Reviving a Water Heritage: Economic and Environmental Performance of Traditional Water Harvesting Systems in Western India

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Introduction
The impending crisis of scarcity of potable water, even in high rainfall zones, has emerged as an issue of serious national concern. It is fairly well established by now that it is no longer feasible to meet all the domestic water needs through perpetual and excessive withdrawal of groundwater. In India, whereas mechanism to ensure prevention of overexploitation of groundwater by variety of competing users (including agriculturists, industrial units and urban settlers) continues to remain in the arena of policy debate, alternative ways and means to meet the growing demand for potable water from the rural sector have come under urgent consideration. This is particularly so as the state-run piped water schemes have left much to be desired in terms of reliability, adequacy and sustainability of supply in rural India.

The relatively recent initiation of reorientation in rural water supply, as part of the overall sectoral reform initiatives, emphasising user financing and local management, faces a number of constraints. The most notable of these hurdles concerns the inadequate or low recovery from the very poor rural households. Despite the soundness of the `efficiency' argument, payment for capital expenditure by individual households in poverty remains a complex issue to tackle.

Objectives
The objectives of the study are to:
- Work out the potential of revival and modernization of traditional water harvesting systems
- Address the vital problematique of ensuring that the availability of potable water in rural households is sustainable.

It is important to recognize that much of the "enthusiasm" generated by the decade-and-a-half-old resurgence of interest in Traditional Water Harvesting Systems (TWHS) as alternatives in solving the rural water crisis, needs to be validated against their actual potential. This is important as TWHS depends on collecting and storing surface run-off and rainwater. Therefore it is an excellent option that does *not* draw upon the valuable groundwater beyond the rechargeable limit.

While TWHS are thought upon as options based on local knowledge, environment and socio-cultural practices, a large number of them can no longer cater to the total demand for water in a given village whose population keeps growing. Further, barring a few, in many cases the traditional form of community-based management of the structures has been a matter of past.

Gross neglect of these common property resources is evident in the existence of damaged structures, pollution of the water and even forcible possession by vested interests for private purposes.

Despite the indifference meted out to these age-old structures in many regions, especially when attention centred around the solution that was expected to come about through the modern piped water system, TWHS continue to function in numerous villages of India and if not fully, these sources could fulfil demand for water for domestic use partially, particularly during the summer months.

Sites
In view of the rather limited and sketchy literature available on TWHS (meant mainly for drinking water purpose) and the growing need to appreciate their environmental and economic performance this study concentrated on three distinct TWHS as extensively found in the Thar Desert and Central Uplands Regions. The systems studied are bavdis in western Madhya Pradesh, wells (which are primarily recharged by nadis) in western Rajasthan and talavs in Kutch region of Gujarat.

Bavdis or the community step wells are shallower than wells, they have beautiful arches along their full height. Bavdis can hold water for a long time because of almost negligible water evaporation when compared to other water bodies. A nadi is essentially a natural surface depression, which receives rainwater from one or more directions. Some nadis have stonewalls on one or two sides to enhance capacity of water retention. A talav is a local water reservoir situated in valleys and natural depressions. In old talavs, only the slope side was provided with strong parapet walls to hold the rainwater. Other sides were naturally supported by outcrops of hillocks or elevated rocky formations.

Methodology
Three distinct approaches were followed:

Hydrogeological and engineering surveys were undertaken to understand the functional dynamics of the systems. These also included exploring possible technical interventions and modifications needed to improve the existing structures so as to enhance the availability of water. Estimates of cost of revival/modernization of TWHS were arrived at following these surveys and consultation with locally informed people, NGOs and concerned engineers and hydrologists in the local state/taluka department offices. Similarly, estimates were also prepared for capital expenditure and O&M costs for installing piped water network in the village, so as to provide tap connection to every household. These sets of estimates were made for all the six sample villages.

Village and Household level surveys were conducted in order to elicit information on demographic and socio-economic variables of the inhabitants and availability of infrastructural facilities. A total of 301 households were surveyed for the purpose. Special care was taken to obtain as much detailed data as possible on water related issues, such as, sources, pattern of use, time taken and distance covered to fetch water and perception about quality. The household and village level structured surveys were supplemented by fairly well attended focus group discussions, oriented in a manner to understand diverse views as expressed freely by the participants. The focus group discussions (FGDs) dealt primarily with the ticklish issues of community ownership and management of the existing TWHS.

The third but vital approach followed in the analysis related to the valuation of popular willingness to pay (WTP) for provision of facilities of water through improved TWHS and supplying water through household level tap connections. This exercise was based upon structured questionnaires prepared following the Contingent Valuation Method (CVM). The introduction of the option of mode of payment was supposed to help reveal respondents' actual ability to pay for the amenities.

These exercises in ascertaining households WTP from possible water supply devices, proposed through the creation of a hypothetical market scenario, provided the most interesting clues regarding popular perception about the TWHS and/or modern piped water supply and their readiness to pay for either or both of these systems.

Results

Drawing upon available documentation on TWHS and extensive field surveys in the broad ecological zones of the Thar Desert and Central Highlands, it is obvious that TWHS not only vary substantially in terms of technology and management, but also their functioning depends crucially on the local discrete environment. Keeping these local specificities in view the potential of selected systems in terms of long-term sustainability can be described in brief, as follows:

Bavdis in Southwestern Madhya Pradesh: These exist in huge numbers. But, mainly due to their typically small size and limited storage capacity, these are probably not the best options for meeting community water needs. However, as observed by the hydro geologists and water engineers, it is possible to deepen existing talavs and dig new ones that, in turn, would recharge bavdis. In Dhababavdi (Barwani district) the currently functioning two bavdis serve a limited purpose and, clearly, cannot address the water scarcity problem of the entire village.

Wells in Western Rajasthan: Wells as TWHS in the western parts of Rajasthan have continued to prove useful even during summer months in the driest geoclimatic region of India. Unlike bavdis, wells are extensively used by the rural communities and are well maintained. All the wells visited in this region during the peak summer season, had good supply of water and the local perception about its quality was positive. An important hydro geological characteristic of the wells surveyed was that the structures had been linked to underground perennial streams/channels. Also, these wells had been built with reference to the surrounding nadis (TWHS by themselves) so as to receive water recharged through them. Such ingenious selection of location and construction of the structures ensured a steady supply of water in the wells. These wells hold much potential to be revived and modernized. One effective approach would be to desilt, deepen and widen the concerned nadis; this will ensure a substantial increase in availability of water in the wells, which may be stored for a long period of time. These structures are also viable options in these regions where piped water system is most likely to fail due to very low groundwater tables.

Talavs in Kutch, Gujarat: Almost all parts of the Kutch region have suffered substantial groundwater depletion and salinity ingress. High incidence of poor groundwater bearing formations has resulted in severe water crisis in the region. Talavs certainly remain an important solution to the water problem in Kutch. In many villages visited, villagers considered water from local talavs to be of good quality and that water is available in them during prolonged spells of summer. The structures in the surveyed villages are unique examples of interconnected talavs, specially designed to prevent drinking water mingling with water in other talavs meant for washing or bathing purposes. In terms of size and capacity talavs are of large dimensions. These are in dire need of revival and modernization and can surely prove valuable in addressing the water shortage problem in Kutch region. Unlike the saline groundwater, talavs retain potable water and also recharge surrounding aquifers as also other TWHS like wells.

Water Quality

A commonly held observation disfavouring TWHS as potential sources of potable water concerns the ‘unprotected’ and ‘unsafe’ nature of the water. This important dimension of quality of water of TWHS must be taken into consideration in evaluating their potential. Water samples from the surveyed TWHS were collected for chemical analyses. Of the seven water samples collected from individual TWHS, in all the cases the water was found suitable for drinking; the incidence of total dissolved solids (TDS) was within permissible limits. Bacteriological analyses of the water samples were also carried out in the laboratory following scientific instructions. These tests, however, indicated to the unsuitability of the water for drinking purposes due to the presence of very high concentrations of coliform bacteria.

Irrespective of the fact that most villagers use the water of TWHS for drinking, cooking and other domestic purposes, these scientific tests indicate deficiencies in water quality. In most cases, as in the surveyed TWHS, quality of water can be upgraded substantially through cost-effective methods of treatment. Whether some sources are to be abandoned, primarily due to lack of any scope to improve water quality, even up to the level of being used for domestic purposes (other than human drinking) only, should be left exclusively to the discretion of the scientific experts.

Valuation of TWHS

Whereas hydrogeological and structural engineering studies could work out interventions that would revive/ modernize the specific TWHS on a long-term sustainability basis, the estimation of both the capital cost as well as O&M indicates the financial investment that would be required. Such estimates are likely to represent the total use value of the environmental 'commodity' in question. As the analysis concentrates on potable water meant for domestic consumption only, the existence value of the commodity becomes irrelevant. Also, the nature of benefits of having access to good quality water is very much within the knowledge of the potential users. It may, hence, be held that the assessment of WTP undertaken in the study falls within the broad purview of cost-benefit analysis. Assuming that the entire cost of revival/ modernization would be shared between all the households in the village, an assessment of the willingness to pay for the improvised structures was made. The most significant aspect of the WTP exercise was that a substantial 65 per cent of all households surveyed were not willing to pay any amount whatsoever for either or both the hypothetically proposed facilities. Despite having a series of independent variables, indicating the most likely socio-economic factors, regressed with the amount of WTP, the state level results showed only per capita consumption of water in Madhya Pradesh and Gujarat and caste of the household in Gujarat as the significant variables affecting the WTP (Table 1). However, when similar regressions were run for Rajasthan none of the variables was found to be significant.

Table 1: Overall Summary of Logistic Regression Results

State/ Level of Significance	1% level of Significance	5% level of Significance	10% level of Significance
Madhya Pradesh			PCHUMQ (1.035)
Rajasthan			
Gujarat	CASTE (0.174)	PCHUMQ (1.049)	

In fact, a close examination of the nature and extent of households' WTP provides interesting insights into such a pattern of response. First, most households in the Rajasthan villages are living in extreme poverty and, naturally, have refused to pay at all for the water from either TWHS or piped systems. The villagers are perfectly aware that the existing wells, from where they have been drawing water free even during the peak summer months, will continue to meet their minimum basic demand for potable water. However, if extreme poverty could lead to negative response for paying for water, in Dhababavdi (the MP village) quite a few villagers living below the poverty line have expressed their willingness to pay even small sums for water facilities. This is so, as this village has practically exhausted all existing sources and the value for water has clearly risen for them.

Second, unlike the capital cost, most villagers in all the surveyed villages were willing to pay for the O&M for TWHS; in many cases the estimated contribution for O&M for the proposed piped system was much higher than that for TWHS. People's willingness to contribute free labour indicates the preference for the revival/ modernization of the TWHS. Table 2 presents the proportions of respondents willing to pay for revival of TWHS, laying of piped system, O&M for both TWHS and pipe network and contribution of free labour across sample villages.

Table 2: Willingness to Pay Across Sample Villages

(Percentages)

Particulars	Madhya Pradesh		Rajasthan		Gujarat	
	Dhababavdi	Temla	Nagana	Godavas	Tera	Reha Mota
WTP_{TWHS}	26.8	11.8	14.3	4.7	77.3	11.8
WTP_{PIPE}	22.0	9.8	5.7	-	18.2	7.8
$WTP_{O\&MTWHS}$	39.0	76.5	97.1	100.0	93.2	90.2
$WTP_{O\&MPIPE}$	29.3	13.7	17.1	-	72.7	13.7
$WTP_{LABOURTWHS}$	92.7	84.3	97.1	100.0	77.3	74.5

An important aspect of this exercise in assessing WTP is that even the most sophisticated methods of valuation may be inadequate to elicit information on the WTP behaviour if the respondents refuse to participate in the `bidding' process due mainly to abject poverty and rejecting the very proposal that potable water could be priced for the rural poor.

Recommendations

A number of technological options to revive/ modernize the TWHS have been put forth by the hydro geological and engineering experts. Most of the considered suggestions have been highly discrete (specific to the system or site per se) and often have incorporated ideas from local inhabitants. For instance, as may be seen from Table 3, especially the bavdis may not prove to be adequate sources of water due to their small size. Table 3 presents brief notes on suggested technological interventions, which may serve as useful guidelines in appreciating the utility and sustainability of individual systems.

Table 3: Structural Issues Relating to the Revival of TWHS

Particulars	Bavdi		Well		Talav	
	Dhababavdi	Temla	Nagana	Godavas	Tera	Reha Mota
Structural Features	Structure is small				Huge capacity and favourable topography	
Potability	Unsuitable for human drinking	Water unsuitable for human drinking	Ground water is becoming saline	Increasing salinity	Used as potable water	Reported to be unsuitable for drinking but good for cooking
Technological Interventions	Desilting of catchments would improve water table	Desilting of local talav is essential for recharge of the bavdi	Desilting of local talav would improve the water and reduce salinity		Some people reported to have had diseases because of the bacterial contaminatio n of the water during late summers	Desilting would improve the groundwater level in the area

Table 4 presents some relevant issues covering management and maintenance of the TWHS. In case of the well in Nagana in Rajasthan and the talav in Tera in Gujarat the local community did management and maintenance of the TWHS. These are the villages where the use of water from TWHS has been extensive and also the quality of water has been well maintained. In the remaining cases, a preference has been expressed for complete or partial involvement of state government in managing and maintaining the sources. In these villages, the general lack of confidence in the efficacy of the sarpanchs in managing these sources is striking. The possibility of public and private participation in financing the revival of the TWHS in these villages may be explored.

Table 4: Management Issues in Revival and Maintenance of the TWHS

Bavdi		Well		Talav	
Dhababavdi	Temla	Nagana	Godavas	Tera	Reha Mota
Presently privately owned, Government should take-over & manage	Government/ Panchayat managed: Distrust among the people regarding the usage of funds	Panchayat Managed	Improper local management	Community managed	Government should take up the management
Sarpanch is illiterate: Lack of leadership	Lack of leadership, Sarpanch illiterate	Leadership is caste biased		The local leaders are highly motivated and concerned for the water management	
No participation from women		Women do not have a say in the local management	Lack of sense of responsibility for maintenance of the existing structures	People are united for maintenance of the system	Generally people were not interested in taking up the maintenance and management of their water supply.

It was apparent that TWHS were not or will not be able to cater to the *total* requirement of drinking water in the villages, mainly due to the rise in population in the past decades. Nevertheless, if revived/ repaired and, importantly, the ownership is shifted from the present private owner to the original community, these sources can be of substantial use, especially during summer.

Piped water system, though preferable, has implications of increasing cost in future either due to increase in population or depletion of groundwater. Additionally, the ubiquitous problem of unreliability of piped water supply has serious implications for considering alternative sources.

Hydrogeology specific technological strategies to harness rainwater and modernize TWHS need to be explored as enhanced supply per se can reduce costs significantly. In such ventures whether and how the State can intervene or shall seek private participation, both for financing and providing technical and management support is an issue to be explored. In TWHS, the trickier issue is management with community participation. The control over the system by the local dominant group is difficult to wish away.

Interestingly, the large-scale prevalence of TWHS in its varied forms in the three states has not been adequately documented in the rather limited literature on the subject. Locating the TWHS through the field survey, wherein about 50 such structures were visited, *in itself* was an important aspect of the study.