



NEPAL  
WATER  
FOR  
HEALTH

# Rain Water Harvesting

Through NEWAH's Diaries  
May 2012

## Foreword

Nepal Water for Health (NEWAH) is an organisation dedicated to serving people without access to safe drinking water and improved toilets, including promoting good hygiene behaviour in rural communities of Nepal. NEWAH is also committed to contributing towards the National target set by the Government of Nepal in achieving 100% access to drinking water and sanitation by 2017. In Nepal, coverage of drinking water is claimed to be 80%, however the quality of water available and the functionality status can be questioned and there are still many communities settled in the ridgeline and remote areas that are hard to reach. Each year the country is losing a large number of children due to water-borne diseases like diarrhoea, dysentery, typhoid, pneumonia, etc.

Since the very beginning, NEWAH has been open and adaptive to change in technology and approaches to suit community requirements and demand. Ensuring access to safe and qualitative water in communities where sources are far and downstream remains a focus of NEWAH to promote the rain water harvesting (RWH) technology projects supported by various national and international donors.

This document is a reflection of NEWAH's achievement in promoting the RWH technology as well as the mechanisms followed in ensuring safe and qualitative water. I am sure that this will act as an informative document to help people understand more about NEWAH's works and contributions towards providing safe drinking water. Moreover, this is a living document and will be updated on a regular basis based on NEWAH's experiences, learning and changing requirements.

I would like to thank the community members in the project locations for their cooperation, belief, and hard-work for making the RWH programme successful. Also, my gratitude goes to the team of Eastern Regional Office, Central and Western Regional Office and Mid Western and Far Western Regional Office for providing regular updates and their tireless support to promote RWH in the neediest communities.

Lastly, I would like to acknowledge Santosh Basnet, Technical Development Division Manager and the Knowledge Management and Advocacy (KMA) team comprising of Ratan Budhathoki, KMA Manager; Anamika Singh Bhandary, Documentation and Communication Coordinator; and Anusha Airi, Communication and Documentation Assistant of NEWAH Headquarters for their effort in producing this document.

If you have any comments and feedback regarding this document, please feel free to send them at [newah@newah.org.np](mailto:newah@newah.org.np)

I wish you a happy reading.



**Umesh Pandey**  
**Director**

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**Front Cover Photo- NEWAH's Bhakunde Project. Photo by Suresh Pun, Forum for Social Welfare, Baglung**

## Executive Summary

This document takes the reader through a background of the initiation of rain water system in Nepal and its' introduction in Nepal Water for Health (NEWAH) projects. It also talks about the advantages of the system in relation to the social, geographic as well as economic condition of the people residing in rural parts of Nepal.

Nepal as we know is a land-locked country with diverse topographies from the plains to the steep hills and the Himalayan range. Unlike in the plains, human habitat and population is dispersed in the hills and mountains. So, under these conditions, reaching out to each and every person living in the nooks and corners of the country with safe and clean water is a challenging task.

Generally Nepal receives precipitation for almost eight months in a year, except for four months of dry spell starting in March. Precipitation pattern as it shifts from the east to the west decreases with the increasing distance from the Bay of Bengal, which is the source of the summer monsoon in Nepal. Eastern Nepal annually gets about 2,500 mm (98.4 in) rainfall; the Kathmandu area about 1,400 mm (55.1 in) and western Nepal about 1,000 mm (39.4 in). Rain Water Harvesting (RWH) Projects are environmentally feasible in all parts of Nepal, except for the rain shadow area that lies beyond the high mountains like Manang, Mustang where annual precipitation drops as low as 160 mm (6.3 in), creating a cold semi-desert like conditions.

Apart from the feasibility aspect of RWH projects, the material requirements and technological components are other important aspects that require analysis and understanding. Hence, the three basic components such as roof (collection area), gutter or the carriage surface and lastly the reservoir tank have been detailed in this document. It also includes information about other crucial aspects like filters and wash-out.

Finally, the document summarises the challenges, risks, drawbacks and lessons learned, based on NEWAH's experience of implementing the RWH Projects for the past 13 years.

## 1. Introduction

Millions of people throughout the world do not have access to clean water for domestic purposes. In many parts of the world conventional piped water is either absent, unreliable, not suitable for the settlements at high ridges or too expensive. One of the biggest challenges of the 21st century is to overcome the growing water shortage.

With technological advancement, various proven methods have evolved for water collection and distribution through pipes for individual and collective communal systems. Along with more conventional water supply technologies, Rainwater harvesting (RWH) has become a valuable and viable alternative or supplementary source of water. Much of the actual or potential water shortages can be relieved if rainwater harvesting is practised more widely.

Rain water harvesting is not something new. Its' history can be traced as far back as to the ancient times, some 3,000 years ago to the 850 BC, if not even farther. People collect and store rainwater in buckets, tanks, ponds and wells, commonly referred to as rainwater harvesting. It has been practised for centuries. Thus collected water can be used for multiple purposes ranging from washing, cooking, drinking to irrigating crops and vegetables.

The rainfall pattern differs from place to place all around the world. Some areas receive large amounts of rain while some very limited. Whatever the reason maybe for such inconsistency, access to this source of water is never restricted no matter where we are. The quality of rain water as opposed to other sources of water makes it even worthwhile to use it for different household as well as business purposes.

### 1.1 Background

RWH is a simple low-cost technique that requires minimum specific expertise or knowledge. Collected rainwater can supplement other water sources when it becomes scarce or is of poor quality. It also acts as a good alternative at times of drought or when the water table drops and wells go dry.

The collected rainwater is a valuable supplement, which would otherwise be lost by surface run-off or evaporation. During the past decade, RWH has been actively reintroduced by government and local organisations as an option for increasing access to water in urban and rural areas. The RWH technology has rapidly gained popularity with users realising the benefits of a relatively clean, reliable and affordable water source at home. In many areas RWH has now been introduced as part of an integrated water supply system, where there is adequate precipitation throughout the year and where the town water supply is unreliable, or there is fluctuation in the regular supply i.e. it cannot meet the demand of the community.

But RWH can also be the sole water source for communities or households. The technology is flexible and adaptable to a very wide variety of conditions, also useful for richest and the poorest communities as well as driest and the wettest parts of the world. Utilisation of rainwater is now an option along with the more 'conventional' water supply technologies used particularly in the rural areas, but increasingly in urban areas as well. RWH has proven to be of great value for arid and semi-arid countries or regions, small coral and volcanic islands, and remote and scattered human settlements.

## Advantages

There are several advantages of RWH system such as:

- The construction materials are locally available and the system is easy to install and use.
- Ensures quality water so the people are less prone to or protected from many water-borne disease like diarrhoea, dysentery, typhoid, etc.
- Frees people from transporting water from far away sources, especially a problem faced by many people living in the ridged areas. This reduces drudgery, saves time that can be used in other opportunities.
- Reduces dependency on the other water sources supplied by government or private sector.
- Provides water security even during the dry season.
- Saves people their water tariff payments.
- Decreases water pollution and helps to conserve the water bodies like rivers, ground water, lakes.
- Water is not polluted with chemicals, which makes it easy for treatment.

## Disadvantages

No system can be as perfect as we wish them to be. When issues arise in the system, which could adversely affect the surrounding environment then it should be attended to immediately. Even the RWH that we consider ideal for areas where there is scarcity of water has few of its own disadvantages which are listed below:

- Limited supply due to uncertainty of rainfall.
- Not suitable for regions receiving scanty rainfall throughout the year.
- Comparatively costly, per-capita cost higher than the regular gravity flow system and ground water system in Nepal.
- Transportation of non-local materials is costlier due to the remoteness and lack of transportation facilities.



## 2. RWH in Nepal

Due to the pollution of both groundwater and surface water, and the overall increased demand for water resources owing to population growth, globally many communities are approaching the limits of their traditional water resources. Therefore they have resorted to alternative or 'new' resources like Rainwater harvesting. RWH has gained importance as a valuable alternative or supplementary source of water.

In Nepal, women and children are mainly the ones bearing the burden of fetching water from various sources. In the rainy season, the slippery steep hills make this task even more difficult for them, even to the extent of risking their lives. So, rainwater harvesting has proven to be of great relief to people living in the hilly areas of the country.

In the recent years collection of rainwater for domestic use has been promoted by various agencies in Nepal. The Department for Water Supply and Sewerage (DWSS) has produced some technical guidance



Conventional way to collect rain water in rural Nepal

on application and construction of rainwater systems. Several other sector agencies and NGO partners such as (RWSSP- Finnida, Helvetas, NEWAH, Rural Water Supply and Sanitation Fund Development Board (RWSSFDB), Biogas Support Programme (BSP) and the NGO Forum for Urban Water Supply and Sanitation) are known to be promoting RWH in the country. In the process of implementing RWH programmes in various parts of Nepal, experience and learning has helped to develop suitable technical, social and financial options for rainwater harvesting. It is estimated that over 11,000 systems at present are in use in the hill districts of Nepal<sup>1</sup>. A 2008 survey by Ministry of Physical Planning and Works (MPPW) and World Health Organisation (WHO) reports that around 78% of the users are satisfied with the service<sup>2</sup>. The survey report concludes that some 47,000 people are getting a satisfactory service out of rainwater harvesting system, often in water stress areas (uphill areas in Kaski, Tanahun, Doti districts).<sup>3</sup>

### 2.1 Potential for RWH in Nepal

Annual rainfall and climate broadly vary throughout the country mainly due to the contrast in altitude. Maximum annual records are registered in Kaski district with 5000 mm of precipitation and minimum in the Himalayan range with 250 mm of annual precipitation. Half of the country receives between 1,500 to 2,000 mm of precipitation. Average annual rainfall in the country is about 1600 mm. Rainfall concentration is highest in one rainy season, i.e. 79.6% of the annual precipitation falls in the Monsoon (June to September) while in Post-monsoon (October- November) it is 4.2%, Winter

<sup>1</sup> Status of Rain Water Harvesting in Nepal, May 2009

[http://www.moppw.gov.np/pdf/Status\\_of\\_RWH\\_in\\_Nepal.pdf](http://www.moppw.gov.np/pdf/Status_of_RWH_in_Nepal.pdf)

<sup>2</sup> Laia Domenech, MPPW & WHO-Nepal, November 2008

<sup>3</sup> Report on Status of Rain Water Harvesting in Nepal, May 2009

[http://www.moppw.gov.np/pdf/Status\\_of\\_RWH\\_in\\_Nepal.pdf](http://www.moppw.gov.np/pdf/Status_of_RWH_in_Nepal.pdf)

(December- February) it is 3.5% and the Pre-monsoon (March- May) season receives 12.7% of the total annual precipitation. Winter monsoon, which has a strong northeasterly flow, is marked by occasional, short rainfalls in the lowlands and plains and snowfalls in the high-altitude areas.<sup>4</sup> The following precipitation data represents the annual rainfall in Nepal from the eastern to far western regions.

S. N.	Station	Annual rainfall (mm)	S. N.	Station	Annual rainfall (mm)
1	Taplejung	1973	12	Palpa	1522
2	Jhapa,	2491	13	Musikot, Gulmi	1835
3	Dhankuta,	922	14	Mustang	260
4	Biratnagar	1773	15	Rukum	1419
5	Solukhumbu	2161	16	Dang	1755
6	Siraha	1374	17	Surkhet	1954
7	Dolkha	2135	18	Banke	1470
8	Kathmandu	1384	19	Jumla	799
9	Chitwan	1851	20	Bajhang	1497
10	Lamjung	3295	21	Dhangadhi	1690
11	Pokhara	3534			

Source: Climatological Records of Nepal (1990-2000)

Collection and use of rainwater from the roof depends on the amount of rainfall and its distribution over the months, effective roof area and storage built. For locality with certain roof area, users have the option to increase use by increasing the tank size.

### Social Acceptance

Using rainwater for drinking purpose may not be acceptable in some households. Nepalese traditional beliefs assert that still water or stored water is *basi* (stale/impure). People rather prefer to drink free flowing water because it is considered *chokho* (ritually pure). One of the other beliefs is that *chhanako pani* (water collected from the roofs) may not be safe to drink. Rainwater being accepted for drinking use does not depend only on individual perception. It is also influenced by the construct, culture and beliefs of communities or group of individuals. The social acceptance could vary from village to village. The acceptance also relies on the availability of other sources of water. When a source is nearby, people generally tend to collect water from the main source for drinking and cooking, while they use the rainwater collected to manage other water uses.

Now, RWH systems are emerging as solutions to people's water problems especially in the hilly rural communities and urban areas where the water stress is high. Water demand is increasing, water sources are depleting and population is inflating in villages. Houses are building and using toilets, personal hygiene activities such as bathing and washing is increasing so people are demanding more water and want their facilities nearby. As water use pattern is increasing, various awareness and education programmes in communities are helping people realise the benefit of RWH. The acceptance and use of the system is growing too.

<sup>4</sup> Nepal: Climate, [http://lcweb2.loc.gov/cgi-bin/query/r?frd/cstdy:@field\(DOCID+np0037\)](http://lcweb2.loc.gov/cgi-bin/query/r?frd/cstdy:@field(DOCID+np0037))



## 2.2 Government Policy on RWH

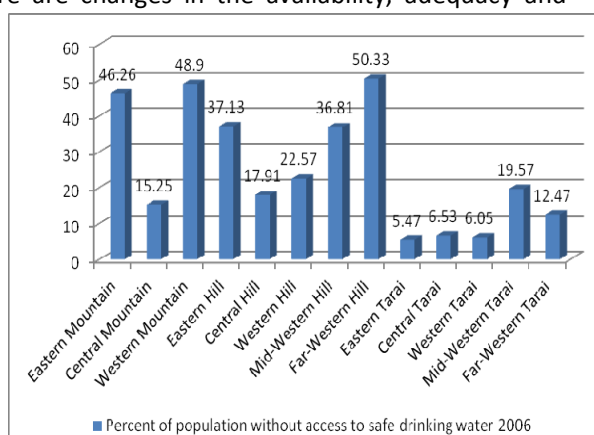
The Government of Nepal has set a target to provide an adequate basic supply of safe drinking water to all its citizens by 2017. And as provisioned by the government to promote RWH some *Working policies*<sup>5</sup> has been developed which are as follows:

- ☞ Mutual support and coordination shall be established with governmental and non-governmental agencies in relation to the development of technology for RWH
- ☞ Private-Public-Partnership (PPP) shall be promoted for the development and implementation of RWH
- ☞ Public awareness shall be enhanced vis-à-vis the collection, storage and use of rainwater, together with the development of appropriate methods for RWH at local level
- ☞ In order to promote the use of RWH technology in the construction of houses in urban and rural areas, institutional guidelines/ directives shall be prepared and enforced, and other necessary provisions shall be stipulated in the Building Codes. Special provisions shall be defined to use this technology in housing projects, buildings, apartments and land of development programmes as well in the construction of communal and industrial buildings
- ☞ This technology shall be utilised for groundwater recharge and to increase the water availability at water sources, stone spouts and ponds
- ☞ RWH technology shall be used to provide water to areas located on high lands/ communal places where there is scarcity of other water sources
- ☞ Use of arsenic-contaminated water shall be discouraged at institutional level by developing RWH technology
- ☞ A guideline shall be developed through the Department of Water Supply and Sewerage (DWSS) for the adoption of appropriate technology for rainwater collection, storage, treatment and utilisation at household and community level
- ☞ The capacity of NGOs, local bodies and communities shall be enhanced.

## 2.3 Safe water access in the Himalayan, Hilly and Tarai regions of Nepal

The climate and topographies of Nepal vary from the east to the west and the Tarai to the mountainous regions; that is the reason why there are changes in the availability, adequacy and access of water sources in the different regions. The Tarai region has access to ground water sources. In the hills people rely on spring sources and mountainous region people receive water from springs, streams and *Kuwas* (spring with fewer yields).

The graph depicts that the population living in the hilly and mountainous regions are the most vulnerable in terms of outreach to safe drinking water. In certain regions almost half the population have no access to drinking water. The bars showing highest percentage are the regions that are remote, poor and have difficult topographical setting, hard to reach, with scattered settlements and having labour-intensive



Graph depicting percentage of people without safe water access based on the three regions of Nepal

Source: NDHS 2006, NLSS 2003/04 and Nepal Human Development Report, 2009

<sup>5</sup> Working Policy, Page 14-15, Working Policy on Rainwater Harvesting, Government of Nepal, Ministry of Physical Planning and Works, Singha Durbar, Kathmandu, Nepal, Asadh 2066 (June 2009)

as well as extremely challenging water procurement practices. This is a challenge in achieving the national goal of achieving universal coverage.

### 3. NEWAH's initiation and approaches

In September 1998, NEWAH introduced the RWH technology for the first time to meet the high demand for water by the local women's committee in Tanahun district as part of the 'Production Credit for Women Group (PCWG)' programme. A Rain Water project was initiated at the *Mannu* Child Care Centre run by these women. The project implemented jointly by the Australian Rotary Club and NEWAH included training and rain water harvesting system construction with the technical assistance of Rotary Club Don Caster, Australia. The nine days training run by David Phillip and Terry of Australian Rotary Club from 10-19 July 1998 at the *Mannu* Child Care Centre trained 16 NEWAH technical staff comprising of Technical Supervisors and Sub-overseers. One female Sub-overseer was also involved in the training.

Subsequent to this, the Karikot Rainwater Harvesting project was implemented in Karikot VDC in Syangja district in two schools, Deurali Primary School and Janahit Secondary School in partnership with local partner organisation *Gaun Sewa Pariwar, Birgha* in the fiscal year 1999/2000. A 24 cubic metre volume ferro cement tank was constructed with 6 millimetres (mm) rod mesh in both these schools. However, the RWH plant installed at Janahit Secondary School was not brought into use for drinking purposes due to traditional belief about quality of roof-top collected water (locally known as *Chhana ko Pani*). It was just used for washing the legs and not even the hands. Hence in 2001/2002 a filtration unit divided into two compartments and filled with layers of sand, stone and charcoal was added to the old tank at Janahit School. Finally the system was brought into use for drinking purpose as well, serving 666 students including teachers. *For a comprehensive list of RWH projects completed by NEWAH please refer to section 3.5.*

#### 3.1 Geography targeted by NEWAH for RWH

NEWAH's water supply projects consist of gravity flow (GF) schemes in the hills and tube wells (TW) in the Tarai plains. However, where it is technologically difficult to reach the people living in ridged hills through the regular GF systems and where there are no reliable or sustainable water sources, RWH has come up as a viable and acceptable option. People from these areas solely rely on downstream river water, travelling more than an hour to fetch a pot of water each day to meet their daily needs. For such communities there are no other options, other than RWH.

NEWAH thus promotes RWH system for either domestic or institutional use where groundwater or surface water cannot be accessed by households and schools situated at an elevation that makes the supply of water within a reasonable distance impossible. In NEWAH's experience, rainwater collection has been helpful for those communities who would have otherwise had to rely on sources located far and farther down from their own communities.

#### 3.2 RWH project identification

The few things that are taken into consideration before selecting a project site to implement a RWH project are:

- If a natural spring source is not a reliable source of water to construct a gravity flow system. It neither meets the requirements of the community in both the rainy and dry season
- If the construction of gravity flow system infrastructure is way too expensive given the steep topography and difficult terrain

- If the source yield is not able to meet the demand requirements
- If construction materials/ skills to construct, operate and maintain the system is locally available

RWH is not a complete solution for household water demand, so NEWAH's first priority is to locate surface water sources like spring or stream to supply water through a gravity flow system in the hills. If the identified spring or a stream source yield is inadequate to meet household demand or if it is technically unfeasible to lift the water up to the village through gravity flow system, then RWH is considered as an alternative.

### 3.3 Technology in use

#### Roof and Tanks

The RWH system that NEWAH helps construct in the hilly and rural communities of Nepal collects rainwater from the roof (CGI sheet roof and RCC roof) either for household use or institutional use such as in schools. Ferro-cement jar or tanks ranging from 2,000 to 20,000 litre capacity are constructed at household level and in schools depending on the requirement. NEWAH also promotes flood water collection which is another RWH method especially for watering the cattle and small irrigation purpose like kitchen gardening and ground water recharge.

Although, various other types of tanks such as Ferro-cement tank, stone masonry tank, brick masonry tank, RCC tank and GI sheets tank are also used in practice for RWH in Nepal in both rural and urban settings, NEWAH constructs Ferro-cement jars because they are cheaper than other tank options in the rural areas (*refer to section 3.6 on cost estimation for more details*). NEWAH also has a RWH system installed at its headquarters in Kathmandu, which uses plastic tanks for water collection. This also serves the purpose of demonstration site for visitors.



**RWH technology installed at NEWAH HQ in the vehicle parking area**

#### Gutters and Inlet pipes

A Gutter (also known as "*Dund*" in Nepali) can be made by using materials such as High Density Polyethylene (HDPE) pipe, Polyvinyl Chloride (PVC) pipe, folded and moulded Galvanised Iron (GI) sheet in different shapes and sizes depending upon the catchment area. Locally available resources

like bamboo or wood can also be used sometimes as an alternative NEWAH uses HDPE pipe for gutter, first flush and delivery pipe from roof to tank in the rural areas. In urban areas NEWAH proposes the use of PVC and GI sheet for gutters, and PVC pipes and fittings for first flush and delivery pipes.

### First-Flushing

A first flush device is a valve or plug that ensures that runoff from the first spell of rain is flushed out and does not enter the system. This needs to be done since the first spell of rain carries a relatively larger amount of pollutants from the air and catchment surface.

### Washout and overflow

Washout system flushes sediments and other remnants from the base of the tank. Earlier, only washout was fitted in the tank but based on NEWAH's experiences necessity for overflow pipe was also felt so as to control the water level and remove the excess water. Now, both washout and overflow pipes are fitted in the system for household and institutional use.

### Water delivery tap

For the household use, a tap is directly connected to the tank and for school use a separate tap stand is constructed in an available space connecting it to the rain water collection jar. Some of the household also prefer a separate delivery tap than attached to the tank.

The suitability of Rain water harvesting is tested on the basis of available water sources during both the rainy and dry season. If the place gets enough supply of water through different sources even during the dry season then RWH is not recommend in those areas. But, if the place receives enough rain water and goes over a hard dry spell during dry season then, RWH can be the best alternative and a relief for the consumers.



## 3.4 Design and Calculations

### 3.4.1 Materials used

The lists of important materials in the RWH system are:

- Tor-steel,
- Corrugated Galvanised Iron (CGI),
- High Density Polyethylene (HDPE) pipes,
- Chicken wire mesh,
- Binding wire,
- Sand,
- Pebbles, and
- Cement.

Type of catchments	Coefficients
Roof catchments	
- Tiles	0.8 – 0.9
- corrugated metal sheet	0.7 – 0.9
Ground surface coverings	
- Concrete	0.6 – 0.8
- Plastic sheeting (gravel covered)	0.7 – 0.8
- Butyl rubber	0.8 – 0.9
- Brick pavement	0.5 – 0.6
Treated ground catchments	
- compacted and - Soil on slopes smoothed soil	0.3 – 0.5
- clay/cow dung threshing floor	0.5 – 0.6
- Silicone-treated soil	0.5 – 0.8
- Soil treated with sodium salts	0.4 – 0.7
- Soil treated with paraffin wax	0.6 – 0.9
Untreated ground catchments	
less than 10 per cent	0.0 – 0.3
- Rocky natural catchments	0.2 – 0.5

### Runoff Coefficients

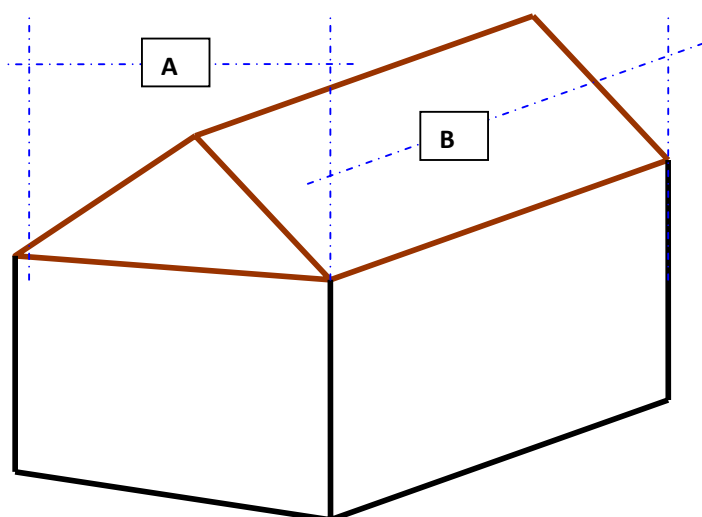
(Source: Rain water harvesting – Arnold Pacey & Adrian Cullis)

### 3.4.2 Major Calculations

#### ROOF AREA:

Following details are available:

1. Area of the catchments (A) = 100 square metres (any arbitrary number)
2. Average annual rainfall (R) = 611 mm (0.61m)
3. Runoff coefficient (C) = 0.85 litre. (calculate the maximum amount of rainfall that can be harvested from the rooftop)
4. Annual water harvesting potential =  $(100 \times 0.61 \times 0.85) = 51.85$  cubic metre (say 51,000 litres)



#### Calculation of Effective roof areas

Example for roof area calculation (A and B in meters)

To determine the effective area which allow for contribution factors i.e. horizontal span for slope + half the vertical rise between eaves and ridge \* gutter length. To calculate this in square meters:-

- 1) Measure A and B in meters.
- 2) Use  $A \times B$  = effective roof area in meters.



## GUTTERS:

Locally available material such as plain galvanized iron sheet can be folded to required shapes. Semi-circular gutters of HDPE material can be easily prepared by cutting those pipes into two equal semi circular channels.

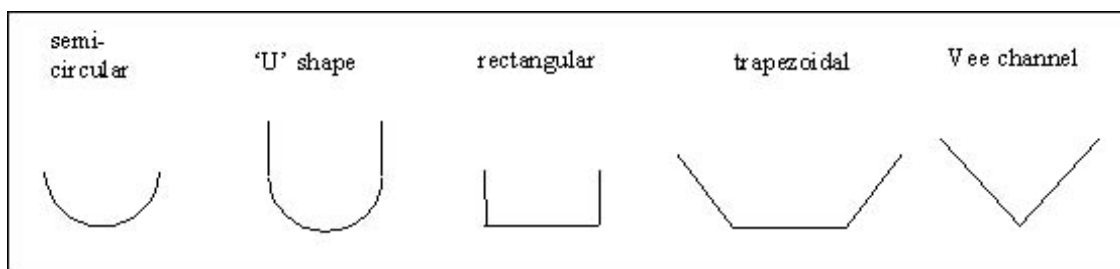
Gutters provide a channel to collect and transport rainwater to the storage tank. For cleaning purposes semi-circular and rectangular gutter is convenient than other shapes. Frequent cleaning of roof, gutter and tank is necessary in RWH system to maintain the quality of water.

NEWAH's general design objective is to find the cheapest guttering arrangement that will achieve an agreed level of performance (such as to collect 95% of annual roof run-off).



**Cutting HDPE pipe in semi-circular shapes for gutter**

### Gutter shapes



**Various shapes of Gutters can be used as per suitability**

## FILTERS:

The filter is used to remove suspended pollutants from rainwater over the roof. A filter unit is a chamber filled with filtering media such as fibre, coarse sand and gravel layers to remove debris and dirt from water before it enters the storage tank of recharge structure.

### Charcoal water filter

A simple charcoal filter can be made in a drum or an earthen pot. The filter is made of gravel, sand and charcoal, all of which are easily available locally. In addition to these, foams are also being used for sieving the impurities before entering into the storage tanks.

### Slow Sand Filter

Slow Sand Filter was the earlier type of filter introduced in 1829. Slow sand filter require large area of land and are costly to install especially in construction of filter chamber. This is expensive to operate due to the laborious method of bed cleaning by surface scraping. The effect of Slow Sand Filter is to remove turbidity and bacteria by biological action. Hence, the system cannot be used in removing colloidal turbidity effectively.

A Slow Sand Filter consists of:

- Enclosure Tank
- Filter units
- Filter Media
- Base Materials
- Under drainage system
- Washout or cleaning system
- Inlet/Outlet pipes and Valves

### **STORAGE TANK:**

#### **Determining the tank capacity**

This is based on the dry period in the whole year, i.e. the period between the two consecutive rainy seasons. For example, with a monsoon extending over four months, the dry season is of 245 days.

Calculating drinking water requirement for the family for the dry season =  $(245 \times 5 \times 10) = 12250$  litres.

*Taking, (245- Days dry season, 5- average no. of family per house, 10 litres for one person – it depends on rainy regions).* As a safety factor, the tank should be built 20% larger than required i.e. a 14,700 litre holding water tank constructed for a family of five is assumed to be sufficient for the dry period.

A typical size of rectangular tank constructed in the basement will be about  $(4 \times 4 \times 1)$  cubic metre.

#### **Construction of a storage tank**

The tanks are made using the simple steps which is as follows:

1. Suitable area near to the corrugated roofs is selected for tank construction.
2. Foundation is then set, which is usually made up of concrete that acts as a platform for the reservoir tank. Generally, the concrete is left to set over a period of 1-2 days.
3. The tank frame is made just like a cage with 24 cubic metre capacity using F-72 steel wire mesh and HDPE pipe. The wire mesh is spread in and out of the reinforcement bars.
4. Then, the frame is plastered with cement, sand and water mixture.
5. After complete plastering, the structure is left for 2-3 days to set and then the HDPE pipes are removed, followed by smooth plastering of the interior of the tank. Then the cover is fixed on the top for protection against dirt and dust.
6. The gutter pipes are fixed to the tank and thus, the reservoir tank is complete and ready for use.

*(Please refer to the photo diagram below for detailed process of construction)*



## A Complete / Whole RWH Jar (Tank) construction process



RWH tank foundation layout



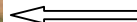
Stone soling in tank foundation



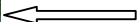
Concrete & reinforcement



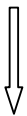
Completed foundation with washout and overflow pipes



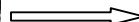
Sizing HDPE pipe for maintaining the proper size and shape of tank



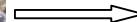
Installing round HDPE pipe and reinforcement, that gives the proper shape of tank



Fixing HDPE pipe as formwork



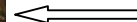
Fixing the chicken wire mesh over the formwork



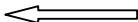
Plastering the tank



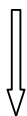
Completed Ferro-cement tank



Completed tank and pipe system



View of complete system



Using harvested rainwater at HH

### 3.5 RWH projects completed by NEWAH

The Rain Water Harvesting Projects done by NEWAH till date (2002-2011) with necessary information is listed in the table below:

S.N.	Project Name	Year	VDC	District	Total Beneficiaries		Total HHs	Water Points
					Community	Students		
1	Janahit Sec. School	2002	Birgha	Syangja	0	666	0	1
2	Dandagaun village	2003	Manpang	Tanahun	150		28	25
3	Shanti Udaya School	2003	Bharatpokhari	Kaski	0	516	0	1
4	Okhare Village	2003	Dandabazar	Dhankuta	151	69	29	28
5	Hanuman Tole Squatter	2002/03	Pokhara NP	Kaski	1009	0	211	1
6	Bidhay Nikunj School	2003/044	Mirlung	Tanahun	0	422	0	2
7	Mahendra School	2004/05		Kaski	0	463	0	1
8	Vokteni RWH	2006/07	Pancahawoti	Udayapur	114	0	22	19
9	Batase RWH	2006/07	Bhayaldanda	Udayapur	345	175	59	61
10	Dhaphkarka	2007/08	Saune	Udayapur	214	316	31	29
11	Chanaute	2007/08	Lekhani	Udayapur	192	0	27	48
12	Dwarsen RWH	2008/09	Melauli & Siddeshwor	Baitadi	369	56	54	55
13	Shree Krishnashram Higher Secondary	2010	Kanyam	Illam	1222	1222	0	1
14	Panchakanya School	2010	Kanyam	Illam	185	185	0	1
15	Thama	2010	Bhimgithe	Baglung	96	238	15	15
16	Chitram Jaisidada	2010	Bhimgithe	Baglung	108	269	17	17
17	Thum Dewaldhara WHS	2008/09	Devasthan	Baglung	338	0	50	40
18	Surkudi	2008/09	Bhimgithe	Baglung	315	162	50	44
19	Bhaterpata	2008/09	Urampokhara	Parbat	361	100	49	50
20	Bhakunde	2008/09	Bhakuride	Baglung	345	117	60	56
21	Payungurdum School	2008/09	Hosrangdi	Parbat	99	99	0	1
22	Chainpur	2008/09	Barbhanjyang	Tanahun	396	0	62	40
23	Saraswati School	2008/09	Barbhanjyang	Tanahun	292	292	0	1
24	Pipalthok	2008/09	Ghansikuwa	Tanahun	121	36	20	21
25	Sukla School	2010/11	Chhang	Tanahun	72	72	0	1
26	Adhikari Tole RWH	2010/11	Laxmipura	Illam	409	0	85	85
27	Saraswati School RWH	2010/11	Laxmipura	Illam	0	1227	0	1
28	Kanyam Healthpost RWH	2010/11	Laxmipura	Illam	0	100	0	1
29	Udaya Tole RWH	2010/11	Dharan Municipality	Sunsari	67	0	15	15
30	Murti Khundruke RWH	2010/11	Laxmipura	Illam	122	0	27	27
31	Siran Tole RWH	2010/11	Kanyam	Illam	144	0	32	32
32	Bhangtar Tole RWH	2010/11	Kanyam	Illam	99	0	19	19
33	School Tole RWH	2010/11	Kanyam	Illam	251	0	54	54
<b>Total</b>					<b>7586</b>	<b>6802</b>	<b>1016</b>	<b>793</b>

(Source: PMIS, NEWAH Headquarters, updated in November 2011)

As listed above in the tabular form, 33 projects have been completed through NEWAH's financial and technical assistance and funding support of various donor organisations in various parts of the country. The RWH projects have about 793 water points that have served a total of 1,016 households and a population of 7,586 community members and 6,802 school beneficiaries.

### 3.6 Cost Estimation

**Table 1: Approximate cost for the RWH project by NEWAH**

S.N.	Particulars	6500 litters Ferro-cement Jar /tank in NRs.			6500 litres Plastic tank in NRs.		
		Total Cost (Rs.)	Cost Contribution		Total Cost (Rs.)	Cost Contribution	
			Cash	Kind		Cash	Kind
1	Cost. Materials, Tools and Equipments	20120	20120	0	58500	58500	0
2	Cement	10500	10500	0	750	750	0
3	Local Materials	7146	5832	1314	1600	1000	600
4	Skill Labours & Roofing, Gutter	12875	7000	5875	12875	7000	5875
5	GI pipes	542.4	542.4	0	542.4	542.4	0
6	Brass Fittings	393.5	393.5	0	393.5	393.5	0
7	HDP Fitting	4390	4390	0	4390	4390	0
8	Fabricating	1707	1707	0	0	0	0
9	Transportation	4564	4564	0	4564	4564	0
10	Portage Local	0	0	0	0	0	0
11	Store Management	0	0	0	0	0	0
	<b>Sub-Total</b>	<b>62238.46</b>	<b>55049.46</b>	<b>7189</b>	<b>83614.9</b>	<b>77139.9</b>	<b>6475</b>
12	Contingency 2.5%	0	0	0	0	0	0
13	WSUC Management Cost ( 2% of Cash )	0	0	0	0	0	0
14	M & E Cost ( 2% of Cash )	0	0	0	0	0	0
15	Training Cost (2%)	0	0	0	0	0	0
16	Support Org. Cost ( Social 2% + Tech. 2% )	0	0	0	0	0	0
	<b>Total Cost of the Scheme</b>						
	<b>Percentage Distribution</b>	<b>100</b>	<b>88.44</b>	<b>11.56</b>	<b>100</b>	<b>92.25</b>	<b>7.75</b>
	<b>Per Capita Cost:</b>	<b>12447.69</b>	<b>11009.89</b>	<b>1437.8</b>	<b>16722.98</b>	<b>15427.98</b>	<b>1295</b>
	<b>Per Litre cost</b>	<b>9.58</b>	<b>8.47</b>	<b>1.11</b>	<b>12.86</b>	<b>11.87</b>	<b>0.99</b>
	<b>Note:</b> Plastic tank's per litre cost is Rs. 9.0 in Factory						

In the table above as we can see, the cost of 6,500 litres Ferro-cement jar/tank and plastic tank come up to Rs. 62,238 and Rs. 83,615 respectively. The cost calculation only includes project cost. It does not include operational costs. However, where possible the operational costs should also be included for the total project cost.

## 4. Quality of Water

A major advantage of rainwater collected from household rooftops is that it is usually much cleaner than water collected from other sources (apart from boreholes and springs). However, the water shouldn't be mistaken to be totally free from contamination as the water collected from the roof could contain faeces remnants from birds, small animals and windblown dust. Moreover, the water usually doesn't contain mineral salts (including fluorides and calcium) which are regarded as beneficial for human health in adequate proportions.

The quality of rainwater is relatively good but is not free from impurities; bacteriological contamination is evident in the water tests<sup>6</sup>. So, the water should be washed out through first flushing and then screening should be done using foam before the water reaches the reservoir tank.

Every year, the reservoir tank must be cleaned so as to avoid slime, algae, bacterial growth, and the build-up of sediments. This would help in making the tank's use sustainable and also maintaining the

<sup>6</sup> Quality of Rainwater, [http://phys4.harvard.edu/~wilson/arsenic/conferences/Feroze\\_Ahmed/Sec\\_3.htm](http://phys4.harvard.edu/~wilson/arsenic/conferences/Feroze_Ahmed/Sec_3.htm)

water quality. Chlorine or bleach can also be used as disinfecting agents. Water collected through the tap should be boiled before drinking.

## 5. Challenges

The major challenges and steps undertaken to resolve challenges in implementing RWH projects are as follows:

- Hesitance of community people to drink or even use the rain water collected from the roof. They were sceptical about the quality of water and almost rejected the concept.
- Rainwater harvesting sites usually fall at the peak point or ridge of the hills so transporting the materials like rods, cement, sand, etc from the road head to the site is difficult. Lots of human resources have to be mobilised to carry the materials to the selected sites, causing the project costs to go high.
- The system is relatively expensive than gravity-flow water scheme. More scattered the settlements are the per-capita costs rises, thus, it is a challenge to persuade donor agencies for investing in RWH technology in Nepal
- The inclusion of disadvantaged households is challenging in rainwater harvesting programmes. Ultra poor households, female headed households and elders often face difficulties to contribute the unskilled labour and the locally sourced materials (mainly sand) required to build the Ferro cement tank.
- Maintenance cost of RWH technology is also high which ultimately hampers the poorest households and impacts the sustainability of the project
- RWH is merely an alternative source of water supply and not a 100% solution to water accessibility. But, if we improvise the system to make it cent percent solution, the costs of the technology even peaks up.
- Skilled-human resources are hard to find in communities to manage and sustain the system.
- Maintaining water quality is one of the problems in the community, e-coli is the main problem in the rainwater harvesting system. Household treatment system should be introduced in the community.
- Alteration in rainfall pattern as a result of climate change impact could pose a challenge for the sustainability of RWH

## 6. Lessons Learnt

Through the experiences gained, the following lessons can be drawn:

- ❖ Generally, rainwater quality complied with drinking water standards. A study showed that E.coli is only detected, mostly in systems presenting a poor condition and irregular cleaning and maintenance practices. Thus, cleanliness of roof and storage tank is critical in maintaining good quality of rainwater
- ❖ A problem was identified for manually opening the valve for first flushing during each down pour because it remained closed most of the time. Thus, the collected water was always contaminated. Therefore, now in few NEWAH projects automatic valves have been introduced, which diverts the first flush away from the storage tank.
- ❖ In places where material transportation is a problem and is costly, use of other locally available materials can be promoted other than the essential materials that cannot be done without by transporting
- ❖ People can be assured about the quality of water by fitting sand filters (having sand and charcoal to remove the impurities) along with the RWH structure. This has been able to convince and make

the people believe that the water would be safe to drink. Where this has been done people are confidently using water for drinking as well as other household purposes

- ❖ Many funding and implementation agencies promote this technology within their programmes. As the number of un-served is high in the remote areas where rainwater harvesting may be the only feasible option to obtain drinking and household use water.
- ❖ The role of local government bodies is also critical in this field. Their support launching awareness campaigns in a regular basis and their involvement on follow up would contribute to ensure the long term sustainability of the systems.

## 7. Way Forward

Some of the opportunities and recommendations are listed below as per the experiences gained by NEWAH.

- Rainwater is an alternative solution and can be used extensively for various domestic as well as other water use purposes. However, we have been limiting the technology serving only hilly and ridge area community while the system can also be a boon to the Tarai locales where prevalence of arsenic contamination and drying up of ground-water reservoir are being encountered as major threats.
- Likewise, the construction of artificial recharge ponds through the collection of surface water run-off shall benefit in two ways;
- Groundwater recharge, and
- Provide recreational areas for domestic animals

## 8. References

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- Human Development Report 2009, page no. 152

## 9. Annexes

### Case Studies

#### Sarbajeet's water storage tank

"Wow!! What a wonderful storage tank. Hopefully as the rain comes along it will give us some relief," says 78 years old Sarbajeet Saru full of joy and hope. For Sarbajeet a resident of Thumki Tole of Bhaterpata, Uram Pokhara VDC in Parbat district, a day's walking distance from the district headquarter Kusma, the community was no better than a desert a few years back. Although during the monsoon access to water was easy in this remote VDC, in winter managing water even for cooking and cleaning was difficult.

In 2009-10 the Bhaterpata Rain Water, Sanitation and Hygiene project was implemented with the support of NEWAH partnering with *Chautarphi Bikash Srot Manch* a local NGO. Soon began the construction of rain water harvesting jars and hygiene and sanitation activities.

Sarbajeet and his family were the first to construct a water storage jar and a toilet. Along with his wife, daughter and son-in-law and a packed lunch he left home as early as 4 o' clock in the morning to carry the sand. It took them the whole day to reach the sand mine and carry it back. Weakened by old age yet determined to carry the sand, soon after Sarbajeet was bedridden for 15 days. But after completion of the construction he says "I am indebted for the support provided to construct a rain water collection jar and facilitation to encourage toilet construction in the community. I will be able to reserve the water during monsoon and use it during the dry season like we save food grains for the winter."

Currently, each and every house in the community has a rain water collection jar, toilets and dish drying racks; this has transformed the daily routine life of the community people. A long stretch of white colored rain water collection jars are visible from top of the hill along with toilets next to the houses. People feel now Thumki Tole has become a better place to live in.

Sarbajit adds, "Now, even my grand children and the future generation will be happy. A lot of hard labor has gone into bringing enough water. It is God's will that I have a rain water collection tank and hope to never see my family members go through the same problem." Sarbajeet is grateful to God for his fate. But, actually it's his determination and hard work which has presented him as an example in the whole village.

*By: Kopila Lamichhane, Health and Sanitation Supervisor  
Bhaterpata Rain Water, Sanitation and Hygiene Project  
Donor Agency: Simavi, The Netherlands  
September 2010*



Sarbajeet and his family pose beside the RWH reservoir

*"I will be able to reserve the water during monsoon and use it during the dry season like we save food grains for the winter." - Sarbajeet Saru*





**Kopila Lamichhane of NEWAH talking to Balmati**

*“Once the jar was ready, a heavy rain almost filled it. Water from the jar is just enough for me for a period of six months. Whenever the sky starts to look gloomy I hope for the rains!” - Balmati Magar*

## The Darkening Sky: A Reason for Joy

“When the sky starts to darken, I feel elated,” expresses Balmati Magar of the Thama Rain Water Harvesting project area in Bhimgitthe, Ward No. 6, Baglung district. There is truth in what she says and it is the rain water harvesting system behind her joy. Balmati has been living by herself for five years, and her weakening legs means she finds it challenging to fetch water from far away.

Life on a hill top has not been easy for Balmati, especially as she had to raise her children (two sons and two daughters) on her own after her husband’s death. In time, Balmati’s daughters were married and her two sons were on their way to India to work. When she started living on her own, Balmati’s condition worsened. Aging weakened her legs. But, unless she made the three hour round trip to collect water, she had nothing to drink. Initially, the neighbours helped her but that did not continue for long, and then she was left to manage it on her own.

When the WASH project was implemented in the community by NEWAH, each and every household started constructing a rain water collection jar and toilet. There was a sanitation and hygiene campaign on how to maintain good personal hygiene and how to adopt household and environmental sanitation techniques across the community.

Initially, Balmati felt helpless when she could not construct her own facilities. But once all the construction work had been completed, the community people helped her to erect a four thousand litre rain water harvesting jar, a toilet and a dish drying rack.

Balmati said, “Once the jar was ready, a heavy rain almost filled it. Water from the jar is just enough for me for a period of six months. Whenever the sky starts to look gloomy I hope for the rains!”

*By: Kopila Lamichhane, Health and Sanitation Supervisor  
Thama Rain Water Harvesting Project  
Bhimgitthe VDC 6, Baglung district  
Donor Agency: Simavi, The Netherlands  
November 2011*



## Rainwater Harvesting Eases Water Woes

This *Dashain*<sup>7</sup> though late, turned out to be murky. Had it been like this in the past the people of Illam would have detested this off seasonal rainfall. But this year, it is different. They are joyous with the rains, as their rainwater storage tanks near home have filled up.

“We were ignoring god’s blessings and creating a chaos for ourselves”, expresses Jeet Bahadur Khadka Basnet from Laxmipur-Bardu village. “In the past, we spent the whole day filling up two pitchers of water and now we are making efficient use of rainwater by collecting it”, he says. Basnet is also the Ex-chairperson of water supply project.



**A women washing dishes with the collected rain water at Bhutane Chowk**

The 115 household from Laxmipur VDC's Khundruke Murti, Bhutane Chowk, Adhikari Chowk, School Chowk, Hajure Bhanjhyang and Bardu faced extreme hardship of water due to their community being located on a hilltop and far up from the water sources. They have now have installed 6,000 litre storage capacity rainwater tanks.

Also, Saraswoti Higher Secondary School has three rain water collection tanks of 20 thousand litre capacity each. This project was financially supported by Rain Foundation, The Netherlands with the technical support of NEWAH

Eastern Regional Office (ERO) along with active participation of community people.

Laxmipur VDC, rich in dairy products, varieties of fruits, vegetables and other cash crops faces the acute problem of water due to its geographical location. According to Ghanshyam Poudel, the Secretary of Water Supply Management Committee, “As the nearby water sources are drying up day by day, the community people are compelled to walk even longer distances than before to fetch water for their daily needs. It is making their lives even more miserable. But he further adds, “The RWH projects have given us some relief from all these water woes.”



**RWH technology at a household in Bardu village**

*“We were ignoring god’s blessings and creating a chaos for ourselves”, expresses Jeet Bahadur Khadka Basnet from Laxmipur-Bardu village.*

<sup>7</sup> Biggest Nepali festival

“Rainwater harvesting is just an alternative water supply technology however the people have been provided 6,000 litre water jars which is enough to store sufficient water for domestic purposes during the dry season”, states Kumar Silwal, Regional Manager, NEWAH ERO. According to NEWAH’s Technical supervisor Pradeep Regmi, “Rainwater harvesting is the most reliable technology for Eastern Nepal as this part of the country comparatively receives more rainfall than the other regions. Thus, this technology needs to be promoted more.”

Basnet tells, “We’re saving water even by buying polythene tanks of varying capacity i.e. 1,000 to 5,000 litres from the market at our own expenses.” A local mason, Ganesh Mukhiya, shares, “Now if the winter monsoon prevails, we will be able to store water for February/March too.”

### **Sanitation improves positively**

Since the access to water supply facilities, people seem to have developed good hygienic behaviour like using toilets, regularly bathing, washing, etc. Local teacher D. B. Rai expresses, “NEWAH’s policy to provide support to households building hygienic toilets with rainwater collection tanks has increased the rate of toilet construction in the community.” According to Poudel, the youth leaders of the village are educating others about the appropriate methodology for toilet construction with an aim of declaring the village as Open Defecation Free.



**RWH tank at a household in Murti Khundruke village**

The local people never in their thought had imagined that water would be available close to their doorstep. Poudel shares, “NEWAH provided pipes, iron rods, cement, sand, pen net and wages for the masons while we made our labour contribution. The school also financially contributed to the wages of the masons and for excavating the holes. We are extremely pleased to achieve a lot within the limited budget.”

### **Benefits to students**

According to Rajendra Adhikari, the school teacher the project has enormously helped Saraswoti Higher Secondary School and the teachers. There are about 400 girls among 733 students in the school. The rainwater harvested is being used for drinking and cleaning. Rules are in place to efficiently utilize the rainwater, so it is expected to last the whole year.

Adhikari adds, "The water supply in the toilet has decreased the rate of absentees and students leaving class during school hours or during their menstruation period. Moreover girls feel less tired in those 3-4 days because they don't have to walk long distances to find a safe place to release themselves due to improper sanitation facilities at school."



**Series of Rain water collection tanks at Saraswoti Higher Secondary School**

As it is, the school does not have enough toilets. For more than 700 students there are only seven toilets. At present with the support of the District Development Committee more toilets are under construction and the District Education Office is helping to provide urinals according to Adhikari.

Nar Bahadur Kattel a Local resident says, "Initially I thought the tjar would not be useful. Now, I repent for not demanding one during the project period." He hopes that in the coming days everyone who have been left behind including himself will have access to this technology. Poudel adds that every household in the village would have water supply if the donors provided some financial and technical support for building tanks for the remaining 200 houses.

*Written by: Bharat Adhikari, Capacity Building and Advisory Service Coordinator*

*Location: Laxmipur VDC, Illam district*

*Date: 17 November 2010*

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*and available online in the following link*

[http://www.gorkhapatra.org.np/detail.gopa.php?article\\_id=43493&cat\\_id=10](http://www.gorkhapatra.org.np/detail.gopa.php?article_id=43493&cat_id=10)

and at NGOforum Nepal's link

[http://www.ngoforum.net/index.php?option=com\\_content&task=view&id=10394&Itemid=6](http://www.ngoforum.net/index.php?option=com_content&task=view&id=10394&Itemid=6)