TRADITIONS OF RAINWATER HARVESTING IN SOUTH ASIA

A SYNTHESIS

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CONTENT

NOTE

This paper is a synthesis of reports written on Traditional Wisdom of Rainwater Harvesting by country researchers in India, Pakistan and Sri Lanka. Therefore, specific references are not quoted in the text as all substance was taken from these three reports. As a guide to the reader, the three country reports are;

(i) Traditional Wisdom - Rainwater harvesting in deserts of India by Arvind Patel, Munitaz Baloch, Bharatkumar Bhati and Rashindkhan Baloch.

(ii) Wisdom of Tradition - Rainwater Harvesting for Domestic and Agricultural Purposes in Pakistan by Amjad Farooque and

(iii) Wisdom of Traditional Collection of Rainwater for Domestic Use in Sri Lanka by R.de.S. Ariyabandu.

All three country reports were written on behalf of Disaster Mitigation Programme of the Intermediate Technology Development Group Sri Lanka.

LIST OF ABBREVIATIONS

RWH	-	Rain Water Harvesting
ADB	-	Asian Development Bank
DMI	-	Disaster Mitigation Institute
GWSSB	-	Gujarat Water Supply and Sewerage Board
GOG	-	Government of Gujarat
BVM	-	Banaskanth Vikas Mandal
NGO	-	Non-Government Organization
PCRWR	-	Pakistan Council for Research in Water Resources

TRADITIONS OF RAINWATER HARVESTING IN SOUTH ASIA

Introduction

Wisdom of Traditional Rainwater Harvesting in South Asia is mostly overlooked, not only in social and economic development but also in applied concept of mitigating disasters. Water remains the life most important component, may it be for biological needs, agricultural or industrial development. In the past people had their own systems to meet the need for water. Harvesting rain for domestic or agriculture was a way of life. However, with the development of modern water supply systems for domestic use and agriculture, the traditional systems withered away leaving the masses to depend totally on new techniques of water supply.

In Rajastan people who left traditional systems for more sophisticated pipe borne water had to face an acute water crisis when the Rajastan canal which provided water dried-up. In Sri Lanka over exploitation of ground water through tube wells and Agro-wells led to water table depletions and indulgence in tube wells have caused low water yields and brackish water due rusting of tube wells. In Pakistan, number of Rainwater harvesting systems have been put into practice due to drying up of conventional sources or becoming to heavily polluted. Hence, the importance of traditional rainwater harvesting has been once again reaslised to mitigate the adverse effects of certain modern water abstraction methods. While rainwater harvesting can offer high quality water for supplementary irrigation in the humid tropics, in desert conditions, it can mean the difference between life and death.

This paper highlights the salient failures of studies conducted in three South Asian countries, India, Pakistan and Sri Lanka, where traditional rainwater harvesting has been documented. While Pakistan and Sri Lanka discusses rainwater harvesting in three districts, India highlights, three types of traditional rainwater harvesting with community participation in states of Rajastan and Gujarat.

The paper discusses the National Scenario of the country, the issues and need for water, the alternative approaches adopted and finally it discusses the different types of rainwater harvesting systems adopted for domestic and agricultural needs.

The discussion on Sri Lanka in this paper is limited to use of rainwater for domestic use. Rainwater harvesting for agriculture in Sri Lanka is well documented in number of other papers and articles.

National Scenario

Rainwater harvesting is not a new concept to South Asia. In 5th century B.C. Sigiriya rock fortress in Sri Lanka possessed one of the best architectural wonders of rainwater harvesting in the form of a series of ponds on top of the fortress. In 4000 BC settlements in Gujarat have built rain water harvesting structures for safe and sustainable water

supply for domestic, agriculture and religious purposes. It has also been reported that the Indus Valley Civilization in 3000 BC to about 1500 BC possessed excellent water supply and waste disposal systems. Hence, importance given to harvest and manage water in the olden days was a tradition and a pre-occupation of the early settlers.

One of the most important aspects of traditional rainwater harvesting was its frugality. Rain Water Harvesting (RWH) Systems were simple, easy to construct and had multiple uses at household or community level. However, in the present context, the top heavy, state sponsored water supply schusses have basically failed to provide adequate water to rural people in most Asian countries. One of the main reasons for this situation was absence of reliable water sources, depleting ground water levels and over indulgence in new water supply technologies, disregarding traditional systems that were very location specific. In India, most drought situations are coped with short term measures like dug wells, tube wells or surface tanks. Prevention and preparedness for drought situation through long term rainwater harvesting is not considered as priority. Hence, a long term comprehensive water harvesting plan would encourage, soil conservation, increase ground water storage and improve the natural environment as a whole.

In Pakistan, developing the desert with appropriate local practices and techniques have been suggested to improve the water situation. Some of the water harvesting methods developed in the desert regions of Pakistan are; Run-off Farming Water Harvesting (RFWH), Micro Catchment Water Harvesting (MCWH) and Rounded Catchment Water Harvesting (RCWH). All these methods harvest rain water as a surface run-off source and encourages replenishment of the ground water table. By improving the water status of the desert, out immigration of settlers and livestock have been reduced. One of the main reasons for out migration from desert areas is lack of water for livestock. However, continuous cultivation due to seasonal non-migration have reported in greater land degradation in desert regions. With respect to domestic water, like in most Asian settlements, scattered nature of rural settlements have precluded conventional water supply systems giving an important role for community based local water harvesting systems to provide water to rural settlements.

Sri Lanka being an island nation with a high rainfall, receives an average of 13.1 Million Hectare Meters (MHM) of water from rainfall. However, due to its seasonal rainfall pattern 5.1 MHM (39%) goes as run-off and out of which 3.3 MHM (65%) escapes to the sea. It has been suggested to harvest some of this run-off to improve the water supply situation to rural communities. According to the predications of the Water Resources Secretariat in Sri Lanka, there would be a 1400 Million Cubic Meter (MCM) deficit of water in the Northern dry zone by the year 2000 and the capital city water demand would double by the same year. This situation may predict additional water requirement to face the deficit situation. RWH apparently appears to be the only solution to the situation as ground water levels are depleting and withdrawals from perennial rivers causing back flows of sea water due to over extraction.

As at present, rainwater harvesting for domestic purposes remains mostly with the rural communities, where seasonal RWH supplements the domestic water needs in the short-term. However, the Sri Lnakan rural peasantry has innovated different types of RWH methods to avoid water scarcity situations. While most of these are short-term solution as stated, some have provided water for longer periods. These are specially found in temples of Sri Lanka where large cement masonry tanks have been used to collect rain water for all uses of temples.

In part of Rajastan cement masonry structures have been constructed as a development form traditional RWH Systems into new technology. These covered water tanks have been constructed explicitly, taking into consideration the fluctuations in annual rainfall across the state. The revival of traditional and new knowledge systems were demonstrated by building **Khadian** with stronger masonry and selective use of cement in Jodhpur Rajastan. In Madhya Pradesh, earthen checkdams, loose boulder checkdams and sunken ponds have been constructed to conserve moisture and reduce soil erosion. Similarly in the Tamil Nadu Water Resource Consolidation Project where operation and maintenance of the system has been handed over to woman farmers groups, rain water harvesting has been introduced at the early stages of project cycle. Such has been the importance given to RWH in the present day context merging traditional wisdom into new technological innovations.

The Issue

The issue in everybody's mind is why rain water harvesting and why talk of traditional wisdom? While Sri Lanka receives an average annual rainfall of 2000 mm Gujarat/Rajastan states in India and Cholistan and Thar deserts in Pakistan receives less than 250 mm of average annual rainfall. Thus in the later case it is essential that rain water has to be harvested to supplement already existing water supply sources. In Sri Lanka though the rainfall is high, seasonal and special variations have created water scarcity situation annually forcing rural communities to walk long distances to fetch water.

In Gujarat, almost every third year is a drought year. 70-75% of the population suffer from water related deficiencies,. According to Gujarat government estimates 70% of the villages are categories as "No Source" villages where safe and sustainable water sources are not available, while this percentage can fluctuate annually, trend of water scarcity is never a declining preposition. In Rajastan, 70%-92% of the villages are faced with chronic water problems mainly due to its desert nature of the state. Hence, the problem of water scarcity is widespread chronic and deep-rooted in the arid states of India.

The National Conservation Strategy, (NCS) of Pakistan emphasizes that land and water are the two most constraining factors for increasing agriculture production. Out of these two factors, water remains the most crucial factor, as availability of water in adequate quantities can encourage double cropping at least on highly productive lands. Pakistans main sources of water are it surface rivers and ground water is considered as the second source. While number of reservoirs capture and store rain water, they are unable to store

additional water during water surplus high flood years for later use. Hence, what is being stored from monsoon rains is used in the following Rabi (dry) season. According to the NCS of Pakistan, diversion losses in surface irrigation systems can be as high as 41%. With respect to domestic water supply, only 53% of the population in Pakistan has access to safe water. According to population distribution, 79% in urban sector and 40% in the rural areas have access to safe water.

95% of the population in rural areas and 90% in urban areas excepting Sindh province uses ground water for domestic use. In Sindh including Karachchi, 92% of the population depends on surface water which is polluted in most cases and unfit for human consumption, unless it is treated or boiled.

In Sri Lanka, 89% of the urban population and 60% of the rural population receives safe water mainly supplied through pipe borne water supply schemes, dug wells and tube wells. In rural areas natural spring water has been supplied through gravity systems to clusters of houses. While Sri Lanka posses a high water supply coverage it does not take into account different levels of services and performance, hence the figures expressed can be misleading. Water supply coverage in rural areas also varies depending on the location. Scattered nature of settlements in the dry zone and hill settlements in the central and Southern wet zone have denied rural communities of domestic water through conventional water supply sources. Hence, some of these communities face sever water scarcity problems due to climatic variations and geographic locations.

Scarcity of water in India appears to be a phenomena associated with the market oriented production systems and "approach" adopted to mitigate the water problem. In pre-independence India, there is mention of food scarcities but hardly any reference given to water scarcity or serious shortage of water in Gujarat or Rajastan. One of the reasons for water shortages in these two states is over exploitation of ground water for agriculture and domestic use. Cultivating water intensive crops and water sector policies, which advocate the use of ground water to increase quantum of water for commercial use, have resulted in heavy "mining" of ground water. In North Gujarat water is extracted from 1500' - 1800' deep tube wells and in Banaskanth in Gujarat water is drawn from 2000' deep tube wells. The result has been that the water table in Gujarat is depleting at the rate of 8' per year and in Jaipur in Rajastan the depletion is 4' per year. These "mined" waters in most cases has more than the tolerable levels of salts, fluoride, Nitrates or Iron. Hence, these waters are mostly unfit for drinking.

In the desert areas of Pakistan, the primary source of water is rainfall, as the available ground water is mainly saline. The desert areas lack any public irrigation sources, hence, human beings and livestock face acute water shortages. In the deserts of Thar, Nara and Cholistan when rain fails, it causes drought and famine. Hence the only solution left for these desert communities is to harvest rain water through appropriate local techniques. With increasing population, food supplies will have to be increased. In the desert regions this can only be done by bringing marginal and desert lands to production and improve on livestock. Water for both these activity have to come from harvesting rain water. Hence,

rainwater harvesting technology remains as the only way to supply fresh water in the deserts when the other alternative supply sources are expensive and unavailable.

In Sri Lanka, seasonal and spatial high intensity short duration rain creates large losses through run-off.
Further, the liberalization of market economy encouraged high yielding, short duration subsidiary food being cultivated under Agro-wells using ground water. The proliferation of ground water through Agro-wells also became popular among politicians due to tangible benefits obtained through Agro-wells. This has created a significant abstraction of ground water, which at present is threatening some parts of the North Central and North Western Province with water scarcities, specially for domestic purposes.

The Alternative Approach

An Alternative Approach is one that comes from the wisdom of tradition, within the local communities, low cost and easy to manage by the local people. Rainwater Harvesting structures for domestic water use and irrigation have emerged with people and they have been effectively being used in the past. However, with change of times most of these structures gave away to new water supply technologies. However, under adverse weather situation, when most other new technologies failed, traditional rain water harvesting systems have managed to survive. Traditional Rainwater Harvesting Systems like, ponds, talar, sarovars, vav or kunds in Gujarat/Rajastant, Tobas, Tarai and Dhands in Cholistan/Thar or tree trunk water harvesting and open air rain water harvesting for domestic use in Sri Lanka have with stood the "Winds of Change" to be sustainable and suitable systems to harvest rain for both agriculture and domestic use.

While most of these systems have local community innovations, developed in the past to suit a particular situation at a particular period of time, adopting the same into present day context needs scientific research before being accepted as alternatives for present water scarcities.

Nevertheless, the concept of traditional wisdom in rainwater harvesting has been well accepted. In Gujarat and Rajastan there has been a perceptible shift in governments thinking on water scarcity problem. Bilateral funding agencies like the GTZ and multilateral agencies like the World Bank and ADB have recognized the importance of rainwater harvesting, ground water recharge and water conservation as alternative practices that can provide water to the thirsty millions in these South Asian states. In Sri Lanka, the Community Water Supply and Sanitation Project (CWSSP), in 1995 adopted rain water harvesting as a means of alternative water supply source for rural communities. The technology itself adopted the traditional wisdom of harvesting roof run-off, merged into the new technology and constructed $5m^3$ robust cement, motor tanks to harvest and store rain water. The success of this approach in Sri Lanka, has encouraged policy makers to accept RWH as an alternative means for domestic water supply. At present, RWH has been accommodate as a water supply option in the second ADB sponsored water supply project. Therefore traditional RWH as an alternative option has been accepted in varying degree in South Asian countries. However, what is important in

adopting traditional wisdom is it should be local community based, low cost, locally managed and sustainable. These elements should be the pre-requisites in translating traditional wisdom into modern engineering technologies.

Types of Rainwater Harvesting in South Asia

This section of the paper review different types of RWH in the three South Asian countries under study. While RWH can be for both domestic use and agriculture, most of the experience sited in reference documents are relate to domestic use. The Rainwater Harvesting experience documented in Rajastan/Gujarat have mainly used the traditional concept of rain water harvesting into modern day realities. Also the Gujarat experience emphasizes on the strong community participation in reviving RWH and discusses the important role played by women.

In the desert regions of Cholistan and Thar, the discussion is mostly focused on the use of traditional RWH structures, some formed naturally due to geographic formations and others man-made or with marginal inputs from the community to establish sustainable RWH structures.

In Sri Lanka Traditional RWH is discussed mainly at household level. The presentations from Sri Lanka emphasizes low input traditional RWH systems that collect small quantities of water adequate for few days. However, Sri Lanka has also improved on the traditional RWH concept, where they have embarked into a more institutionalized RWH system, using $5m^3$ Ferro-cement and Brick-dome tanks. The importance of Traditional RWH in Sri Lanka is that most of the household level systems are still functional at their own traditional level without being subject to the "Winds of Change".

Roof Water Harvesting at Household Level

Northern Gujarat is a desert and an arid region with an annual rainfall ranging from 50 to 250 mm. Some parts of Northern Gujarat (Patan district) consistently suffer from water scarcity. This has effected the livelihood of large number of rural people. While low rainfall is a perennial problem, saline ground water further aggravates the problem for rural communities. However, the Banaskantha Dwera Matila SEWA Association (BDMSA) used this problem to form village cooperatives to support livelihood under difficult conditions.

BDMSA encouraged the rural community to participate in construction of "tankas" at household level to harvest roof run-off. The physical size of these houses made it possible to harvest adequate water to fill a surface tank built on the compound. The size of the "tanka" varies with the family size. In Patan district, under this experiment a family of four needs a "tanka" of 10,000 liters to satisfy their non-drinking needs of water. Usually "tanka" water is used for cooking, water for cattle, washing and for religious worship. Cost of these "tankas" vary from IRs 16,000 - 19,000 depending on the capacity. However, BDMSA encourages the beneficiaries to contribute 30% of the total cost of tankas. These tankas have reduced out migration of inhabitants from these areas. Usually 20% - 80% of villages migrate during summer months causing much

hardships for women and children. This effects family well-being and has a direct impact on development of the village. With a "tanka" of 10,000 liters a family of four can survive of 100 day using water for all their requirement including water for cattle.

In the Anternesh village in Patna district there are five 10,000 liter "tankas" being constructed through community participation. In Fangli village in the same district there are five tankas of 15,000 liter each. This village is also served by other water supply sources like dug wells, rivers, and small streams but non appear to be reliable unlike RWH "tankas". Hence, people have more faith on "tankas" for their water needs. Constructions of these "tankas" have generated short-term employment for village mesons and construction labourers. According to estimates, one mason and two labourers can construct a "tanka" within 10 days. The success of "tanks" as a RWH structure for desert areas of Gujarat is a direct result of the partnership between supporting institutions of BDMSA, DMI, GWSSB, GOG, and BVM. Also the village Panchayat and beneficiary community have participated actively in making the RWH concept a reality.

A similar approach was adopted in Sri Lanka, where the CWSSP under the Ministry of Housing and Public Utilities initiated a RWH project for rural communities in the wet and intermediate zones. The implementations of RWH project in this case was totally demand driven with 20% equity participation from the beneficiaries and 80% from the project. Two types of 5000 liters tanks were constructed at household level. The surface tanks were made of Ferro-cement while the underground tanks were brick-motar. Total cost of these tanks vary from Rs. 7000 to 9000 depending on the type of tank. The acceptance of these tanks as a reliable means of water supply can be judged by the current spread of this technology. At present there are about 4000 such tanks constructed in five districts in Sri Lanka. While the initial implementation of RWH tanks were by the CWSSP, it has now being taken-up by number of development NGOs, as a means of water supply to poor households in rural Sri Lanka.

In the Tharpakar desert in Pakistan rich people have constructed their own "tanks" at household level using Reinforced Cemented Concrete (RCC) or sometimes Bricks motar. These "tankas" collect water from either roofs or courtyards which ever the case may be. Roof water harvesting is apparently a common phenomenon across the towns and villages of Tharpakar. In most cases the "tanka" water is used for drinking purposes. Therefore, the household elders have a special claim in maintaining and protecting these tankas. When these tankas are constructed underground, some households have built rooms adjoining to "tankas" to cope with the summer heat. These "tankas" can vary between 10,000 - 15,000 liters and could cost Rs. 10,000 - 15,000 (Pakistani Rs.) depending on the size. The water collected can be used by a family of 10-12 for an approximate period of one year. On the other hand sandy clay walled round shaped "tankas" of 7,000 - 12,000 liters can be as low as Rs. 3,000 - 5,000 per unit. These type of "tankas" are build by relatively poor people. Rich people on the other hand enhances the water harvesting by using polythene on roof tops and paving courtyards with concrete. These innovations, while enhancing water supply can also reduce contamination of rainwater. "Tankas" are also found in farmhouses where collected rain water is used during cultivation times.

Improving run-off with chemical sealents, soil covers, wax asphat or graveled plastics could harvest adequate water even from a 10 mm annual rainfall to satisfy household needs. An average courtyard of 200 m^2 can harvest 18,000 liters of rainwater from an annual rainfall of 200 mm.

The experience from Sri Lanka on Traditional RWH is a scaled down effect of the types already mentioned from India and Pakistan. In Sri Lanka rural people in the wet and the dry zones collect rain water during times of rain. However, the collecting vessels and storage containers are mostly limited to kitchen utensils and in some cases small brick-motar tanks of 200-350 liters. Interestingly, Sri Lankan peasants have novel ways of collecting rain water.

Broadly, traditional RWH in Sri Lanka can be categorized in to three groups.

(a) Roof water harvesting using indigenous temporary gutters.
(b) Using different techniques to harvest rain water from tree-trunks
(c) Open air rain water harvesting techniques

In the first case, one observes rural households in the dry zone using split trunks of Royal Palm (**Borassus habellifer)** Bamboo or Aricunut (**Areca catechu**) as gutters to harvest roof run-off. While these gutters are low cost and can be easily found in rural areas, it needs to be frequently cleaned and replaced with new ones. The second type, using tree trunks for harvesting rain is widely practices in most parts of Sri Lanka and it is a deep-rooted tradition of the rural peasantry. Usually a Banana stem-files, a dried Royal Palm leaf or a tin sheet formed into a down pipe is tied to the tree-trunk to collect water that seeps down the trunk. This practice is common during times of rain. People employ this technique to collect good quality water but in small quantities, usually 15-20 liters per day. The collected water is essentially used for drinking as the traditional water sources like dug wells often get contaminate during the rainy season. Traditionally, people have used coconut (**Cocus nucifera**) and Jack (**Atocapas nobilis**) to collect rain water. Rural people believe that the leaf symmetry of coconut palms can filter falling rain water, hence the quality is better.

The third technique of collecting rain water through open air harvesting is simply laying a large polythene sheet of say, 10 X 12 feet in the open when it is raining. The Polythene is supported by four, wooden sticks of 4-5 feet and of the Polythene is tapered towards a central hole to collect falling rain water. The water is collected into small household vessels placed bellow the hole of the Polythene. People collect this water purely for drinking as the quality of water is better than most other ground water sources during rain. Some households have used galvanized tin sheets instead of polythene sheets due to its longevity in use but the method of collecting water has to be changed due to the non flexible nature of galvanized sheets. However both material have their own advantages and disadvantage. Polythene on the other hand can break under heavy rain. Besides these methods there are other methods of traditional rainwater harvesting in Sri Lanka. These methods like rock catchment run-off, using inverted umbrellas to harvest rain and use of large diameter (1400 liter) traditional vessels to collect rainwater are few and far between.

However all these techniques were employed to collect rain water as a supplementary source of water to other conventional sources. Hence, rainwater harvesting in Sri Lanka has always being partial unlike in other instances in India and Pakistan. While rainwater is clean to drink, the quantities collected are small due to lack of proper containers and water storage is poor, thus leading to frequent contamination.

Some of the Advantages of RWH using household tanks are as follows;

i) As the storage tank is an individual ownership it is always better maintained.

ii) It improves household water security through easy accessibility of water, available within home stead and reliability of water.

iii) Rainwater quality is better than most other ground water.

iv) The technology is easy to understand, build and maintain by households.

v) Tank structures are more permanent and robust, hence the life time can be more than 10 years.

Harvesting Rainwater in Surface Natural Tanks (Ponds)

RWH is not only limited to cement concrete constructions. The natural rainfall can be captured and stored for agriculture (reservoirs) as often found in the dry zone of Sri Lanka and Southern India. The storage tanks can vary from few thousand Acre-feet to hundreds of thousand acre-feet cultivating large extents of land.

However, in this paper the discussion is focused on using large ponds or small reservoirs for RWH mainly for the purpose of domestic use and livestock.

In the Banaskanth district in Gujarat, a large numbers of women under the guidance of SEWA had participated in rejuvenating a water pond by lining plastic sheets on the tank (pond) bed. It is said that water and salinity are perennial problems in the area. During the wet months ponds fill with water but periodic droughts evaporate much of the water in ponds and large part of the remaining water gets seep down to the ground water table.

What remains in the ponds often get salty due to natural soil formation in the area. While, traditionally, people have harvested rainwater in **talavs** and **sarovars,** these local structures have disappeared with the introduction of piped water supply. Though pipes were connected to lot of villages there was hardly any water in the pipe lines due to heavy leakages and high demand. Hence, "pipes without water" is common phrase in these villages. Under this situation women and children had to migrate upto 600 miles down south and 700 miles up North in search of water and fodder. It was this situation that the women of SEWA wanted to arrest. A meeting was called in the village to discuss the options. Out of number of conventional options like dug wells, tube wells, over head tanks etc. villagers decided on rejuvenation of existing ponds as the strategy to improve the water situation in the village. This option was decided due to its cost effectiveness, convenience of harvesting rainwater into the pond, peoples likeness to use pond water and willingness of the people to participate in providing labour. BDMSA and DMI gave

the necessary technical and institutional support. As a result, the community in partnership with DMI and BDMSA decided to rejuvenate the pond by using plastic sheets as pond lining. In total 300 casual labourers from the village along with six professionals and 12 skilled labourers have worked for 6 months to complete the pond lining. Once the lining was completed, a sump was built on a side of the pond to avoid any contamination and damage to pond bank by potential users of the pond water. The total cost of lining amounts to Rs.2,100,000 (Indian Rs.). The immediate impact of this effort was, availability of drinking water throughout the year, decrease in workload for women, reduce health risks, minimize out migration and strengthen water security of villagers with respect to domestic requirement.

In the Alwar district of Rajastan a similar attempt to that of Banaskantha in Gujarat, has successfully revived the Ruparel Revulets from a drought stricken basin to a river full of life. Since 1947, shifting cultivation practices became wide spread in the Ruparel catchment. People started clearing forest for cultivation and some even shifted from animal husbandry to farming related activities. With this practice, in five years the area started to suffer from erosion and the top soil got washed away. Once the top soil was washed away land degradation was rapid. This led to drying up of springs due absence of trees and shrubs to retain water. The end result was people started moving to other areas and repeating the same practice. This led to the depletion of the ground water table in the entire Ruparel catchment. As a result of this, local people were compel to travel long distances in search of water. More than water for human use, it was the cattle who suffered most due to lack of water. Many people had to migrate to Jaipur and New Delhi in-search of water and employment. The worst kind of social impact of Ruparel drying-up was that even the low caste from the surrounding areas would not give their daughters in marriage to prospective bridegrooms from Ruparel, because the brides parents don't want their daughters to be "water maids" for rest of their life.

It is at this stage that a group of activists called Tarun Bharat Sangh (TBS) thought of working with the draught victims to revive the Ruparel. According to TBS, "Victims are the best managers of disaster". Hence, TBS and the effected community started to construct "Johads" - semi circular earthen pond that is build along the contours of hill slope for slowing, stopping and storing rain water. These "Johads" have a wide base to collect run-off from Tinny streams and Rivulets. Since the first collaborative efforts between TBS and the local community, 354 Johads have been constructed in 133 villages in the region. Since Johads were made out of rammed earth, most of the construction cost was labour which was offered willingly by the community. In some villages as much as one-forth of the cost of a Johad was given by future uses of Johads. On the average a Johad cost between 20,000 - 50,000 Pakistani rupees.

Within nine years of initiating to build Johads, in the Ruparel catchment, the river started to flow all throughout the year. This changed the economy and environment of the Ruparel catchment and its inhabitants. Revival of the Ruparel, raised the water table and gave easy access to water, soil erosion decreased and farming practices were increased. Those who migrated to other areas came back to their indigenous occupation of cattle

rearing, flora and fauna revived in the area. Hence there was a complete improvement in livelihood for Ruparel inhabitants.

Rainwater Harvesting in Man-made Depressions

In the Pakistan desert regions of Cholistan, Tharparkar and D.I. Khan, Rain water is harvested in natural or man-made depressions. These are large water harvesting bodies with capacities upto few million liters of water. The water harvested is mainly used for domestic purposes and for cattle. These water harvesting structures are community owned and they are managed and used by communities with specific user rights.

Tobas

Tobas as found in the Cholistan desert are mostly naturally occurring or at times man-made. The tobas are large and can collect over few million liters of water even under very low rainfall conditions, (180 mm per annum). The Cholistan soil are such that it can saturate within a very short time, hence it is ideal for water harvesting due to high compaction and low infiltration.

Use of Water

Most tobas are named after the clan living close to the toba. Usually 10-15 families live around a toba and use the water. Usually people of a clan are blood relations. Toba water can last for about 4-10 months depending on the size, and climate factors. When one clan finishes their toba water they either depend on wells which are brackish water or migrate to a another toba close by. Usually people in deserts allow others to take refuge in one anothers toba however at times of active water shortages there had been conflicts in sharing water.

Maintenance of Tobas

Most Tobas are usually centuries old hence they need regular maintenance. However the only maintenance in Toabs is to desilt them once every 4-5 years. Desilting is a community activity. People cooperate in this activity as they all depend on it and also because they are from the same blood clan.

As Tobas collect water from surface run-off, increasing run-off is a primary criteria for development of tobas. Among number of methods for increasing run-off, land alteration is the most suitable method in terms of cost and site specificity. In this methods ditches of different sizes are prepared in the catchment of each toba for rapid conveyance of run-off.

Evaporation and seepage losses are the most notable ways of water loss from tobas. According to research conducted by PCRWR evaporation losses are estimated to be about 39%. While seepage losses are about 28%. Thus, more than 50% of the water is lost from tobas without any impact on the community and environment.

As the toba catchment is the natural surface, the water harvested can contain large number of impurities. Research conducted on water quality of tobas indicate that the

physical quality deteriorate with time and RSC appears to increase with time in toba water.

According to PCRWR research tobas in Cholsitan desert can collect sufficient water for drinking and cultivation of fruits and vegetables if water saving irrigation techniques like drip and sprinkler systems can be used. It is estimated that more than 0.14 - 0.59 million acre-feet of water per annum goes as run-off and this amount is sufficient to cultivate 0.1 million acres of land under water intensive irrigation practices.

Cholistan offers two most essential variables for harvesting rainwater, large catchment area and low infiltration soil type. If these two variables are present in any other area, rainwater collection can be possible. Also the toba technology is very simple, it does not need any financial or material inputs, all it requires is human labour.
Hence, replicability becomes even more easier. Therefore, if the tobas can be properly managed by the communities with sound community awareness on using toba water, these tobas can ensure year long water security for the Cholistan community.

Tarai, Tonkas and Dhands

These are three types of traditional rainwater harvesting structures used in the Tharparkar region of Pakistan. Tarais are man-made depressions in narrow valleys between stabilized sand dunes. Tonkas are underground storage tanks harvesting roof run-off and court yard run-off from individual houses. Tonkas are sometimes build by farmers in fields where hard clay surfaces are available. Dhands are depressions between sand hills which collect rain water during rainy season. Dhands are widely used in the Nara region adjoining Tharparkar.

Both Tarai and Dhands are used to store rainwater for both domestic and livestock. However, it has also being used for small scale agriculture. One of the main drawbacks of these two structures is the water stored does not last for more than five months and often it finishes before the next rainfall takes place. Water loss from these structures is mainly due to evaporation and seepage. Absence of wind breaks in the Thar desert has caused high siltation of Tarai. Desilting of Tarais are usually undertaken by the community. Sometimes women use the tarai bed clay for house plastering, thus, instilling an automatic desilting process. In the Nara region, Dhands have been often contaminated due to dead animals in them. Therefore, it has been suggested to reduce seepage by using pond bottom sealents like viny sheets, filling with clay, ploughing organic matter or binding soil particles with polyvinyl soil amendments. All these will reduce seepage and save more water for the surrounding communities. Preventing contamination hazards by dead animals is also considered as an improvement to dhands. While both tarai and dhands have their own problems of retaining water and maintaining the quality, people use to dig wells close to taris and dhands to tap the perched ground water that seeps from these water sources. The water harvested through these wells are mostly used for domestic purposes and livestock. As such the quality of perched ground water is good and can be dependable.

Talais of D.I. Khan

Talis in D.I. Khan are similar to Tobas of Cholistan. People dig these talis as depressions to collect rain water. Talais are of different sizes. One that holds water for a year can be as big as 10 feet deep and 50' in diameter. Talais can be either dug manually or by tractors, which ever way it is a community effort. If labour or tractors are hired then community collect funds for payment. However, though talais are constructed collectively, there is no agreement to share water collectively, hence water related conflicts are common when all the talais dry-up and have to share neighbors talais.

Talai waters are used for domestic and livestock. Sometimes talais are even used for bathing of children and cattle. This could contaminate talai waters. Women usually carry water twice a day from talais for domestic use. This infact has become a social event for may women who are otherwise confined to houses due to local customs and traditions. Ownership of the talai depends on the ownership of the land. However, this does not restrict others (non-owner community) from taking water from talais.
Unlike in Cholistan and Thar deserts, Talais in D.I. Khan are physically guarded by a person at all times. This person, known as **Rakha** (caretaker) has a small room constructed on the banks of talais to protect the talai water from pollution by livestock and children. Hence, much security is given to talai water in D.I. Khan than other areas. Talais are also constructed in farmers fields to collect rain water. Without this water no cultivation is possible in the plains of D.I. Khan and Kulachi.

Advantages and Disadvantages of RWH

Rainwater Harvesting appears to be the only low cost method available to most rural communities to satisfy their water needs. The examples illustrated from the three Asian countries suggest that RWH structures can be build and managed by the local people. As such the governments have to act only as facilitators or with minimum financial interventions. Development of RWH in Sri Lanka indicates that the beneficiary contribution in construction of RWH has increased from 20% to 50% due the need of rainwater harvesting and increased sense of ownership.

Rainwater also supplies better quality water to rural communities specially during rain, when most water sources are subject to contamination.

RWH when practiced at homestead, gives the add advantage of having adequate water at accessible distance to be fetched by anybody irrespective of age and sex. Hence, their is an improvement in household water security, with respect to domestic water needs.
In the desert areas of Rajastan/Gujarat the practice of RWH mitigates out migration of people and livestock in-search of water and fodder. It has also improved the emergence of flora and fauna in river catchments and have had a positive impact on arresting depletion of the ground water table in desert regions.

On the other hand the biggest disadvantage of RWH is its total dependence on the rainfall pattern. Considering the global climate change and variability and unpredictability of

rainfall, the concept of RWH becomes most vulnerable. This incidentally is a function of intensity of rainfall, catchment area and storage capacity.

As the catchment area and storage capacity can be manipulated, sufficient rain water can be collected even under very low and unpredictable rainfall.

However, low mineral content in rainwater has caused health problems among humans and animals in Pakistan. In some parts of Thar desert deficiencies in sodium and chlorine have been detected due to prolong use of rainwater for drinking and use of non-saline (sweet) ground water.

In countries like Sri Lanka where rainfall is high, most of the rainfall goes waste as surface run-off. What is collected under traditional techniques are sufficient only for few days due to low storage capacity and poor management of stored water.

Potential and Replicability

Potential for RWH exists anywhere that receives rain. However the success of RWH depends on the methods employed to harvest rainfall. Potential, though exist everywhere, the efficiency of RWH depends on climatic and man-made factors (i.e. size of catchment and storage).

Traditional wisdom in RWH exist in most Asian countries. However it needs to be properly harnessed to benefit the local communities to satisfy their water needs. Harnessing traditional wisdom to suit present day requirements need financial support and commitment.

Rainwater harvesting technology is very simple. Hence, it can be replicated anywhere, given the following conditions can be satisfied;

(a) Regular normal rainfall with natural or man-made catchments adequate to harvest water to satisfy the local needs.
(b) Local community involvement in construction and management of RWH structures.
(c) Availability of methods to improve the efficiency of catchments, reduce seepage and evaporation in large scale natural catchments like in Cholistan and Tharpaker in Pakistan.
(d) State and NGO commitment to encourage, build awareness and motivate local communities to practice RWH as an alternative means of water supply for domestic and livestock needs.
(e) Need to harvest rainwater with adequate financial collateral and subsidies to supplement rainwater with conventional water sources.

Conclusion

Rainwater harvesting is an age old tradition that exists among most Asian cultures. However, with the introduction of new water supply technologies, RWH has been abandoned in most cases. Nevertheless rural communities in Asian countries which includes desert settlers in places like Rajastan, Cholistan and Tarparkar, practice RWH as their main source of water supply. In this instance, it is the traditional wisdom that is being put into good use to harvest rainwater. Hence, where the need exists the traditional wisdom has given the communities the skill of harnessing water from the skies to mitigate disasters and distruction of communities and development of settlements. Therefore, it would be prudent to adopt the traditional wisdom of RWH in modern water supply options as a fall back mechanism for domestic water supply. While most conventional water supply users face water scarcities when supplies fail due to technical reasons or drought, RWH systems have supplied water to its users due to local level collection and judicious management practices. Hence, their is an improvement in water security of rainwater users and the livelihoods have improved since the use of rainwater as an alternative source.


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