.33	
b) Institutional ownership	7	46.67	

Table 1: Selected RWH Systems by Implementing NGO Partners & Ownership Types of RWH systems, 2011

The Department of Urban Development and Construction has been working since early 2006 on promotion of rainwater harvesting in the urban areas. This effort is supported by UN-Habitat, NGO Forum for Urban Water Supply and Sanitation, ENPHO, Lumanti, etc. DUDBC has just produced a final draft of the RWH Guidelines which are to be used to guide municipal authorities and those engaged in the building trade. The focus of the guidelines is on collecting safe water for domestic purposes, conservation of water in the urban setting and management of drainage and flooding.

2.4 GOVERNMENT POLICY

The policies of the Government of Nepal aim to provide an adequate basic supply of safe drinking water to all its citizens. The methodologies of ensuring such access have been laid down in various government documents which guide the water supply development activities of government and NGOs.

In some instances coverage is not possible or sustainable using groundwater or surface water as households may be situated at an elevation that makes the supply of water within a reasonable distance from the household impossible, or because the quality of the water is compromised by chemicals such as arsenic. In such instances, project authorities may consider supporting a domestic or institutional rainwater harvesting system.

Rainwater is a valuable resource, which should be exploited in the most efficient way to protect the people's health and livelihood. To ensure good utilization and conservation of water resources, the Government of Nepal has prepared a policy on rainwater harvesting to promote suitable developments in rainwater harvesting for human consumption and domestic use, and facilitate guidance and capacity building.

The policy aims to

• foster optimum utilization of rainwater to cater for the needs of rural and urban households that face shortages of water for daily use;

• stimulate development of technical and financial solutions to effective rainwater harvesting in domestic and institutional settings;

• provide an enabling framework for local government and ngos to encourage and facilitate application of rainwater harvesting in all suitable situations.

Thus, the Ministry of Physical Planning and Works, with its departments; and in collaboration with the Ministry of Local Government, will promote the application of rainwater harvesting through support for research, piloting and evaluation of all relevant aspects of the rainwater harvesting chain. To that end the Ministry will encourage its departments, NGOs, universities and the private sector to develop and test suitable technologies and approaches.

Rainwater Harvesting has gradually been gaining interest in both the urban and rural areas.

To further raise the capacity in Nepal, the Ministry of Physical Planning and Works has consulted stakeholders and has drafted a concept for a Policy on Rain Water Harvesting.

2.5 RAIN WATER HARVESTING TECHNIQUES:

There are two main techniques of rain water harvestings.

- Storage of rainwater on surface for future use.
- Recharge to ground water.

The storage of rain water on surface is a traditional techniques and structures used were underground tanks, ponds, check dams, weirs etc. Recharge to ground water is a new concept of rain water harvesting and the structures generally used are :-

Pits :- Recharge pits are constructed for recharging the shallow aquifer. These are constructed 1 to 2 m, wide and to 3 m. deep which are back filled with boulders, gravels, coarse sand.

Trenches:- These are constructed when the permeable stram is available at shallow depth. Trench may be 0.5 to 1 m. wide, 1 to 1.5m. deep and 10 to 20 m. long depending up availability of water. These are back filled with filter. materials.

Dug wells:- Existing dug wells may be utilised as recharge structure and water should pass through filter media before putting into dug well.

Hand pumps :- The existing hand pumps may be used for recharging the shallow/deep aquifers, if the availability of water is limited. Water should pass through filter media before diverting it into hand pumps.

Recharge wells :- Recharge wells of 100 to 300 mm. diameter are generally constructed for recharging the deeper aquifers and water is passed through filter media to avoid choking of recharge wells.

Recharge Shafts :- For recharging the shallow aquifer which are located below clayey surface, recharge shafts of 0.5 to 3 m. diameter and 10 to 15 m. deep are constructed and back filled with boulders, gravels & coarse sand.

Lateral shafts with bore wells :- For recharging the upper as well as deeper aquifers lateral shafts of 1.5 to 2 m. wide & 10 to 30 m. long depending upon availability of water with one or two bore wells are constructed. The lateral shafts is back filled with boulders, gravels & coarse sand.

Spreading techniques :- When permeable strata starts from top then this technique is used. Spread the water in streams/Nalas by making check dams, nala bunds, cement plugs, gabion structures or a percolation pond may be constructed.

2.6 COMPONENTS OF A ROOFTOP RAINWATER HARVESTING SYSTEM

Although rainwater can be harvested from many surfaces, rooftop harvesting systems are most commonly used as the quality of harvested rainwater is usually clean following proper installation and maintenance. The effective roof area and the material used in constructing the roof largely influence the efficiency of collection and the water quality.

Rainwater harvesting systems generally consist of four basic elements:

(1) A collection (catchment) area

(2) A conveyance system consisting of pipes and gutters

(3) A storage facility, and

(4) A delivery system consisting of a tap or pump.

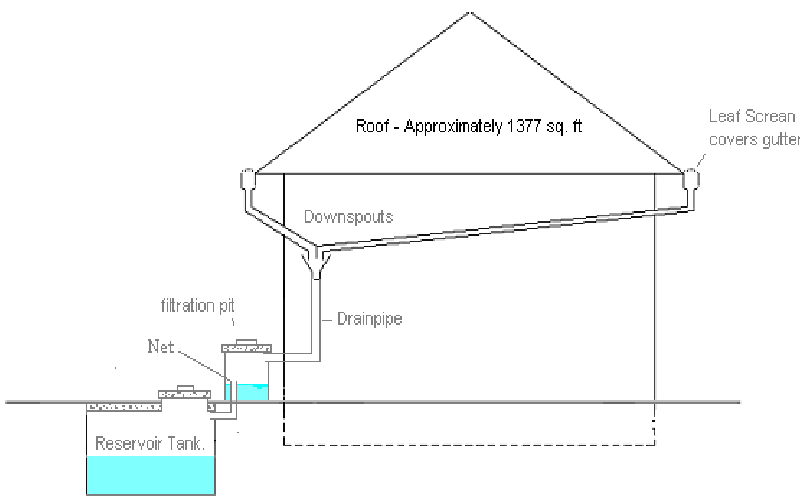


Table 2: Sketch identifying different components of the system

2.6.1 A collection or catchment system

It is generally a simple structure such as roofs and/or gutters that direct rainwater into the storage facility. Roofs are ideal as catchment areas as they easily collect large volumes of rainwater.

The amount and quality of rainwater collected from a catchment area depends upon the rain intensity, roof surface area, type of roofing material and the surrounding environment. Roofs should be constructed of chemically inert materials such as wood, plastic, aluminium, or fibreglass. Roofing materials that are well suited include slates, clay tiles and concrete tiles. Galvanised corrugated iron and thatched roofs made from palm leaves are also suitable.

Generally, unpainted and uncoated surface areas are most suitable. If paint is used, it should be non-toxic (no lead-based paints).

2.6.2 A conveyance system

It is required to transfer the rainwater from the roof catchment area to the storage system by connecting roof drains (drain pipes) and piping from the roof top to one or more downspouts that transport the rainwaterthrough a filter system to the storage tanks. Materials suitable for the pipework include polyethylene (PE), polypropylene (PP) or stainless steel.

Before water is stored in a storage tank or cistern, and prior to use, it should be filtered to remove particles and debris. The choice of the filtering system depends on the construction conditions. Low-maintenance filters with a good filter output and high water flow should be preferred. “First flush” systems which filter out the first rain and diverts it away from the storage tank should be also installed. This will remove the contaminants in rainwater which are highest in the first rain shower.

2.6.3 Storage tank

Storage Tank or cistern to store harvested rainwater for use when needed. Depending on the space available these tanks can be constructed above grade, partly underground, or below grade. They may be constructed as part of the building, or may be built as a separate unit located some distance away from the building.

The storage tank should be also constructed of an inert material such as reinforced concrete, ferrocement (reinforced steel and concrete), fibreglass, polyethylene, or stainless steel, or they could be made of wood, metal, or earth. The choice of material depends on local availability and affordability. Various types can be used including cylindrical ferrocement tanks, mortar jars (large jar shaped vessels constructed from wire reinforced mortar) and single and battery (interconnected) tanks. Polyethylene tanks are the most common and easiest to clean and connect to the piping system. Storage tanks must be opaque to inhibit algal growth and should be located near to the supply and demand points to reduce the distance water is conveyed.

Water flow into the storage tank or cistern is also decisive for the quality of the cistern water. Calm rainwater inlet will prevent the stirring up of the sediment. Upon leaving the cistern, the stored water is extracted from the cleanest part of the tank, just below the surface of the water, using a floating extraction filter. A sloping overflow trap is necessary to drain away any floating matter and to protect from sewer gases. Storage tanks should be also kept closed to prevent the entry of insects and other animals.

2.6.4 Delivery system

Delivery system which delivers rainwater and it usually includes a small pump, a pressure tank and a tap, if delivery by means of simple gravity on site is not feasible.

Disinfection of the harvested rainwater, which includes filtration and/or ozone or UV disinfection, is necessary if rainwater is to be used as a potable water source.

Storage tanks or reservoirs

The storage reservoir is usually the most expensive part of the rainwater harvesting system such that a careful design and construction is needed. The reservoir must be constructed in such a way that it is durable and watertight and the collected water does not become contaminated.

All rainwater tank designs should include as a minimum requirement:

- a solid secure cover - a coarse inlet filter

- an overflow pipe - a manhole, sump, and drain to facilitate cleaning - an extraction system that does not contaminate the water, e.g. a tap or pump.

Storage reservoirs for domestic rainwater harvesting are classified in two categories:

1. surface or above-ground tanks, most common for roof collection, and

2. sub-surface or underground tanks, common for ground catchment systems.

Materials and design for the walls of sub-surface tanks or cisterns must be able to resist the soil and soil water pressures from outside when the tank is empty. Tree roots can also damage the structure below ground.

The size of the storage tank needed for a particular application is mainly determined by the amount of water available for storage (a function of roof size and local average rainfall), the amount of water likely to be used (a function of occupancy and use purpose) and the projected length of time without rain (drought period).

First flush and filter screens

The first rain drains the dust, bird droppings, leaves, etc. which are found on the roof surface. To prevent these pollutants from entering the storage tank, the first rainwater containing the debris should be diverted or flushed. Automatic devices that prevent the first 20-25 litres of runoff from being collected in the storage tank are recommended.

Screens to retain larger debris such as leaves can be installed in the down-pipe or at the tank inlet. The same applies to the collection of rain runoff from a hard ground surface. In this case, simple gravel-sand filters can be installed at the entrance of the storage tank to filter the first rain.

Rainwater harvesting efficiency

The efficiency of rainwater harvesting depends on the materials used, design and construction, maintenance and the total amount of rainfall. A commonly used efficiency figure, runoff coefficient, which is the percentage of precipitation that appears as runoff, is 0.8.

For comparison, if cement tiles are used as a roofing material, the year-round roof runoff coefficient is about 75%, whereas clay tiles collect usually less than 50% depending on the harvesting technology. Plastic and metal sheets are best with an efficiency of 80-90%.

For effective operation of a rainwater harvesting system, a well designed and carefully constructed gutter system is also crucial. 90% or more of the rainwater collected on the roof will be drained to the storage tank if the gutter and down-pipe system is properly fitted and maintained. Common materials for gutters and down-pipes are metal and plastic, but also cement-based products, bamboo and wood can be used.

2.7 PHASES OF CONSTRUCTION

2.7.1 Site Selection

Site for constructing RWH system should be at lease 3 meters away from the foundation of the main building. RWH cistern should not be constructed beside huge tree as the roots of the tree will crack the cistern. Besides, birds and animals nesting on the tress will also be a cause of pollution.

2.7.2 Construction Material

BSP-Nepal as always is very conscious regarding quality and has always insisted and encouraged its partners and stakeholders to conduct good quality work. Since, it strongly gives higher priority on good quality rather than investment in new structures. Therefore, if the construction materials that are to be used in the RWH cistern such as cement, sand, aggregate, etc are not of good quality, the quality of RWH cistern will be poor even if the design and workmanship involved are excellent. In order to select these materials of best quality, their brief description regarding the specifications has been given hereunder.

2.7.2.1 Quality Of Stone

If stones are to be used for constructing the RWH cistern, they have to be clean, strong and of good quality. Stones should be washed if they are dirty. One should always avoid using round shape boulders due to their stability. Therefore it should be broken in to halve to expose clean surface for strength of bonding.

2.7.2.2 Quality Of Cement

The cement to be used for the construction of RWH cistern has to be of high quality Portland cement for a brand with a good reputation. It must be fresh, without lumps and must be stored in a dry place. Bags of cement should never be staked directly on the floor or against the wall. One should always place wooden planks on the floor to protect cement from dampness.

2.7.2.3 Quality Of Sand

Sand for the construction of RWH cistern must be clean. Dirty sand has a very negative effect on the strength of the structure. If the sand contains 3% or more impurities, it must be washed. The quality of impurities especially the mud in the sand can be determined by a simple bottle test. For this test, small quantity of sand is put in the bottle. After this, water is poured in and is stirred or shacked vigorously. The bottle is than placed stationary so it settles down. The particles of sand are heavier than that of mud so it settles down quickly. After about 20 – 25 minutes, the layer of the mud verses sand inside the bottle is measured. Course and granular sand can be used for concreting work but fine sand will be better for plasterwork.

2.7.2.4 Quality Of Water

Water is mainly used for preparing the mortar for masonry work, concreting, and plastering. It is also used to wash stones before using them. Beside these, water is also used for washing sand and aggregate. It is advised not to use water from pounds and irrigation canals for these purposes, as it is usually too dirty.

2.7.2.5 Quality Of Aggregate

Gravel should not be too big or very small. It should not be bigger than 25% of the thickness of the concert product where it is used in. As the slabs and the top of the dome are not more than 3" thick, gravel should not be bigger than 0.75" (2 cm) in size. Furthermore, the gravel must be clean. If it is dirty, it should be washed with clean water.

2.8 OPERATION AND MAINTENANCE

The following maintenance work is required in the operation of this technology:

- Regular cleaning of the rooftops and gutters: Rainwater is generally considered to be free of contamination, and, hence, it requires no treatment. Nevertheless, the roofs and gutters should be cleaned regularly to remove particulates and accumulated materials. Rainwater of the first few hours of the beginning of rainy season should not be collected in the tank, but should be used for flushing the roofs and gutters. Asbestos cement sheets and metal sheet roofing coated with lead-based paints should be avoided as they may be dangerous to health.

- Frequent cleaning of the storage tanks: The storage tank is the most expensive part of any rain water catchment system and determining the most appropriate capacity for any given locality and catchment area will critically affect both its cost and the amount of water available for supply. To ensure the longevity of the tank and quality of the water supply, regular cleaning of the tank should be carried out.

- Inspection of gutters and feeder pipes and valve chambers to detect and repair leaks: Rooftops are commonly used as catchments, even though ground catchments can provide a larger catchment areas, yield a greater volume of water to be collected, and are cheaper to construct. However, the use of ground catchments competes with agriculture for available land. Hence, in Nepal, both flat roofs, with tiles or plastered concrete leading to a floor drain, and sloped roofs are used. Sloped roofs are preferred to flat roofs because sloped roofs are accessible only for cleaning and repair purposes, and the harvested rainwater has less chance of being contaminated. Regular inspection of the drainage systems and conveyance systems minimizes water loss.

However, because this technology can be constructed and maintained locally, the Nepalese projects have been handed over to the users committees which bear the overall responsibilities for operation and maintenance of the systems. Such works as may be beyond the capacities and means of the users committees are carried out by the District Water Supply Offices.

2.9 COMPUTATION OF ARTIFICIAL RECHARGE FROM ROOF TOP RAINWATER COLLECTION

Factors taken for computation:

Roof top area 100 sq.m. for individual house and 500 sq.m. for multi-storied building.

Average annual monsoon rainfall - 780 mm.

Effective annual rainfall contributing to recharge 70% - 550 mm.

	Individual Houses	Multistoried building
Roof top area	100 sq. m.	500 sq. m.
Total quantity available forrecharge per annum	55 cu. m	275 cu. m.
Water available for 5 member Family	100 days	500 ys

Chapter 3
RESEARCH METHODOLOGY

It contains research design, study area, sampling procedure and nature of data, sources of data collection, data collection tools and techniques, tools of data and organization of study.

3.1 RESEARCH DESIGN

This study is held on descriptive as well as exploratory research design, which is considered an appropriate and best way for the analysis of this type of research work. It is descriptive because it has described the community's people's background, level of education, occupation, way of living, etc. As well as it is exploratory research because it had attempted to investigate the impact of rainwater harvesting in the life of people who are using it.

3.2 NATURE AND SOURCES OF DATA

Both qualitative and quantitative data is used in this study. This study is mainly based on primary data. All the primary data is collected by field visit, observation and interview. Secondary data is based on different published and unpublished books, booklet and journals related to Government, Nongovernmental and Local Agencies, etc.

3.3 STUDY AREA

Kanyam falls in the mountainous region located in Mechi Zone, Ilam District in eastern Development Region. This district mainly contains subtropical, temperate and alpine forest with 2500 to 3000 mm of rainfall a year, and mostly during the monsoon season in the summer and its hilly northern area receives more rainfall than the south. District has cold climate and snowfall is also accounted in winter. Tea farming is the main occupation of the people in this district. (Meto. Station Ilam).

There are 32 RWH systems in Kanyam 4, Sirantole for domestic purpose, and two systems in Kanyam 5 and 8 in school for institutional purpose respectively of 6m3 Ferro cement jar and 20m3 Ferro cement tank. In these areas, it is promoted and implemented by NEWAH. The system for household purpose was constructed in 2010 and for institution in 2009. The construction of the RWH systems in Kanyam 4, were completed in November.

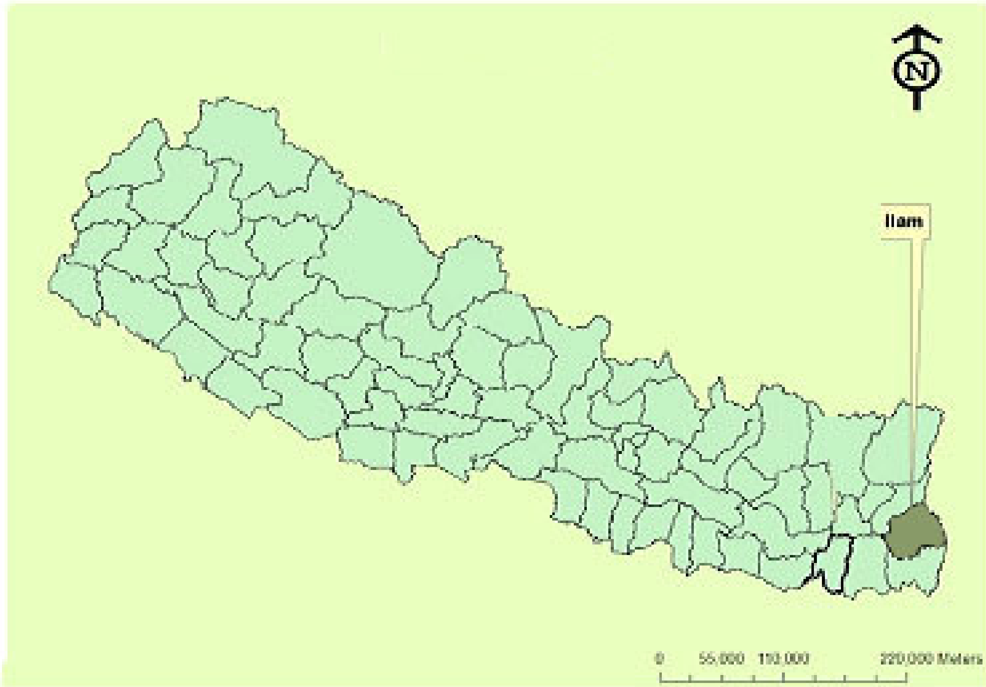


Figure 2: Study Area

3.4 SAMPLING PROCEDURE

In any research study, it is not possible to include all the people of targeted area so everyone use sample for their study. Therefore, in my study also very limited number of people was chosen as sample.

The survey was designed to draw samples of rural households' and institutional information from Kanyam vdc, Ilam in order to represent the total system installed in the area. The survey of HHs was taken in ward no. 4 of Kanyam. And for the Institutional system survey, ward no.5 and 8 were chosen.

The study was conducted through field visit to visit the implemented sites and to observe the condition of RWH systems as well as to interact with the owners and community people on the working of installed systems including the technology. Informal interaction with the stakeholders was carried out. The sample for the study was limited to 15 RWH systems. Because of time and resource limitation all 35 RWH systems were not possible to visit. In terms of percentage aforesaid sample number of RWH systems comes to 43%. The capacity of RWH storage tanks of household type did not exceed 6,500 liters while it is more than 15,000 liter in the case of institutional type.

The sampling has also tried to include the communities of different ethnic groups for example: Brahman, Chettri, Rai, and Dalit. The total number of the surveyed households was in Kanyam 4 and 2 for institutional survey in Kanyam 5 and Kanyam 8. Effort has been made to make the diversity while selecting the respondents in the districts regarding the income generation activities. Similarly, the survey has tried to cover the joint family house and nuclear family household of the community with the respective judgment of the surveyor at the field level. This stratification sampling process is used for selection of different ethnic group within the sample HHs.

3.5 DATA COLLECTION TOOLS AND TECHNIQUES

Different method and tools are used to collect the required information. For collecting the primary or fresh, first hand data, field visit, unstructured interviews, observation and the structured questionnaire, focus group discussion activities are applied. The source of data collection is as follows:

3.5.1 Field visit and observation

In field visit, each and every household which is selected for the sample were visited, and in the field visit activities researcher had closely observe all the hidden and silent feature of the study area. The situations of the health consciousness of the respondent were closely observed.

3.5.2 Unstructured interview

To know more about the field side researcher had asked various unstructured questions to the respondent. In this method researcher herself actively asked question to the respondent. The cultural behavior, social system, way of living, their norms values and the other strategies of the community can be well analyzed through this method.

3.5.3 Questionnaire survey

Questionnaire survey is more reliable source of data from which every research can get one frame to predict its view. So, one structured question was developed to get realistic and accurate data from the household survey. Respondent of the study area is not well educated so very simple and clear question was prepared. With the help of that prepared questionnaire researcher had developed all data or the information which need for the study.

3.5.4 Focus group discussion

Focus group discussions were conducted in the village. Local people, teachers, and the user of rainwater harvesting and the non user including both sexes who is selected as the sample was actively take part in focus group discussions. In focus group discussion they had discuss about the possibility and probability of the rainwater harvesting

3.6 TOOLS OF DATA ANALYSIS AND INTERPRETATION

The survey included both qualitative and quantitative data collection tools. A set of structured questionnaire as in Annex II and III respectively for Water Impact Assessment in case of Household and Institution has been developed in order to get the detailed information from the inhabitants. Household level questionnaire included sections on household demographics, education, living conditions, asset ownership, access to water and sanitation, agricultural production, livelihoods, income and expenditures, use, availability and quality of water of different sources, knowledge and level of satisfaction with RWH system, consumption pattern of harvested water as well as water from other sources mostly for drinking, cooking, washing/cleaning, kitchen gardening and biogas and other relative information.

To get site specific information general observations of RWH system, water withdrawing system condition of washout and catchment, sanitary situation of surrounding HH of each given sampled systems was also done in these areas. GPS reading was used to get data on elevation and location of the system. Physical measurement of the catchment area was also taken.

For clear comprehensive and systemic presentation and analysis of the data collection through different instrument both descriptive and as well as analytical method has been used in the study. The analytical part is largely qualitative in nature like family structure, age, sex, composition, size and structure of household, and decision making etc. so qualitative data are analyzed with the help of simple statistical tools such as tables and percentage method. After completing data collection activities, it has been comprehensively scrutinized for its relevancy. Raw data have been edited first. Thereafter, data's errors have been removed. At last data have been coded and classified into descriptive and numerical characters, and then computing them, finally meaningfully conclusion has been achieved.

Chapter 4

ANALYSIS & DISCUSSION

4.1 PHYSICAL

The types of the roof of the sampled HH were CGI sheet, which were placed by owner during construction period of house. This signifies the roofs are old and they are corroded. The water drained from such roofs is not safe for drinking purpose. Therefore, it requires periodic testing of water.

Figure 3: Rusted catchment area

4.1.1 Building Types And Roofing

4.1.1.1 Catchments Area

There are no any overhanging branches present near the catchment area of Shree Panchakanya Primary School, Shree Krishana Ashram Higher Sec. School. But in case of the household systems 25 % of the total samples, the catchment areas were near the overhanging branches.

Beside this, all the catchment area was full of dust. According to the survey, the catchment area for domestic purpose varies from 7 - 29 m2 and the catchment area in the institution is 222 m2 in Kanyam 5 and 157 m2 in Kanyam 8

4.1.1.2 GUTTER SYSTEM

HDPE pipe is used for gutter system. There were no any kind of debris in it and it was in U shape with cap at one side. In Kanyam 4, 23% of the total samples were not provided with gutter system, which are shown in photo no. 5, 7, 8 and10 of Ilam District. Also, the gutter system alignment was improper in Kanyam 4 Netra Bdr.Khadkas'house.

4.1.1.3 FIRST FLUSH

It is the important part of the system to maintain the hygiene and cleanliness of water. This survey shows 18% people are unaware of this system. It is installed only in 77% of existing system. In Kanyam 4, Kedar Poudel and Santosh Vujel's first flush system wash partially covered with mud.

4.1.1.4 Washout

Its main purpose is to remove water from the tank. There was a leakage problem in washout of about 18% of the system.

4.1.1.5 Water Withdraws System

For every system the water withdrawing mechanism was tap. All the HHs height varied from 4.5-8 cm from bottom of tank. This height is supposed to be above 5 cm. from bottom of the tank. The tank of Primary School is partially underground but the height between tap and washout is 36 cm. Tank of Higher Secondary School the tank is in higher elevation and water withdraw system is in lower elevation. So, the height measurement from bottom of tank to tap was difficult. But the water supply pipe and washout pipe is connected in same level.

4.1.1.6 Filtration System

In case of domestic purpose screening is used for filtration and only 15% of household has the screening system. And in institutional purpose slow sand filter is used for filtration of Rain water.

Parameters	Gutter system	First flush	Wash out	Water with draw system	Filtration
Existing	16	15	20	20	6
Not-Existing	4	5	-	-	14
Good Condition	16	15	15	20	6
Bad condition	-	-	5	-	-

Table 3: Filtration System

4.1.2 RWH TANKS: Capacity and Existing Condition:

4.1.2.1 Position Of Tank

In Ilam all the HHs are above the ground and institutional systems are partially underground. In Kanyam 4, it was found that 2 3 jar of HHs were taller than the height of the house.

4.1.2.2 Ferro-Cement Jars

The jar capacity of each household was 6m³. Nowadays almost all the users of a Kanyam 4 are using the jar for collecting the tap water of their own house. Dharan 17 is storing the rainwater in the jar which they are preserving for the use in dry seasons. There were a leakage problem through storage tank and washout in case of the HHs. And, it is represented by fig.3 below.

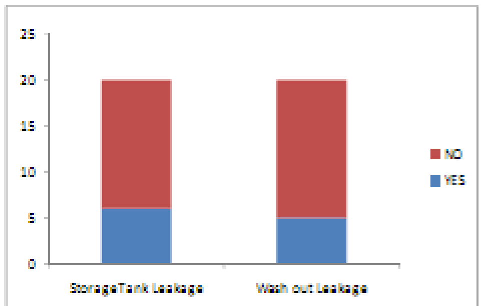


Figure 4: Existing Leakage in Tank and Washout of HHs sample

This above fig. shows that out of total HHs, there is leakage problem in 6 storage tanks and 5 washouts. Except this, according to villagers of Kanyam 4, there is problem of seepage in jars, constructed in second batch. The users or any other organization does not address these problems.

4.1.2.3 Ferro Cement Tank: Institutional System

Each tank is of 20 m3. There were 5 sample tanks in Kanyam for institutional purposes which are in well condition without any leakage, seepage and cracks.

4.1.3 RWH Tanks: Repair & maintenance

As the system has not been more than a year old, there is no any necessity of repair and maintenance. But in most of the systems, there was leakage of water through washout. According to users, they consult with the local technician if they face any problem and then also inform the implementing organization (NEWAH). The fig. below represents the user's opinion poll for the repair and maintenance cost of system. This show, 41% of users are unaware about the cost of repair and maintenance.

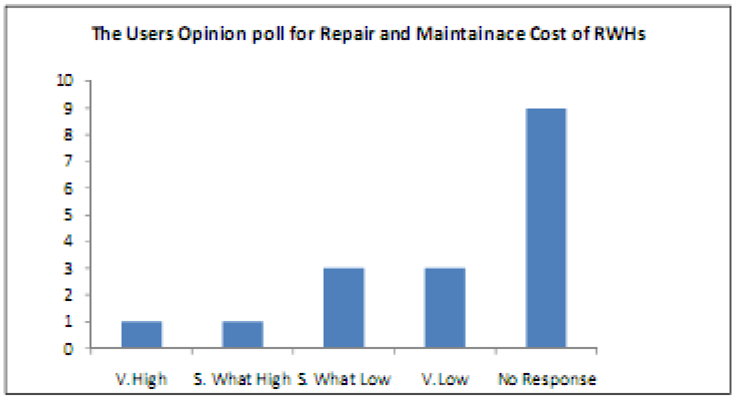


Figure 5: Opinion poll for repair and maintainace cost

It also came into notice that 8 out of 20 HHs had not received any kind of training regarding the RWHs. The remaining 12 were provided with only general instructions which included information regarding the use of first flush system and coating of the catchment by corrosion resistance paint.

NEWAH has also handed a user manual to each HH and institution prepared by BSP Nepal/RHCC regarding general information about the RWH system. But unfortunately some of beneficiaries have misplaced or lost the user manual.

4.2 SOCIO ECONOMIC CONDITION

The time saved is utilized for childcare, household cleaning, more attention to kitchen work, farming, other IG activities and social work.

There is visible impact upon social condition in the sense that majority of households themselves have experienced positive changes in social behaviors. About 60 percent households had expressed that it has increased closeness among family members, 35 percent felt that it has increase closeness among their neighbors. Likewise, about 28 percent households are of the opinion that it has increased various kinds of social works. In respect of promoting involvement of saving credit activities, merely 6 percent household said that the program has contributed. There was virtually made no comment it has decreased closeness and cooperation among family members and neighbors, which is quite encouraging.

The RWHS has assisted to promote economic activities and income growth. The use of harvested water in economic activities ranges from 5% to 60%. The average is 17 percent. The increase in income after the installation of the systems varied from 5 % to 30%. The average income growth however seems to be 11%.

Figure 6: View of RWH jar along with Toilet attached Biogas Plant

4.3 SANITARY CONDITION

From the graph below, the proper toilet installed in sampled Household is before the construction of RWH System which is higher as compared to others. But from users interaction it was found that the users had problems of mosquito breeding due to kitchen garden, improper sanitation and destruction of structure, due to plantation, human and animal accessibility near the system. According to the interaction with users some of the HH were not in situation to construct toilet due to unavailability of space and financial problem.

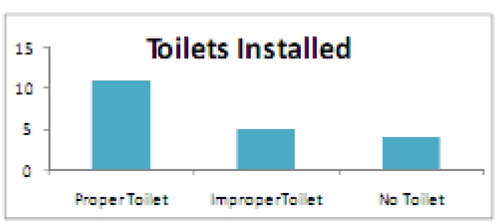


Figure 7: Existing Toilet Condition

4.4 WATER SITUATION

4.4.1 Water Dependency upon other Sources

During dry periods before construction of RWH system people were totally dependent upon other sources like nearest river and tap water supply which is nearly 1 2 km away from the HH. The source water used by the household are for drinking, cooking, washing /cleaning, cattle rearing /livestock, kitchen gardening and others (sanitation and farm). The pie chart of water utilization by the sample HH depicts that people haven't consumed rainwater for drinking purpose because they do not trust on its quality. And the water from the source they drink is by without treatment during summer and by boiling in winter.

Figure 8: RWH jar at Kanyam, Ilam

In case of institution, water from the source is used for drinking, preparing tea and is used in toilet as well. Due to outside contamination in the RWH tank the water is currently used only for cleaning and construction purpose.

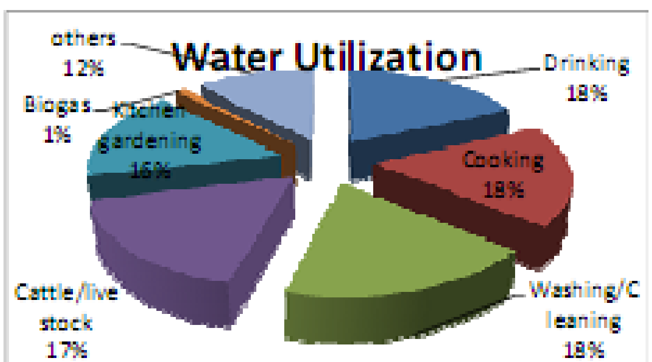


Figure 9: Different Utilization of RWH

4.4.2 Water Fetching Time

The availability of water from source I (nearest community tap) is throughout the year but during dry periods it is insufficient. The total time required for water collection is 15 30 minute if they don't have to wait for their turns otherwise it takes 1 2 hours .The frequency of water collection in a day ranges from 2 4 trips. With RWH installation they are now saving 2 5 hrs time during dry periods by RWHs. The fig.4 below shows women are mainly responsible for water collection as compared to men. The graph below also shows the benefitted populace from the RWH system in sampled area.

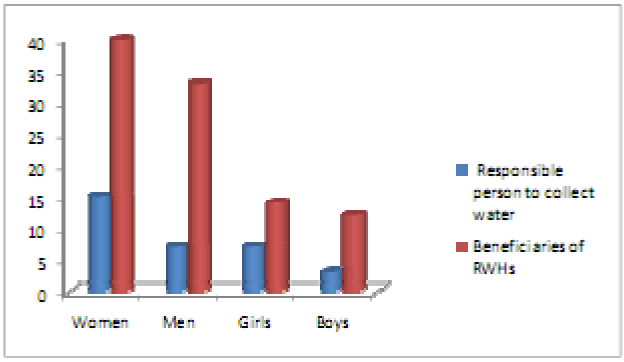


Figure 10: Responsible person to collect water in total Beneficiaries of RWHs in HHs

4.4.3 Water Demand

The daily water requirement for domestic purpose ranges from 100 300 liters. The daily water consuming activities include drinking, cooking and cattle rearing.

4.4.4 Water Quality

Both source and rain water is not safe for drinking purpose. Since, the water from the source I is tap, whose main source is river which may be polluted.

4.5 USERS PERSPECTIVE

The beneficiaries are fully satisfied in both jar and tank type of the system. 32% of consumers did not like this system before but now, they would like to recommend this type of system to other household/villagers and institutions too. In the view of users, their contribution for construction of plant is very low as compared to total construction cost of the supporting organization NEWAH. Almost all the users were motivated to build the RWH due to insufficient water supply and an opportunity for water storage near the house. The benefited parameters such as time saved in fetching water, children education, better hygienic condition (personal, latrine, house), availability of water for livelihood enhancement, less accidents, hazards in collecting water, improved diet, less quarrelling for scarce source of water in important view of users is shown in fig. below.

Figure 11:View of RWH System

4.6 PROBLEMS AND DISSCUSSION

For consumers, in the 1^{st} post rainy season and the rain water stored in tank will be used in coming dry period. The system such as gutter, water withdrawal system, screening, first flush and most of the structure is in good condition, because the construction was completed only 7 months before the monitoring visit. The catchment area of each household needs to be painted to avoid rusting of CGI sheet.

With the fact that the system is completed only before 3 months and some systems are still under construction, coming monsoon will be 1st rainy season for consumers of kanyam 4, due to delay of completion of structure, they could not store rainwater of previous monsoon season. But, the jars which had been completed are used for storing tap water to avoid cracking of the jars.

In case of institutional tanks at Kanyam 5, this is the first post rainy season, but due to leakage of water from joint on overflow pipe, the tank was emptied for its repair. As the tank was repaired after rainy season, during the visit it was empty.

Since the filtration chamber was easily accessible to children, this may contaminate collected water. So, it is recommended to fence around the chamber.

In Kanyam 8, the collected rainwater is being used for construction of new school building and the tank could not be cleaned before the end of monsoon. So they are not using the water for drinking purpose.

Chapter 5
CONLUSION AND RECOMENDATION

A large number of RWH methods are available in literature. However each method is site specific and demand specific. The RWH system depends on the topography, land use pattern, rainfall, demand pattern and economic status of the stake holder. Each structure requires detailed analysis of hydrology (rainfall and demand), to pography and other aspects. The present study is aimed at providing best techno-economic RWH structure so as to minimize or eliminate the dependency of the industry on purchased water. With the available data the first step is to find the volume of water need to be stored.

5.1 CONCLUSION

Rainwater harvesting activities are very much alive in some countries, being revived in others while in some it is a thing of the past with less or no appropriate documentation. For countries with success stories, they could be attributed to certain uniform practices and these could be the spring board to the success of this exercise

- Continued research and demonstration on materials used and design aspects of RWH
- Institutional mandate, RWH must be somebody's responsibilities as opposed to independent initiatives as is the case.
- Public education,
- Operation and maintenance
- Economical analysis

5.2 RECOMMENDATIONS

• Along with the user manual, it's better to provide users with pamphlet on its operation and maintenance, which is more noticeable and understandable.

• It is better to take water quality test of Kanyam immediately after this monsoon in both household and institution.

• Skill of the local technician should be enhanced by providing more training to mason.

• The roof tops should be painted with corrosion resistant paints.

APPENDIX III

PHOTOGRAPHS

Gutter system

Catchment area with system

First flush

Water withdrawal system

Owner : Maya Rai

Gutter system

Catchment area and structure

Dristrict : Illam,Kanyam-5 (Shree Panchakanya Pra.Bhi. Vidhyalaya)
No. of tanks = 2



Rain water harvesting system


Withdraw system


First flush

Kanyam-8 (Shree Krishana Ashram Higher Secondary School and locally known as kanyam school)
No. of tanks = 3



Rain water Harvesting system


Filtration Chamber


First fush

LETTER OF RECOMMENDATION

LETTER OF APPROVAL

ACKNOWLEDGEMENT

ABSTRACT

LIST OF ABBREVIATION

LIST OF FIGURES AND TABLES

Contents

Chapter 1 1
INTRODUCTION 1
1.1 BACKGROUND 1
1.1.1 The World Water Crisis 2
1.2 INTRODUCTION 3
1.2.1 The Role Of RWH In Rural Development 4
1.3 STATEMENT OF THE PROBLEM 4
1.4 OBJECTIVES OF THE STUDY 5
1.5 RATIONAL OF THE STUDY 6
1.6 ORGANIZATION OF THE STUDY 6
Chapter 2 7
LITERATURE REVIEW 7
2.1 NEPAL WATER SCENARIO 7
2.1.1 Water Demand, Supply System And Scarcity In Nepal 7
2.1.2 Historical Development Of Rainwater Harvesting And Utilisation 8
2.2 AN OVERVIEW ON RAINWATER HARVESTING 10
2.2.1 Why Rainwater Harvesting? 11
2.2.2 Application Areas 12
2.2.3 Criteria For Selection Of Rainwater Harvesting Technologies 12
2.3 APPROACHES ON RAINWATER HARVESTING 13
2.3.1 Historical Development of Rainwater Harvesting In Nepal Scenario 14
2.3.2 Status Of Rainwater Harvesting In Nepal 15
2.4 GOVERNMENT POLICY 16
2.5 RAIN WATER HARVESTING TECHNIQUES: 17
2.6 COMPONENTS OF A ROOFTOP RAINWATER HARVESTING SYSTEM 18
2.6.1 A collection or catchment system 19
2.6.2 A conveyance system 20
2.6.3 Storage tank 20
2.6.4 Delivery system 21
2.7 PHASES OF CONSTRUCTION 22

2.7.1 Site Selection 22
2.7.2 Construction Material 22
2.8 OPERATION AND MAINTENANCE 24
2.9 COMPUTATION OF ARTIFICIAL RECHARGE FROM ROOF TOP RAINWATER COLLECTION 25
Chapter 3 26
RESEARCH METHODOLOGY 26
3.1 RESEARCH DESIGN 26
3.2 NATURE AND SOURCES OF DATA 26
3.3 STUDY AREA 26
3.4 SAMPLING PROCEDURE....................27
3.5 DATA COLLECTION TOOLS AND TECHNIQUES 28
3.5.1 Field visit and observation 28
3.5.2 Unstructured interview 28
3.5.3 Questionnaire survey 28
3.5.4 Focus group discussion 29
3.6 TOOLS OF DATA ANALYSIS AND INTERPRETATION....................29
Chapter 4 31
ANALYSIS & DISCUSSION 31
4.1 PHYSICAL 31
4.1.1 Building Types And Roofing 31
4.1.2 RWH TANKS: Capacity and Existing Condition:....................32
4.1.3 RWH Tanks: Repair & maintenance 33
4.2 SOCIO ECONOMIC CONDITION 34
4.3 SANITARY CONDITION 35
4.4 WATER SITUATION 36
4.4.1 Water Dependency upon other Sources 36
4.4.2 Water Fetching Time 36
4.4.3 Water Demand 37
4.4.4 Water Quality....................37
4.5 USERS PERSPECTIVE 37
4.6 PROBLEMS AND DISSCUSSION 38
Chapter 5 39
CONLUSION AND RECOMENDATION....................39
5.1 CONCLUSION 39
5.2 RECOMMENDATIONS....................39

References
Appendix I ………………………………..Questionaire for HH
Appendix II………………………………Questionaire for Institutional
Appendix II………………………………...…………Photographs

LIST OF FIGURES

Figure 1: Ferro Cement Tank For RWH......15
Figure 2: Study Area......27
Figure 3: Rusted catchment area......31
Figure 4: Existing Leakage in Tank and Washout of HHs sample......33
Figure 5: Opinion poll for repair and maintainace cost......34
Figure 6: View of RWH jar along with Toilet attached Biogas Plant......35
Figure 7: Existing Toilet Condition......35
Figure 8: RWH jar at Kanyam, Ilam......36
Figure 9: Different Utilization of RWH......36
Figure 10: Responsible person to collect water in total Beneficiaries of RWHs in HHs......37
Figure 11:View of RWH System......38

LIST OF TABLES

Table 1: Selected RWH Systems by Implementing NGO Partners & Ownership Types of RWH systems, 2011......16
Table 2: Sketch identifying different components of the system......19
Table 3: Filtration System......32