Working Paper 302

Rainwater Harvesting Initiative in Bangalore City: Problems and Prospects

K S Umamani
S Manasi

ISBN 978-81-7791-158-9

Institute for Social and Economic Change (ISEC) is engaged in interdisciplinary research in analytical and applied areas of the social sciences, encompassing diverse aspects of development. ISEC works with central, state and local governments as well as international agencies by undertaking systematic studies of resource potential, identifying factors influencing growth and examining measures for reducing poverty. The thrust areas of research include state and local economic policies, issues relating to sociological and demographic transition, environmental issues and fiscal, administrative and political decentralization and governance. It pursues fruitful contacts with other institutions and scholars devoted to social science research through collaborative research programmes, seminars, etc.

The Working Paper Series provides an opportunity for ISEC faculty, visiting fellows and PhD scholars to discuss their ideas and research work before publication and to get feedback from their peer group. Papers selected for publication in the series present empirical analyses and generally deal with wider issues of public policy at a sectoral, regional or national level. These working papers undergo review but typically do not present final research results, and constitute works in progress.

RAINWATER HARVESTING INITIATIVE IN BANGALORE CITY: PROBLEMS AND PROSPECTS

K S Umamani and S Manasi*

Abstract

The challenges of urbanization pose immense infrastructure pressures. Bangalore's urban woes are getting critical, hence Bangalore Water Supply and Sewerage Board has made Rain Water Harvesting (RWH) mandatory based on the Bangalore Rainwater Harvesting Regulations, 2009, a positive imitative towards water conservation. Our study aimed to explore the adoption and implementation of RWH and results revealed need for further strengthening in the implementation processes. Survey of 200 households indicates that 94 per cent of the households adopted RWH out of compulsion. 81 did not follow proper technical procedures. Awareness levels regarding cost aspects were poor leading to exploited by plumbers and there was need for more people-friendly support services.

Introduction

At the 2000 UN Millennium Summit, the experts came up with certain significant resolutions in order to hasten the development process which ultimately culminated in the formulation of Millennium Development Goals (MDGs), of which goal 7 in particular related to environment and water. The Goals aims at reducing the proportion of population having no sustainable access to safe drinking water and basic sanitation by half by 2015. In the context of water, it means the provision of potable water for drinking and hygiene within a given time-frame. Compared to other sectors, the water requirement for drinking and hygiene purposes is low; therefore, that rainwater could be a relatively sufficient source for meeting such requirements. It is however considered prudent to adopt technologies of urban hydrology to suit the changing scenarios to help the society by making it decentralized and economical (Konig and Uberlingen, 2009). The present paper is the outcome of a study that focused on the emerging trends in respect of Rain Water Harvesting (RWH) implementation and management in Bangalore, and is based on field views in response to the initiatives that BWSSB had taken. The study tries to explore issues and constraints facing various stakeholders with regard to RWH implementation and also looks into the institutional initiatives taken as well as interventions made in respect of RWH. The findings are presented with key messages and recommendations.

RWH can be boon in several respects given the urgency of mitigating the current water crisis. Rain water could be collected and used for drinking purpose, but adequate precautions need to be taken to avoid water contamination. RWH augments water supply, and reduces the expenditure on water besides being eco-friendly. RWH also helps reduce flooding/water-logging in addition to increasing the availability and quality of ground water. It also reduces the dependency on regular water supply, prevents soil erosion and rejuvenates defunct wells/bore wells through recharging of ground water. Although there are no significant disadvantages associated with RWH, it can be harmful if not executed as per the prescribed design. In such cases, the disadvantages include contamination of water

* Associate Professor, CHRD, and Assistant Professor, CEENR, Institute for Social and Economic Change, Bangalore – 560 072. E-mail: umamani@isec.ac.in; and manasi@isec.ac.in.

if rooftops are not kept clean, water logging if ground water is not recharged properly and flooding of roofs if filters are not properly designed and cleaned frequently. Rainwater stagnates on the earth-surface if the water is not reused properly. Further, improper installation could lead to seepage of water into under-ground drains, nearby toilet pits as also wastes discharged by industrial units contaminating ground water.

Varied methods of RWH have been popular and being practiced across countries and users. While some of them have found adoption in urban areas on a large scale, there are others adopted on individual initiatives and installed at buildings, airports, hotels etc.

RWH at International level

Rain water harvesting is traced back in history to biblical times; 4000 years ago in Palestine and Greece an extensive RWH apparatus existed. In ancient Rome, residences were built with individual cisterns and paved courtyards to capture rain water for augmenting water flow from city's aqueducts. As early as the third millennium BC, farming communities in Baluchistan and Kutch impounded rain water and used it for irrigation dams (Source: http://www.tn.gov.in/dtp/rainwater.htm)

In the Hawaii islands of USA, the RWH structures installed in the National Volcano Park consist of rooftop of the building, a ground catchments area, a storage tank and red wood water tanks. It provides water for 1,000 workers and residents of the park and 10,000 visitors per day. Several smaller buildings here have their own rainwater harvesting installations. The water is further treated at a water treatment and pumping plant for providing good quality water.

In China, Gansu happens to be one of the driest provinces. The Rainwater Catchment Project implemented by the Gansu Provincial Government supports farmers through one rainwater collection field and two water storage tanks, and provide water to one piece of land per farmer for growing cash crops and supply drinking water to households. In Tanzania, rainwater is collected from the hipped roof made of corrugated iron sheets and led into two "foul" tanks and then to two underground storage tanks. The water is then pumped into a distribution tank that is connected to the plumbing system of the house. In Botswana, the town and district councils under the Ministry of Local Government have taken the initiative by way of adopting RWH through thousands of roof catchments and the construction of tank systems in schools, health clinics and government houses. RWH systems are regulated in Bermuda through a Public Health Act which recommends that catchments be coated with white latex paint which is free from metals that could leach into the collected water. Then the rainwater is collected in storage tanks for further distribution. (Source: http://www.unep.or.jp/Ietc/Publications/Urban/UrbanEnv-2/9.asp 14.07.2011)

In Uganda and Srilanka, traditional methods are used for collecting rainwater from trees using banana leaves or stems as temporary gutters. In a single storm, up to 200 liters can be collected from a large tree. Here rainwater gets harvested close to the point where rain reaches the earth. Similarly Jalkund,-- a micro harvesting technology for rural hill farmers-- has proved very useful. Jalkunds are constructed at high ridges of crop catchments where the water stored is used for crop production, livestock and fish production.

RWH in India

Practices of RWH systems are to be found throughout history across civilizations in India. Water has been harvested since pre-historic times using traditional methods. Historically, ancient civilizations emerged and developed near water sources; during the Harappan civilization, (around 6,000 years ago) rain water was collected directly in the open wells (source: CD displayed in the Theme Park). Designs of traditional structures varied from state to state and even from region to region depending on the monsoon patterns. As per Archeological and historical records, Indians were adept in constructing dams, lakes and irrigation systems during the reign of Chandra Gupta Maurya [392-297BC]. In the 11th century AD, the largest artificial lake in India was constructed by the king Bhoja of Bhopal. It covered an area of over 65000 hectares and was fed by 365 streams and springs. Indians had developed indigenous techniques for diverting river water into artificial channels for agriculture through simple engineering structures. The KRS dam of Mysore is the best example of such a structure.

In the absence of a river source nearby, Bangalore has always been heavily dependent on lakes and tanks. Bangalore had developed an intricate system of RWH during 1860's itself. The then Commissioner of Bangalore, Sir Lewing Bentham Bowring, had in 1866 laid storm water drains to divert the rainwater to outlying tanks, and very little rainwater was allowed to go waste in this process (Dying Wisdom by Anil Agarwal and Sunita Narain 1997). Evidently, water harvesting has been part of our civilizational ethos.

Rain water harvesting is a simple process in which rainwater is collected and stored for regular use. The old practice of RWH is to collect rainwater from a building rooftop and fill it in large tanks. The water so collected is used for all purposes except drinking; however it could be treated to potable standards as well.

Rainwater Harvesting Techniques

Broadly, there are two main techniques of rain water harvesting (1) Storage of rainwater on surface and (2) Ground water recharge.

Storage of rainwater on surface

The structures used include underground tanks, ponds, check dams, weirs etc. which receive direct rainfall (footpaths, roads and rooftops). However, the ideal catchment is the rooftop as a large volume of runoff is generated from it and also contamination of water is less on roof-tops as compared to other two options. (http://www.ecoindia.com/education/rainwater-harvesting.html)

(a) Rooftop RWH

Either flat or inclined roofs are suitable for RWH. Heavy rains yield sizeable volume of water while drizzles don't. The roof area determines the quantum of water that could be collected, which is generally 20 litre/Sq m or 2 litre/Sq feet. Down-ward water pipes made out of PVC, HDPE, cement pipes or half cut horizontal plastic pipes (for inclined roofs) are fixed to the rooftop and connected to a storage sump or PVC tank with specially designed filter, mesh etc. The stored water can be used for secondary purposes and, if treated through boiling, filtering and other purification methods, it can be used for drinking.

To avoid contamination, precaution should be taken to protect stored water by covering it properly so that either sunlight or dust does not enter the sump/tank. It is also important to manually maintain the storage system by cleaning of filters, removing of leaves and twigs and other wastes from the mesh etc, for obtaining good results.

Plate 1: Rooftop RWH, Theme Park, Photo: Manasi. S

(b) Rooftop Rain water for recharging of open wells and bore wells

Rainwater collected from rooftops may be filtered using suitable filters to recharge groundwater in an existing open well or bore well. The filtered rainwater may be directly let into an open well through a pipe from any side of the well. Care should be taken that the water pipe is slightly projected into the well and a bend at the end of the pipe guides the water flow downwards. This avoids splashing of water causing damage to the well-wall. Water level in the well could fluctuate according to the intensity of the rains as well as the rate at which ground-water is recharged by the collected rainwater.

It is suggested not to allow the filtered rainwater into a bore-well, functioning or defunct, because the filter may not hold fine silt or dust from the rooftops. If silt or dust passes through the filter, the micro pores or aquifers in the bore can get blocked and cause permanent damage to the bore-well. . Therefore it is advised to build a specially designed infiltration gallery[i] next to the bore well to inject the filtered rainwater into the bore well.

Groundwater Recharge Technique

The percolation of excess rain water through an infiltration system to the subsurface is called ‘Artificial Ground water Recharge’. In the floor area, water recharge would be about 1lt/Sq m, whereas in the pavement area i.e. through pavers with gaps, it would be about 10 lt/Sq m. Another estimate indicates that when the breadth of a footpath is 3m, 3,00,000 liters of rainwater flows for 1 mile; more will be the flow of rainwater if more is the breadth of the footpath (BBMP brochure).

Plate 4: Ground water recharge pit, Theme Park, Photo: Manasi. S

RWH in Bangalore

Bangalore's urbanization process has been alarmingly fast, making it a challenge for the government to build the much needed infrastructure facilities. Bangalore, the capital city of Karnataka, happens to be India's sixth most populous city and also the fifth most populous urban agglomeration. Bangalore, with its strategic location as well as congenial climate, attracts people from all over the country. Of the many challenges that urban Bangalore faces, water scarcity remains one of the critical issues. Availability, Accessibility, Equity and Quality have been the serious challenges, while environmental concerns like ground water depletion and contamination are equally challenging.

Bangalore draws water from river Cauvery, about 100 km away incurring huge financial costs. Water flows against gravitational force from Cauvery, and is pumped at various stages before reaching Bangalore. Thus, Cauvery travels a distance of 100km to a height of 500mts against gravity using 71mw of electricity. A huge amount of Rs.25 crore is being paid as power charges every month, but Bangalore still faces an acute deficit of water supply against the total demand. Hence, BWSSB has drilled a large number of bore wells for alternative water supply. In addition, citizens also drill private bore wells in order to ensure reliable supply of water. This has resulted not only in the rapid increase of the number of bore wells throughout Bangalore, but also overexploitation of ground water. It is estimated that currently the number of bore-wells in Bangalore is around 2 lakhs. The ground water level has receded by about 10mts between 1978 and 2003 (Amruthavarshini, 2010). Several defunct wells and failed (dry) bore-wells can be seen throughout the length and breadth of Bangalore. Another issue that adds to groundwater depletion is the leveling up of tanks. Bangalore has an advantage of having nearly 70 rainy days spread over the year. However, Bangalore's drainage system (infrastructure) can handle only 30mm of rainfall in one hour. So whenever there is a heavy down pour, the city faces flooding and water-logging. There were about 370 tanks in Bangalore, but their number has declined over time due to improper management and several of them have transformed into Stadiums, Parks, Bus stops and Buildings. Major lakes in the city have given way to buildings, parks, bus stands, Stadiums etc, and tar/ cement roads have gobbled up space, leaving no place for rain water run offs to seep into. The rainwater infiltration has also declined as the soil exposed to this purpose has decreased over time.

Further, the storm water drains were designed about 20 years ago and their carrying capacity remains the same even though the city has expanded enormously. Although BBMP has the technical expertise to re-design/widen the drainage network, the process is evidently time consuming and involves huge costs (Times of India 26.04.2011). Frequent incidents of storm water getting mixed with sewage are another issue that needs serious attention. Besides, the sewer system of Bangalore is 80 years old and lacks the capacity to take large volume of sewage water. Even as BWSSB has a plan to make zero sewage storm water drains so that they are free of wastes that block rainwater flow.

The Bangalore Water Supply and Sewerage Board (BWSSB) has taken up various steps to improve its services with water conservation as one of its focus areas. RWH would play a dual role by way of solving water crisis on the one hand and mitigating the havoc often caused by heavy rains, on the other (DH News Service 04-10-2010). It is estimated that 4 crore liters of water can be collected a year if RWH is adopted on one acre of land. Therefore, if RWH is carried out in an area of 9300 acres of land, about 1500 crore liters of water could be collected a year (BBMP, Brochure).

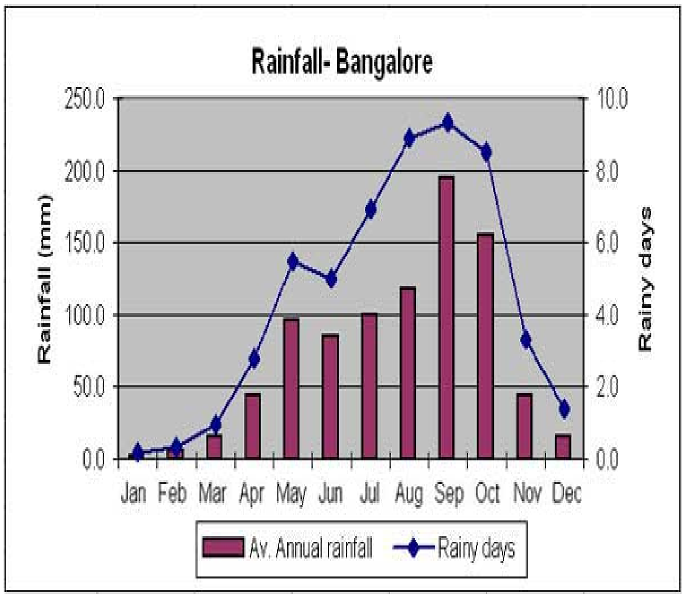
In view of its inherent advantages, RWH has been made mandatory for households in Bangalore city with a site dimension of 40 ft. x 60 ft. and above from 2009. There has been a gradual increase in the number of RWH installation after the BWSSB amendment Act became operational. Several scientists and architects have worked on the methods to be adopted in respect of RWH. Theme park, the first information and research centre on of RWH established jointly by BWSSB and KSCST at 5th block, Jayanagar, functions as a centre for creation and dissemination of awareness on RHW.

Currently, per capita water demand in Bangalore works out to about 150 ltrs. to 200 ltrs. per day, while the actual supply comes to about 100 ltrs. to 125 ltrs per. day, bringing the shortage of water to about 40%

Table 1: Rainwater Potential in Bangalore (1985 – 2005)

Months	Rainfall in mm	Rainy days
January	2.3	0.2
February	6.4	0.3
March	16.0	1.0
April	44.5	2.8
May	96.0	5.5
June	85.7	5.0
July	100.3	6.9
August	117.8	8.9
September	194.6	9.3
October	154.5	8.5
November	43.9	3.3
December	15.8	1.4
Total	**877.8**	**53.2**

Source: BBMP Documents



Source: BBMP Documents

Against this backdrop, this study intends to the emerging trends in respect of RWH implementation and management in Bangalore. The insights gained from the responses of stake holders to field enquiries form the basis of this evaluation. The study also tries to explore issues and constraints facing various stakeholders with regard to RWH implementation. The study covers one specific area within the Corporation limits, where RWH is being largely implemented besides capturing the perceptions of people regarding RWH and their socio-economic status. The study also looks into the institutional initiatives taken and interventions made in respect of RWH. The findings are presented with key messages and recommendations.

Methodology

We have used both primary and secondary data for the study: primary data from the households and secondary data from institutions such as BWSSB, BCC, BDA and the KSCST. The study was conducted in Bangalore from April 2011 to July 2011. Based on discussions with the officials of the BWSSB, the area for the survey was identified. RWH adopted areas across Bangalore has been divided into Central, North, South, East, and West and South East zones. No data was available on the number of households that had adopted RWH across areas within these zones. Hence, among the zones, we selected the South Zone and two localities within this zone (Girinagar and Katriguppe) where several households have already adopted RWH, as the sample. A questionnaire covering various aspects on perceptions, usage, problems, cost incurred on installing RWH was designed and canvassed. Although the study could not cover all zones in Bangalore, it was able to capture some important developments that are reflective of the situation in other areas as well.

Role of Institutions

BWSSB

BWSSB has been promoting RWH, in various ways such as publishing materials pertaining to RWH, conducting training programmes for plumbers and organizing awareness programmes for the public besides implementing RWH in their own office premises. BWSSB has also taken up installation of RWH in 40 of its buildings throughout Bangalore. BWSSB is also vested with the responsibility of monitoring the proper installation of RWH structures and BWSSB officials regularly check RWH storage tanks while taking water-meter readings.

Organizing Training Programmes for Plumbers

BWSSB in collaboration with the KSSCT holds one day training programmes for plumbers on a regular basis. Till date 1,155 Plumbers in 38 batches have been trained under this programme in terms of skills required for installing RWH. On completion of the training programme, the trainees receive a certificate from the BWSSB to the effect that they are authorized to provide technical advice and implement RWH. The resource persons for training programmes are drawn from within the BWSSB and other departments.

Awareness Creation Initiatives by BWSSB

Theme Park *-* BWSSB, in collaboration with the KSCST, has built a Theme park in Jayanagar, which is a resource centre for disseminating information regarding RWH. The Theme park, called 'Sir M. Visweshwaraiah Rain Water Harvesting Centre' happens to be India's First Rain Water Information Centre designed by architects from Bio Diversity Conservation of India Limited. The Theme Park visually displays 27 RWH models making it convenient for visitors to choose one in terms of design and costs. Interestingly, every aspect of conserving rain water effectively is displayed; for instance, the flooring within the park is paved with cement slabs with openings to facilitate percolation of rain water, and visitors can witness the efficacy of such slabs. Efforts are taken to ensure that explanations are given by the staff regarding various models, their usage and benefits. Emphasis is also laid on specific types in terms of filters available and their advantages/disadvantages; similarly, barrels, containers etc. required for RWH are displayed and their functions explained. 'Help desk' adds to the convenience with resource persons readily giving additional information and clarifications regarding RWH. Reportedly, the officials have observed a positive response from the visitors and a commensurate progress in terms of an increase in the number of RWH installations each year. Overall, the exhibition combining theory and practical aspects has positively led to awareness creation.

Plate 7: Theme Park, Photo: Umamani

Creating Public Awareness

BWSSB has so far conducted 21 RWH Abhiyana Programmes with a complete model of RWH mounted on a vehicle as a means of mobile publicity. BWSSB has conducted RWH programs in almost all Legislative Assembly constituencies in Bangalore in addition to 25 parks like Lalbag, Cubbon Park, Sanky Tanky, and the Parks at Rajajinagar, Hebbal, and Mahalakshmi layout etc. Jathas are held with students participating in the processions to promote RWH. Further, students from Engineering Colleges have also gone through trainings programmes besides being part of various camps. RWH awareness programs have been held in schools as well.

Other initiatives

Other initiatives include motivating/encouraging to all the educational institutions in Bangalore to adopt RWH. Over 362 Slums in Bangalore have been surveyed and it is proposed to approve RWH on group basis in these slums, which is expected to ease the water supply related burden of BWSSB by 15% to 20% in the days to come.

Karnataka State Council for Science and Technology

KSCST has directly been involved in RWH promotion besides practically demonstrating its promotion through implementation. RWH systems have been installed in twenty landmark buildings and four exhibition plots in Bangalore. Demonstration of groundwater recharge technologies together with its financial aspects has been taken up at Bangalore and Tumkur. Such displays are in place at Vidhana Soudha, BBMP, BWSSB – BSK field office, Fire station, Beedy workers colony, RTO office, Deputy Commissioner's office, Pollution Control Board etc. KSCST is also involved in conducting various training programmes for Engineers, Architects, Planners, Contractors, Plumbers, Masons etc. Several awareness camps have been also organized in different municipal wards of both Bangalore and Tumkur by KSCST, in addition to establishing RWH resource and training centers for Southern states at the Mahatma Gandhi Regional Institute for Rural Energy Development in Bangalore and District RWH

Nodal Centre across 27 districts in the state. Technical support is provided for establishing RWH systems in 176 villages (one each in every taluk of Karnataka) and 23,680 rural schools in the state. About 10,000 people from Bangalore and other parts of Karnataka have availed of technical support regarding RWH from the Council. . (http://kscst.iisc.ernet.in/rwh_files/rwh_initiate.html; accessed on 4.07.2011)

KSCST's expertise in RWH technology has received wider recognition; its patented innovation 'Popup Filter', designed especially for filtering rainwater from rooftops, has been adopted by a Gujarat-based private company for mass production and marketing.

Bruhat Bengaluru Mahanagara Palike

BBMP has come up with various initiatives to promote RWH. It has identified two main types of RWH methods: (1) Harvesting rainwater from the surface of the earth and storing for present usage through containing it in all the water bodies such as lakes, ponds, rivers, the direct use and (2) Recharging ground water in a scientific manner for improving ground water level, by constructing recharge pits and in order to add life to wells and bore wells, live or failed. BBMP aims to reduce the pressure on major valleys coming under BBMP besides using rain water to improve the growth of flora and fauna. BBMP took up 3 major programmes in the year 2010-11 viz. (1) Rainwater harvesting; (2) Planting saplings and (3) Preservation of trees. 'Bridge an Edge' is a vital programme under which RWH is adopted using percolation of rainwater through trees.

Results

In order to understand the ground situation and also to get feedback from the public regarding RWH, a survey was conducted focusing on certain specific areas of Bangalore City. Two sets of questionnaire were prepared separately for the survey, for collecting information from (1) households with RWH structures and (2) households without RWH structures.

Households with Rain Water Harvesting Structures

One hundred and twenty households of site dimension 60 ft x 40 ft. with RWH structures were surveyed. The built area on these sites varied from 10000 sq feet to 35000 sq feet.

Almost all households (99 percent) surveyed have BWSSB connection with over than 93 percent of households using municipal water for all purposes. Only 7 percent of the households owning bore wells use bore-well water also. Residents of this area do not experience water shortage even though such situations do occur rarely, mostly during the summer, forcing people to postpone some of the household chores for a day or two. Dependency on Tankers is found insignificant; only two families reported as having bought water from a tanker during such emergencies.

Respondents who have installed RWH structures (79 per cent) have done so mainly because of the force exerted by the BWSSB (Table 2) rather than on their own interest. As opined by the respondents, they were issued notices and were compelled to do so by the BWSSB officials; in fact, they felt helpless that water connection would be suspended if they did not oblige. This has resulted in the installation of RWH structures, just to pre-empt the law and avoid water supply suspension. They feel that the RWH, if made mandatory during the time of construction would be less cumbersome than when insisted at a later stage. A significant number of households (87 percent) have adopted underground recharge method.

Table 2: Reasons for Installing RWH

Reasons	Number	Percent
Compulsion from Govt/BWSSB	95	79.2
Self interest	25	20.8
Total	**120**	**100.0**

Source: HH Survey Data

Table 3: Method of RWH Adopted

Type of RWH Installed	Number	Per cent
Roof top	23	19.16
Underground recharge	104	86.6
Directly to Bore Well	4	4.2
Directly to open Well	20	17.5

Source: HH Survey Data

Note: Figures do not add up to the total since in a few houses both roof top and underground recharge methods are in existence.

Out of 120 households with RWH structures, 86.6 per cent (104 households) have adopted groundwater recharging method, while 19.16 percent (23 households) roof top harvesting method. The remaining 20 percent households are found to have directed the roof top rain water directly either to bore well or open well without filtering or treating water. This approach has mainly been adopted because the wells had dried up or they were not in use. Residents feel that water collected could possibly be used for washing or gardening. In addition, there are technical specifications that need to be adopted for roof top rain water harvesting and reusing rainwater. Majority of the households were not willing to take up roof top RWH as it is more expensive, and also because it involved fixing and maintaining filters. Besides, most of them face space constraints, owing to which they do not seem to be very keen on using harvested rain water; rather ground water recharging seems to be a more convenient option for them for obvious reasons.

Deviations in terms of design are commonly found among the households that have adopted RWH technique. Scientists have suggested specific designs where in an infiltration gallery be designed to recharge a bore well irrespective of its working condition, i.e., live or failed. Mere filtering of rainwater for letting into the bore well directly would cause damage not only to their bore wells, but also the surrounding bore wells besides polluting ground water. In practice, many households have not followed this design due to the lack of awareness of its harmful effects. Another deviation observed is the location of recharge pits in close proximity to the bore wells, which could lead to pollution of ground water.

Usage of Harvested Rainwater

Among the households that have adopted roof top rain water harvesting, two were found using water for cooking and drinking. They have directed rooftop water directly to their overhead tanks and use that water for all purposes. However, they have installed water filters/purifiers in their kitchens for filtering water. They seemed convinced of the efficacy of their method of using harvested rainwater; they were rather skeptical about using BWSSB water which they feared could be contaminated from possible sewage leakages. The remaining households used water for cleaning toilets, gardening and bathing (Table 4). It is interesting here to note that only 9 families opined that the quality of harvested rainwater was good. The rest of the respondents were not sure about the quality of harvested rain water and feared that allowing it to mix with either BWSSB water or their own bore-well water could lead to contamination and health hazards.

Table 4: Usage of Harvested Rainwater

Purpose	No	Percent
Only for ground water recharge	**52**	43.3
Only for Cleaning	22	18.3
Only for Gardening	18	15
Only for Bathing	5	4.2
For Cooking and Drinking	2	1.6
All purposes	6	5
No response	15	12.5
Total	**120**	**100**

Source: HH Survey Data

Problems Encountered After the Installation of RWH structures

Only one RWH adoptee-household reported as having encountered problems with respect to the maintenance of filter, while others felt it was difficult to specify the problems instantly, and that only after a span of few years, they would be able to list out the problems. Three respondents, while speaking about maintenance felt cleaning of dried leaves, twigs on roof tops as a difficult task.

Table 5: Problems Encountered with RWH structures

Problems	No of HHs
Maintenance of Filter is difficult	1
RWH is not recharging our bore well/open well	1
Others Specify (physical strain and no use)	3
Total	**5**

Source: HH Survey Data

Water Scarcity

As can be seen from Table 6, four families were found experiencing water scarcity (3 percent). Out of these four households, only two households purchased water from tankers occasionally during critical conditions.

Table 6: Alternative water source during Scarcity

Alternate Source	No of HHs
Use public taps/Bore wells	1
Use group wells/Neighbors'	1
Purchase water from tankers	2
Purchase can-water for drinking	0
Bottled water	0
Total	**4**

Source: HH Survey Data

Source of Knowledge on RWH

Table 7 clearly indicates that BWSSB and BBMP have played a major role in creating awareness with respect to RWH. Several people reported that pamphlets were distributed by BWSSB line men or meter readers and they also persuaded them to install RWH structures. Next in the order comes the publicity made in media like news papers, magazines and TV.

Table 7: Sources of knowledge on RWH*

Source of Knowledge	Number	Percent
BWSSB	92	76.7
BBMP	31	25.8
KSCST	0	0
Theme park	0	0
NGOs	0	0
Newspaper/TV/ Magazine/internet	36	30.0
Others	3	0

Source: HH Survey Data

Note: Figures do not total up to 100 due to multiple responses

Advantages of RWH

As shown in Table 8, majority of households (84%) expressed that RWH increased ground water level and thus helped overcome water scarcity. Only 13 percent of them acknowledged it as eco-friendly; 5 percent felt it helped in reducing water bills; 4 percent cited reduction in electricity bills, while nearly 3 percent felt it helped to prevent soil erosion and 3 percent expressed that water could be stored for future use. All this indicates that people are by and large aware of the advantages associated with rainwater harvesting and also that they are positive about RWH, as a technique.

Table 8: Advantages of RWH

Advantages of RWH	No	Percent
Increase in ground water level	101	84.2
No water Scarcity	42	35.0
Reduction in water bills	6	5.0
Reduction in electricity bills	5	4.2
Eco-Friendly	16	13.3
checks soil erosion	3	2.5
Stored water for future use	4	3.3

Source: HH Survey Data

Expenditure incurred on installing RWH structures

Table 9 shows that none of the respondents has taken bank loans for the installation of RWH structures; however, a substantial variation is observed in the expenditure incurred on the installation of RWH structures, which is understandable given the dissimilarity in building structure and the type of RWH that the households have adopted. However, people feel that guidance and authentication of these figures in terms of costs by the BWSSB would have been more useful. A majority of respondents (46%) are found to have spent less than Rs.15000; 23% of them are found to have incurred expenditure between Rs.16,000 and Rs.25,000, while only 3% have incurred expenditure of Rs.26,000 and above. However, 28 per cent of the respondents were unable to specify the costs as it was incurred by the heads of their families, who were not present during the survey.

Table 9: Expenditure Incurred towards Installation of RWH structures

Total Expenditure	Number	Percent
Rs < 15,000	55	45.8
Rs 16,000=25,000	27	22.5
Rs > 26,000	4	3.3
Don't Know	34	28.3

Source: HH Survey Data

Problems Encountered with RWH Installation

As can be seen from Table 10, 98 percent of the households reported as having not encountered any problems during the installation of RWH structures. Only two households reported certain problems - one felt it was an unwanted financial burden while the other expressed displeasure as they had to undergo a lot of physical strain.

Table 10: Problems Encountered with RWH Installation

Problems encountered	Number	Percent
Yes	2	1.7
No	118	98.3
Total	**120**	**100.0**

Source: HH Survey Data

Recommending RWH to Others

A majority of the respondents (94 per cent) reported that they would recommend RWH to others -- surely an encouraging sign of RWH awareness and its popularity.

Table 11: **Recommending RWH to Others**

Recommending RWH to Others	Number	Percent
Yes	113	94.2
No	4	3.3
No response	3	2.5
Total	**120**	**100.0**

Source: HH Survey Data

General perceptions of People regarding RWH

Most of the families are optimistic about RWH. Even a few of them have expressed that "adopting RWH is a sign of our country's progress', 'RWH helps to save our mother earth". A few others expressed that irrespective of size restrictions, everybody should adopt RWH. A few others quoted Tamil Nadu government's achievements in respect of RWH while others came up with technical suggestions such as designing rooftops in an arc shape so as to ease and increase the quantity of harvested rainwater. Another suggestion was that government should take the responsibility of evolving/prescribing a suitable design for roads so that not a single drop of rain water is wasted. Few people opined that rain water is the purest and the best form of water for drinking as compared to water from other sources.

Households without Rain Water Harvesting Installations

Households that have not adopted RWH have been clubbed together as a control group, with the objective of understanding the reasons and perceptions for not adopting RWH. These households (105) without RWH structures, but with similar site dimensions (40x60) were chosen from the same area where households with RWH installations were chosen for interviews. Here again, the built area varied from 15000 sq feet to 35000 sq feet. A separate questionnaire was prepared for collecting information from these households.

As can be seen from Table 12, BWSSB is the main source of water supply for almost all these families; only one family reported as being dependent on its open well.

Table 12: Sources of Water Supply

Water Source	Cooking and Drinking		Secondary Purposes	
	Number	Percent	Number	Percent
BWSSB	102	97.1	93	88.57
Bore Well+ BWSSB	48	45.7	47	44.76
Open Well	1	1.0	2	1.90
Paid Tankers	1	1.0	0	0.00

Source: HH Survey Data

None of the households excepting one faced any water shortage. This particular family reported as having purchased water from tankers (4 times per month) spending about Rs.1400 per month.

Awareness about RWH

It is interesting to note that 94 percent of these household members were aware of RWH (Table 13). As can be seen from Table 14, the major source of knowledge regarding RWH was BWSSB (57.6 percent). Rest of the respondents mentioned news paper/TV, internet, magazines etc. as the source of knowledge. Six households reported as having attended BWSSB awareness programmes.

Table 13: Awareness about RWH

Aware about RWH	Number	Percent
Yes	99	94.3
No	6	5.7
Total	**105**	**100.0**

Source: HH survey Data

Table 15: Awareness about RWH through different sources

Source of Knowledge	Number	Percent
BWSSB	57	57.6
News papers/TV/other Media	42	42.4
Total	**99**	**100**

Source: HH Survey Data

Reasons for not installing RWH structures

Approximately 18 percent of the respondents have cited four major reasons for not installing RWH structures, such as (1) not being aware of it (2) nobody insisted on it (3) financial problems and (4) lack of space for installing it. Among the people who were not aware of RWH, around 12 percent respondents felt that it was of no use and a waste of money. More than half of the respondents (53.3 percent) cited their advanced age, poor health and the lack of capable persons in the household to carry out the task as reasons for not adopting RWH. It is ascertained that most of these households belong to retired/aged people and their children stay elsewhere. About 16 percent of the families were found reluctant to express their views regarding the non-installation of RWH structures.

Table 17: Reasons for not installing RWH structures

	Number	Percent
Not aware of it	4	3.8
Nobody insisted	5	4.8
financial Problem	5	4.8
Lack of space	5	4.8
Not Necessary reasons • No water scarcity • Excess water in the bore well. • Undergone RWH indirectly. • Waste of money.	13	12.4
Other reasons specified • Lack of education • Hectic schedule • Not workable throughout the year • Health problem	56	53.3
Not willing to respond	17	16.2
Total	**105**	**100.0**

Source: HH Survey Data

Installation of RWH structures in future

Families were also asked about their intentions to install RWH structures in future. Most of the respondents (44.4 percent) were found to be not interested in installing. When probed further, these residents stated that they did not experience water scarcity and hence it was not necessary, while certain others reported that it won't be possible even in the future due to lack of space. The other responses included opposition towards RWH as they felt it was made compulsory or insisted upon only in specific areas of Bangalore and not the whole of Bangalore. A few households with excess water in their bore-wells felt recharging as unnecessary; a few others considered it as a waste of money. About 15 percent of them were yet to explore the possibilities and hence were not in a position to specify the methods they could adopt. Among those who were certain to install RWH structures in future, 8 percent seemed to prefer roof top harvesting, while 25 percent underground recharge.

Table 18: Plans for installation of RWH structures in future

	Number	Percent
Interested	29	27.6
Not Interested	21	20.0
Yet to explore	15	12.2
Roof top RWH	8	7.6
Recharge ground water	25	23.8
Not willing to respond	7	6.6
Total	**105**	**100**

Source: HH Survey Data

Conclusions and Policy options

To summarize, RWH is an essential and welcome initiative taken up by the BWSSB individually, as also by the various institutions involved in RWH. However, it is important that the process of implementation of RWH is strengthened further throughout the state. It is also important that the initiatives taken in respect of RWH across various institutions are coordinated so as to ensure better results.

Awareness Creation Initiatives

RWH- a 'Compulsion' must be transformed as RWH - a 'Necessity'

Providing a context in which RWH becomes important would play a crucial role in terms of its implementation. Further, it is also desirable that BWSSB urges the citizens to appreciate the need for adopting RWH by way of making it a felt necessity rather than an act done under coercion.

Need for more popularization through books and pamphlets

There is a gap in distribution of the published material. The BWSSB and BBMP should therefore take charge of distributing booklets in a more systematic manner. There are a few individuals eager to work as volunteers for promoting RWH whose services can be effectively utilized.

Promotion of Awareness creation programs

- The programmes related to RWH must be aired on T.V., Radio and published in newspapers repeatedly.
- Number of awareness camps conducted by BWSSB should be increased and advance intimation given to residents of the area about the event.
- Involvement resource persons for promoting RWH should be ensured.
- Other popular and effective modes of communication like street plays could be tried for promoting RWH concept.
- The current `Theme park approach' is one of the best methods for promoting RWH. However, there is a need to make it more popular through advertisements in addition to conducting excursion trips for the various institutions/resident-bodies to the Theme Park.

On Technical aspects and Costs

In general, people are not aware of the technical details of RWH and also costs related to installation of RWH structures. For instance, people lack awareness as to how the harvested rainwater can be injected into bore wells. Access to proper information will avert deviation from accepted design and thereby safeguard ground water quality. Another important aspect is making provision for providing proper information on cost aspects institutionally. This would help citizens take informed decisions. This aspect assumes significance because variations in prices quoted by plumbers could make residents skeptical towards the whole process of RWH.

Need for being sensitive to consumer preferences and providing better support services

A blanket insistence of adoption of RWH without understanding the practical constraints involved could lead to process defaults. It has been observed that many senior citizens living in ancestral houses are financially weak (pensioners) and physically dependent. It is important to be sensitive to the needs of such residents by way of providing a package of RWH services through the BWSSB or any other authentic sources and charging them in installments.

Reference

Amruthavarshini – By A.R. Shiva Kumar

BBMP, Brochure

BDA Documents, 2011

BDA's initiative to conserve a great heritage

DH News Service 04-10-2010

Dying Wisdom by Anil Agarwal and Sunita Narain

http://www.earthconservation.net/rainwater-harvesting-process.html

http://www.ecoindia.com/education/rainwater-harvesting.html

http://www.rainwaterharvesting.org/Urban/Model-Projects.htm http://www.tn.gov.in/dtp/rainwater.htm

http://www.ecowaterharvesting.com/rainwaterharvesting.html

http://www.meritnation.com/discuss/question/688203/what-is-rain-water-harvesting-plzz-i-need-proper-definition

http://www.worldproutassembly.org/archives/2006/08/rainwater_harve_1.html

http://www.rainwaterclub.org/docs/R.W.H.industries.urban.pdf

http://www.waterjustice.org/pv.php?news=101

http/www.rainwaterclub.org/docs/R.W.H.industries.urban.pdf

http://kscst.iisc.ernet.in/rwh_files/rwh_initiate.html accessed on 4.07.2011. Times of India 26.04.2011

http://www.unep.or.jp/Ietc/Publications/Urban/UrbanEnv-2/9.asp 14.07.2011

http://praja.in/en/projects/3230/announcement/rain-water-harvesting-bangalore-report 19.07.2011

http://www.slideshare.net/mynk/rain-water-harvesting-kscst 19.07.2011

http://praja.in/en/blog/rithesh/2010/04/15/bangalore-bore-well-data 19.07.2011

http://go.microsoft.com/fwlink/?linkID=199831

http://www. Practical.Action.org

http://www.popularmechanics.com/science/environment/water/4314447

http://www.naturalnews.com/029286_rainwater_collection_water.html

http://green.blogs.nytimes.com/2009/06/29/the-legalities-of-rainwater-harvesting/

Konig W Klaus and Uberlingen, 'Rainwater Harvesting for Water Security in Rural and Urban Areas in UNEP, 2009, Rainwater harvesting – A lifeline for human well being, Prepared by Stockholm Environment Institute.

Preservation of lake in Bangalore city

Rajiv Gandhi drinking water mission, Government of India as quoted by R.N. Athavale

Standards Australia 2006

UNEP, 2009, Rainwater harvesting – A lifeline for human well being, Prepared by Stockholm Environment Institute.

WHO et al.2003

Recent Working Papers

272 Determinants of Migration and Remittance in India: Empirical Evidence
Jajati Keshari Parida and S Madheswaran

273 Repayment of Short Term Loans in the Formal Credit Market: The Role of Accessibility to Credit from Informal Sources
Manojit Bhattacharjee and Meenkashi Rajeev

274 Special Economic Zones in India: Are these Enclaves Efficient?
Malini L Tantri

275 An Investigation into the Pattern of Delayed Marriage in India
Baishali Goswami

276 Analysis of Trends in India's Agricultural Growth
Elumalai Kannan and Sujata Sundaram

277 Climate Change, Agriculture, Poverty and Livelihoods: A Status Report
K N Ninan and Satyasiba Bedamatta

278 District Level NRHM Funds Flow and Expenditure: Sub National Evidence from the State of Karnataka
K Gayithri

279 In-stream Water Flows: A Perspective from Downstream Environmental Requirements in Tungabhadra River Basin
K Lenin Babu and B K Harish Kumara

280 Food Insecurity in Tribal Regions of Maharashtra: Explaining Differentials between the Tribal and Non-Tribal Communities
Nitin Tagade

281 Higher Wages, Cost of Separation and Seasonal Migration in India
Jajati Keshari Parida and S Madheswaran

282 Pattern of Mortality Changes in Kerala: Are they Moving to the Advanced Stage?
M Benson Thomas and K S James

283 Civil Society and Policy Advocacy in India
V Anil Kumar

284 Infertility in India: Levels, Trends, Determinants and Consequences
T S Syamala

285 Double Burden of Malnutrition in India: An Investigation
Angan Sengupta and T S Syamala

286 Vocational Education and Child Labour in Bidar, Karnataka, India
V Anil Kumar

287 Politics and Public Policies: Politics of Human Development in Uttar Pradesh, India
Shyam Singh and V Anil Kumar

288 Understanding the Fiscal Implications of SEZs in India: An Exploration in Resource Cost Approach
Malini L Tantri

289 Does Higher Economic Growth Reduce Poverty and Increase Inequality? Evidence from Urban India
Sabyasachi Tripathi

290 Fiscal Devaluations
Emmanuel Farhi, Gita Gopinath and Oleg Itskhoki

291 Living Arrangement Preferences and Health of the Institutionalised Elderly in Odisha
Akshaya Kumar Panigrahi and T S Syamala

292 Do Large Agglomerations Lead to Economic Growth? Evidence from Urban India
Sabyasachi Tripathi

293 Representation and Executive Functions of Women Presidents and Representatives in the Grama Panchayats of Karnataka
Anand Inbanathan

294 How Effective are Social Audits under MGNREGS? Lessons from Karnataka
D Rajasekhar, Salim Lakha and R Manjula

295 Vulnerability Assessment Of The Agricultural Sector In Yadgir District, Karnataka: A Socio-Economic Survey Approach
Sarishti Attri and Sunil Nautiyal

296 How Much Do We Know about the Chinese SEZ Policy?
Malini L Tantri

297 Emerging Trends in E-Waste Management - Status and Issues A Case Study of Bangalore City
Manasi S

298 The Child and the City: Autonomous Migrants in Bangalore
Supriya RoyChowdhury

299 Crop Diversification and Growth of Maize in Karnataka: An Assessment
Komol Singha and Arpita Chakravorty

Price: Rs. 30.00

ISBN 978-81-7791-158-9

INSTITUTE FOR SOCIAL AND ECONOMIC CHANGE
Dr V K R V Rao Road, Nagarabhavi P.O., Bangalore - 560 072, India
Phone: 0091-80-23215468, 23215519, 23215592; Fax: 0091-80-23217008
E-mail: lekha@isec.ac.in; Web: www.isec.ac.in