

Rain Water Harvesting as Alternative in Water Scarcity Area: A Case Study of Takoli Gad Watershed, Garhwal Himalaya

M.K. Parmar, R.S. Negi

Department of Rural Technology, H.N.B. G.U. Srinagar Garhwal, Uttarakhand, India

ABSTRACT: Water is the prime product of the forest and it is the basic human need which is felt more acutely in the drought condition being faced by the country. About 100 million people in 12 states of the country are facing severe water crises [11]. Even the basic need of two and a half liters of water per day for drinking purpose, has become difficult to meet in these states. The other effect of drought is loss of agriculture, fodder, water for cattle and migration of people and cattle from the area in search of water. Present study emphasis on the rainwater harvesting problem in Takoli Gad watershed. Most of the villages are located over the spurs on the both side of the Takoli Gad catchment, most of the villages are suffer from the acute shortage of water. Takoli Gad watershed carry very little amount of water in dry season.

KEYWORDS: Rain water harvesting

I. INTRODUCTION

Rain water harvesting is a generic term which includes all activities for collection of rainwater through an appropriate structure for using the stored water conveniently. Roof top rainwater harvesting is a special case of rainwater harvesting, water harvested from rooftop can be used directly for domestic consumption or, be stored as groundwater. In the hydrological cycle, rainfall is the entry point of fresh water on the surface of the earth. It is therefore, logical to catch the rain before it runs away [4]. The inhabitants of Takoli Gad watershed having facing acute shortage of water (drinking as well as other purposed used water) may also be solved by rainwater harvesting methods. Making of springs sanctuaries may also conserve the springs in the watershed. By these methods of rainwater harvesting the wasteland of this catchment may be converted in the forest land, which will be further helping in regeneration of springs & other source of water in the watershed.

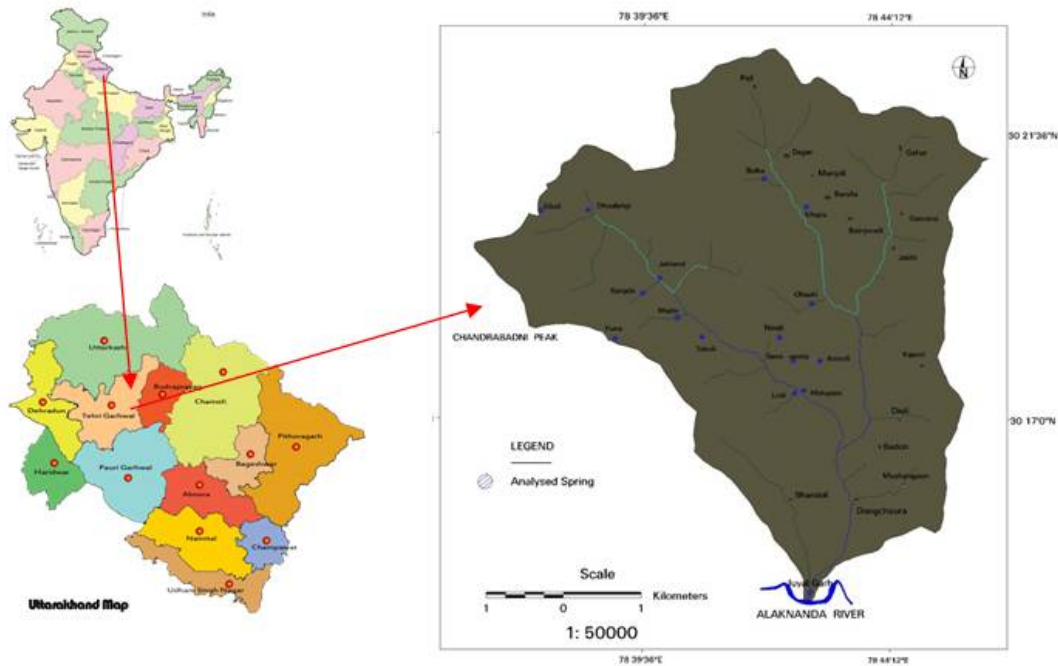
Methodology: The methodology of this study confined to field observation, in depth interviews, sample collection, data presentation and analysis. For the better understanding of the site situation both primary and secondary data sources are used. In order to assess the appropriate water harvesting system, various formal and informal approaches are adopted in the field survey and data analysis. The location variation is analyzed by considering the physiography, climate, social structure and availability of materials for water harvesting systems. Community's idea and culture related to water harvesting system is analyzed carefully. The study is conducted during the period from January 2007 to December 2008.

Location of the area: Geographically the catchment (Takoli Gad) is lying between the $30^{\circ} 14'$ to $30^{\circ} 23'$ N latitude and $78^{\circ} 37'$ to $78^{\circ} 46'$ E longitudes in the Survey of India toposheet No. 53 J/11, 53 J/12 and 53 J/15 with an area of about 131.43 Km^2 . It comes under jurisdiction of district Tehri Garhwal, Uttarakhand. The area is approached by Kirtinagar-Tehri and Kirtinagar- Chauki all weather roads. The area falls in inner Garhwal lesser Himalaya and is characterized by gentle and mature topography. The Takoli Gad originates from the Eastern slope of the Chandrabadni Peak (2278 meter) and join the Alaknanda at Juyal Garh (605 meter). Jakhand and Dagar Gad are the two main sub streams / tributaries of the Takoli Gad watershed.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016



Map: Location Map of Study Area

II. WATER STATUS IN THE STUDY AREA

This is observed that water resources in the Himalayan region are rapidly becoming degraded. Many places water resources have disappeared because of over exploitation of water resources and climate change during the past few decades. The consequent loss of ecosystem services and biodiversity is hampering sustainable development. The elevations of the Himalayas do not allow the monsoon clouds to cross the Himalayas and therefore, heavy rainfall is received in this part from July to September every year. This rain fall provides much needed water for the agricultural crops in the plains and its percolation in the rocks recharge the water table which supplies water in the winter and summer months.

Rainfall, Runoff: Rainfall is the natural source of water and plays a vital role in the development planning of any watershed. Study revealed that Takoli Gad watershed received a total rainfall of 2029 mm (at Paindula) and 2055 mm (at Tiuna) in 2007 and 2662 mm (at Paindula) and 2684 mm (at Tiuna) in 2008 (monthly rainfall values are given in Fig 1.5 and 1.6 chapter 1). The rainfall was measured 13.01 mm in rainy season and 4.07 mm in summer season (at Tiuna) and 12.9 mm in rainy season and 4.00 mm in summer season (at Paindula) during 2007, While during 2008 the rainfall was measured 12.51 mm in rainy season, 8.29 mm in summer season (at Tiuna) and 12.45 mm in rainy season and 8.24 mm in summer season.

The runoff during summer was recorded 1336.0 l/ha/d (at Paindula), 4000.0 l/ha/d (at Tiuna) in 2007 and 2056.0 l/ha/d (at Paindula), 2748.0 l/ha/d (at Tiuna) in 2008. During rainy season this value was recorded 3040.0 l/ha/d (at Paindula), 6392.0 l/ha/d (at Tiuna) in 2007 and 7692.0 l/ha/d (at Paindula), 5120.0 l/ha/d (at Tiuna) in 2008 (Table 1 and 2).

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016

Altitude (msl)	Land use	Summer		Rainy		Total
		Rainfall mm/d	Runoff L/ha/d	Rainfall mm/d	Runoff L/ha/d	Runoff L/ha/d
740 Paindula	Wasteland	4.00	1336.0	12.90	3040.0	4376.0
1614 Tiuna	Wasteland	4.07	4000.0	13.01	6392.0	10392.0

Table 1: Rainfall (mm/d), runoff (L/ha/d) in two altitudinal zones in Takoli Gad Watershed during 2007.

Altitude (msl)	Land use	Summer		Rainy		Total
		Rainfall mm/d	Runoff L/ha/d	Rainfall mm/d	Runoff L/ha/d	Runoff L/ha/d
740 Paindula	Wasteland	8.24	2056.0	12.45	7692.0	9748.0
1614 Tiuna	Wasteland	8.29	2748.0	12.51	5120.0	7868

Table 2: Rainfall (mm/d), runoff (L/ha/d) and soil loss (kg/ha/d) in two altitudinal zones in Takoli Gad Watershed during 2008.

Water Usage in the Valley: Throughout the valley there is scarcity of drinking and irrigation water. A characteristic feature of the valley is that drinking water is generally brought from natural spring. Most villages are settled near the spring. These springs satisfied much of the drinking water requirements of the valley before some decades. Now the Jal Sansthan provides drinking through pipelines to almost all villages in Takoli Gad region. But pipe lines became either permanently defect or seasonally defect after just five or six years of installation due to various factors are:

- The Jal Sansthan implemented the programme either directly or through contractors without involving local community at various stages from planning to maintenance. As a result, the community felt that it is the duty of government to provide drinking water to them for their entire lifetime. Therefore when after installation, the pipelines failed due to poor technical quality of installation the community did not take initiative to manage the pipeline by them selves.
- In some schemes, sub standard material was used for construction of water harvesting and filter structures.
- The pipeline was not laid two-three feet underground but aboveground.
- Some time due to the natural hazards like land sliding creates great problem.

Name of Village	Source	Pipeline length (Km)	Village/Hamlets covered	Status
Paindula	Dagar Kuroli	18	Paindula, Kakarpali	Intermittently working
Neuli	Tola	24	Neuli, Kuneda	Intermittently working
Pab Nandi	Tola	24	Pab, Nandi, Kuneda	Intermittently working
Semi -Semla	Tola	22	Semi, Semla	Intermittently working
Kuneda	Tola	20	Kuneda	Intermittently working
Talyamandal	Murogi	08	Malli & Talli Talyamandal	Intermittently working
Maikhandi	Murogi	06	Malli & Talli Maikhandi	Intermittently working
Chouki	Bainjwadi	04	Chouki	Intermittently working
Kandoli	Bainjwadi	02	Kandoli	Intermittently working
Amoli- Dhaulangi	Machchiyari	04	Amoli, Dhaulangi	Intermittently working
Lusi	Bagdwal	02	Lusi	Intermittently working

Table- 3: Status of drinking water schemes in ten villages

Irrigation: The total irrigated land in Takoli Gad Watershed is 310.66 ha. Farmers are mostly depends upon rainfall. Although this area falls under rainfall zone, but the distribution of rainfall is erratic. Although in this area rainfall is

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016

occurring more and some areas very less. There are many perennial small-small streams in the watershed area. Mostly people use that water for irrigation. There are no such facilities for the irrigation of this region.

Advantages of rain water harvesting

- (a) Promotes adequacy of underground water
- (b) Mitigates the effect of drought
- (c) Reduces soil erosion as surface run-off is reduced
- (d) Decreases load on storm water disposal system
- (e) Reduces flood hazards
- (f) Improves ground water quality / decreases salinity (by dilution)
- (g) Prevents ingress of sea water in subsurface aquifers in coastal areas
- (h) Improves ground water table, thus saving energy (to lift water)
- (i) The cost of recharging subsurface aquifer is lower than surface reservoirs
- (j) The subsurface aquifer also serves as storage and distribution system
- (k) No land is wasted for storage purpose and no population displacement is involved
- (l) Storing water underground is environment friendly

III. RAIN WATER HARVESTING METHODS

There are three methods of harvesting rain water as given below :

1. Storing rain water for direct use
2. Recharging ground water aquifers, from roof top run off
3. Recharging ground water aquifers with runoff from ground area

1. Storing rain water for direct use: In place where the rains occur throughout the year, rain water can be stored in tanks. However, at places where rains are for 2 to 3 months, huge volume of storage tanks would have to be provided. In such places, it will be more appropriate to use rain water to recharge ground water aquifers rather than to go for storage. If the strata are impermeable, then storing rain water in storage tanks for direct use is a better method [6]. Similarly, if the ground water is saline/unfit for human consumption or ground water table is very deep, this method of rain water harvesting is preferable.

2. Recharging ground water aquifers from roof top run off: Rain water that is collected on the roof top of the building may be diverted by drain pipes to a filtration tank (for bore well, through settlement tank) from which it flows into the recharge well. The recharge well should preferably be shallower than the water table. This method of rain water harvesting is preferable in the areas where the rainfall occurs only for a short period in a year and water table is at a shallow depth.

3. Recharging ground water aquifers with runoff from ground areas: The rain water that is collected from the open areas may be diverted by drain pipes to a recharge dug well / bore well through filter tanks. The abandoned bore well/dug well can be used cost effectively for this purpose [8]

Methods of recharging subsurface aquifers

The various methods of recharging subsurface aquifers are:

1. Through recharge pit.
2. Recharge through abandoned hand pump.
3. Through recharge trench.
4. Recharge trench with bore.

1. Recharge through recharge pit: This method is suitable where permeable strata is available at shallow depth. It is adopted for buildings having roof area up to 100 sqm. Recharge pit of any shape is constructed generally 1-2 m wide and 2-3 m deep. The pit is filled with boulders, gravel and sand for filtration of rain water. Water entering in to RWH structure should be silt free. Top layer of sand of filter should be cleaned periodically for better ingress of rain water in to the sub soil [1].

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016

2. **Recharge through abandoned hand pump:** In this method, an abandoned hand pump is used as recharging structure. It is suitable for building having roof top area up to 150 sqm . Roof top rain water is fed to the hand pump through 100 mm dia. pipe. Water fed in the Rain water harvesting structure should be silt free. Water from first rain should be diverted to drain through suitable arrangement. If water is not clear then filter should be provided [3].
3. **Recharge through recharge trench:** This method is used where permeable strata is available at shallow depth. It is suitable for buildings having roof top area between 200 & 300 sqm. In this method, trench of 0.5-1.0 m wide, 1-1.5 m deep and of adequate length depending upon roof top area and soil/subsoil characteristics should be constructed and filled with boulders, gravel and sand. Cleaning of filter media should be done periodically [9].
4. **Recharge trench with bore:** This method is used where sub-soil is impervious and large quantity of roof water/ surface run off is available. In this, trench is made 1.5-3 m wide and 10-30 m length depending upon water availability. Wells of 150-300 mm dia. and 3-5 m deep (below previous layer) are constructed in the trench. Numbers of wells to be dug are decided in accordance to water availability and rate of ingress. Trench is filled with filtration media. A suitable silt chamber is also inserted with grating for water diverting arrangements as shown in the figure [15].

IV. CONCLUSIONS

A set of technologies has been recommended for each union depends on the available hydrogeological information and according to the views of field personnel. However, these technologies have to be implemented systematically ensuring the participation of communities. According to the findings and recommendation the action research followed by ensuring the active participation of community can make the system successful. So proper knowledge and information have to gather from the action research and shall have to be provided to the community so that the option can meet the basic criteria of the water supply such as safe, adequate and reliable round the year. It is to be mentioned that if a technology is new for the particular area, utmost care should be taken for its implementation and replication. Some important options have to take care and monitor regularly. They are described below.

Management of Stored Water Proper management of stored water is very important to satisfy the requirement for the purpose it has been constructed. Because rainwater has a limitation and it can only be collected in the rainy days when it rains. The experience regarding implementation of the technologies in the field will be helpful for upgrading the technological mapping and for proper application of the technologies.

In most Unions of the study area rainfall is sufficient to make rainwater harvesting a reliable and economical source of water even during short-term droughts. Because rainfall is generally copious in the location where it will be used and the complex and costly distribution systems will be eliminated. But Successful and widespread integration of rainwater harvesting systems requires education, training to the community regarding its purity or quality, economic value and environmental benefits [2,7,10,11,12,13,14].

REFERENCES

- [1] Rainwater harvesting in pdf format- video, courtesy of the city of Austin <http://www.twdh.state.tx.us/assistance/%20conversation/conversation/rain.htm>.
- [2] Rainwater harvesting in honduras - technical description the harvesting of water from the surface of roofs for domestic or agricultural uses is a technology. <http://www.oas.org/sp/prog/chap5-1.htm>
- [3] Wedc-garnet,inc/ roof water-roof water harvesting. <http://www.%20iboro.ac.ac.uk/departments/cv/wedc/garnet%20/tncrain.html>
- [4] Central ground water authority - the official web site of the central ground water authority of India provides a primer on rainwater. <http://www.cgwaindia.com/>
- [5] Rainwater harvesting -elements of casa"s rooftop catchment. <http://www.ag.arizona.edu/oals/oals%20/dru/waterharvesting.html>
- [6] Rainwater harvesting systems for mountains by gretchen rupp,pe, extension engineer specialist <http://www.mantana.edu/wwwph/pules/mt9707.html>
- [7] Rainwater harvesting from jade mountain (jm). floating suction filter <http://www.%20jademountain.com/waterproducts/rainwatercistamswp.html>
- [8] Software tools for harvesting, storage and utilization of capturing water. cida. combating desertification. www.idre.ca/books/reports/1997/21-oie.html

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016

- [9] Rainwater harvesting-patil 364 22nd wepc conference: discussion paper new delhi, india,1996 rainwater harvesting dr.medha j.dixit and prof. subhash m. patil india <http://www.iboro.ac.uk/departments/cv/wede/papers/22/grouph/dixit.plf>
- [10] Sourcebook harvested rainwater- rainwater harvesting section of sustainable building sourcebook describes the potential for collecting. <http://www.greenbuelder.com/source%20book/rain%20water.html>
- [11] Water wiser -the water efficiency cleaning house reuse/recycling & rainwater harvesting-cisterns/rainwater harvesting systems- advanced technologies for commercial buldings. <http://www.%20waterwiser.org/template2.page1=reuselinks%20&page2=links-memu>
- [12] Water wiser - the water efficiency cleaning house rainwater harvesting-texas guide to rainwater harvesting available in pdf.. <http://www.waterwise>
- [13] www.rainwaterharvesting.org
- [14] www.aboutrainwaterharvesting.com
- [15] Research Paper on Water Harvesting System, Habitat for Humanity International-Bangladesh Dhaka HRC (North) Office 2010.