ASSESSMENT OF DRINKING WATER QUALITY AND AVAILABILITY THROUGH RAINWATER HARVESTING IN AN ARID REGION

By

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Centre for Rural Development and Technology

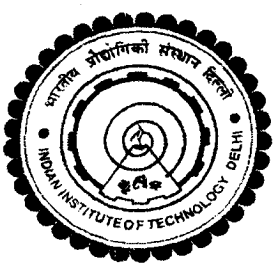
Submitted

In fulfillment of the requirements

for the award of the degree of

DOCTOR OF PHILOSOPHY

to the



INDIAN INSTITUTE OF TECHNOLOGY, DELHI

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Ground of drinking water; Rainwater harvesting.

Dedicated

To

My Parents,

Lord Mahakaleshwar,

Wife Dr. (Smt.) Aruna,

Children Miss. Esha, and Master Shubham.

CERTIFICATE

This is to certify the thesis entitled "**Assessment of drinking water quality and availability through rainwater harvesting in an arid region**" being submitted by Mr. Avadhesh Kumar Singh Bhadauria to the Indian Institute of Technology, Delhi, India, for the award of the degree of "**DOCTOR OF PHILOSOPHY**", is a record of original bonafide research work carried out by him. Mr. Avadhesh Kumar Singh Bhadauria has worked under our guidance and supervision.

To the best of our knowledge, the thesis has reached the requisite standard. The material contained in this thesis has not been submitted, in part or in full to any other University or Institute for the award of any degree or diploma.

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A.K.S.Bhadauria

ABSTRACT

Water is the basic need of human beings. An important role of any welfare state is to supply safe and potable water to its rural and urban masses. An assessment of drinking water supply and availability in the rural arid region of Rajasthan state is made in this study. A case study of Chacha village in arid region of Rajasthan state was undertaken. The study was conducted to evaluate the present status of rain water harvesting structures, in terms of water quality, quantity and cost analysis etc. In situ details were collected through field investigations in a selected village. The study area in the arid region is a backward village of western Rajasthan state which represents the complexities of drinking water supply systems. Inspite of scanty rainfall, a large number of traditional rainwater harvesting structures exists in this region. Average rainfall of this study area is 197.6 mm. The people collect rainwater with their traditional skills and use it for drinking and other purposes for the rest of the year. Rainwater quality for the study area was examined for a long period of time to check the quality aspect of water under arid climatic conditions. Studies on tap water quality through rural water supply programme were undertaken over a period of one year for this village. Views of common man, public representatives and government officials related to water supply schemes were collected through questionnaire. Cost comparison of rainwater harvesting structures with piped water supply schemes was also carried out and reported in this thesis. The modern technology based tap water supply are not covering the whole population and proved to be costlier, energy consuming, unreliable and not fully safe especially in context of arid region. Traditional structures of *Tanka* provided good quality of water for drinking. Therefore amalgamating traditional water harvesting with modern systems can play a

major role in meeting the drinking water demand of the area in environment friendly way. Average demand of drinking water per capita per day was estimated as 2.65 litres in the village taking a sample of eight human beings in a year of study. It was found that maximum drinking water demand was 3.51 litres per day in the month of May and minimum was 2.10 litres per day in the month of December and February. Tap water supply is not sufficient to selected rural region especially in summer months of April to July and hence 10469755 litres of water scarcity was observed in year 2004 as per the total domestic and cattle water requirements. Traditional water harvesting structures like *Tankas* and rooftop water harvesting structures can play vital role for fulfilling water requirement. Water available by tanker water supply was not completely safe as per drinking water standards. Average 270 numbers of people (year 2002 - 2004 average) were seriously affected by water borne diseases by the use of tanker supplied water during the summer months. Interestingly, the most affected persons were below 6 year age group children and above 45 year aged persons with average percentage of 47 % and 22 % respectively (year 2002 to 2004). It has been observed that no harmful changes in water quality were found during storage of rainwater in traditional systems like *Tanka* RWHS and rooftop RWHS. During the storage for a long time of nine months, water quality changed to slightly alkaline. Calcium hardness, total hardness, chloride, pH, total dissolve solids and alkalinity increased but remained under safe limits hence water remained safe and uncontaminated. This phenomenon also indicates the use of construction material in traditional rainwater harvesting structure i.e. *Tanka* and roof top rainwater harvesting structures, which have an effect on the quality of rainwater during storage for the long time. These construction materials (i.e. locally available stone and

lime concrete) are also not creating any harmful effect on the stored water for almost a year. Tap water quality analysis for a year long study reports excess fluoride (1.50 mg/l to 2.60 mg/l), which may cause fluorosis disease in near future in villagers. There is a need to control the fluoride content in piped water supply. This emphasizes that where water is contaminated by excess fluoride, the traditional system of rainwater harvesting could be a better alternative for drinking water supply. Water supply systems in this area are completely free from arsenic problems.

It is found that traditional systems like *Tanka* seems to be sustainable and it should be preserved and encouraged for use. This is demonstrated that traditional rainwater harvesting structures like *Tankas* are found to be more suitable for supply of drinking water needs of rural population in scattered arid region of Rajasthan state. In the current context of severe scarcity experienced for drinking water in arid region, the traditional systems of rainwater harvesting is worth extending to other regions for achieving sustainable water supply in rural arid region of India. Rural masses are fulfilling their water needs through rainwater harvesting in *Tankas* and rooftop water harvesting structures, etc. The study reveals that the present rainwater harvesting structures are also in a position to cater the needs of rural masses for approx. 3 - 6 months and from rainwater harvesting and rest of the needs can be met with supplementing the water by piped water supply from the nearest water sources, thus ensuring the potable water round the year. However, there is need for necessary financial aid from government for meeting the initial cost and educating the masses for its upkeep of these units. Thus rural structures are proving to be good source of potable water at reasonable cost.

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