Decentralized Artificial Recharge Movements in India: Potential and Issues

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Introduction

Rainwater harvesting (concentrating runoff from watersheds for beneficial use) was practiced in the arid- and semi-arid tracts of India as early as the sixth century. Encompassing any practice that collects runoff for productive purposes, rainwater harvesting includes three components: 1) a watershed area to produce runoff; 2) a storage facility (soil profile, surface reservoirs or groundwater aquifers); and, 3) a target area to beneficially use the water (agriculture, domestic or industry). The classification varies depending on the spatial scale of the runoff collection, from in-situ practices managing rain on the farmland (often defined as water conservation) to external systems collecting runoff from watersheds outside the cultivated area. Rainwater harvesting practices are further classified by storage strategies from direct runoff concentration in the soil to collection and storage of water in structures (surface, subsurface tanks, and small dams). In many decentralized artificial recharging activities, rainwater harvesting is a part and parcel of the decentralized artificial recharge.

In many parts of India, especially in the arid- and semi-arid regions, due to variations in the monsoon and scarcity of surface water, dependence on groundwater resources has increased tremendously in recent years. Easy availability of credit from financial institutions for sinking tube wells coupled with provision of subsidized/ free electricity for pumping in many states has exacerbated the increased extraction of groundwater. On the other hand, rapid urbanization and land use changes has decreased drastically the infiltration rate into the soil and has diminished the natural recharging of aquifers by rainfall. These factors have contributed to lowering the water table so much that many dug wells and tubewells are decreasing now in their yield and ultimately drying up. The situation becomes more precarious during summer, when most of the yield of dug wells and shallow tubewells either reduces considerably or dries up. The drinking water crisis, which is prevalent in most of the villages during the summer, imposes serious health hazards to the rural masses and, is responsible for the loss of a huge livestock population for want of drinking water and fodder (Shah 1998).

Artificial recharging is the planned, human activity of augmenting the amount of groundwater available through works designed to increase the natural replenishment or percolation of surface waters into groundwater aquifers, resulting in a corresponding increase in the amount of groundwater available for abstraction. Augmentation of groundwater resources through artificial recharging of aquifers, which supplements the natural process of recharging, has become relevant in situations witnessed in India, where the rainfall is seasonal (monsoon) and is not spread uniformly across the country, and the quantum of natural recharge is inadequate to meet the increasing demand of groundwater resources. The artificial recharging of groundwater has been taken up as one of the corrective measures on the supply side to compensate for this overexploitation and to retard the drying of tubewells. The artificial recharging of shallow aquifers to supplement groundwater is not new to this country. It has been in vogue from time immemorial in the hard-rock, semi arid regions of India, where artificial recharging co-existed with the water conservation of monsoon rains through innumerable small water-holding structures (called dug wells) and dugout ponds (called '*ooranies'*).

This paper looks at the historical evolution of the groundwater recharge movement; how it has gathered momentum; who promoted these activities; and what it has achieved to-date. The paper highlights the potential of decentralized groundwater recharging as well as the associated issues. At the end of the paper, a road map for long-term and near-term strategy for artificial recharging is suggested.

The next section briefly presents the progression of the use of artificial recharge in India.

Progression of Artificial Recharge Movement in India

Artificial recharge, one of the oldest activities undertaken in India to conserve rainwater both on the ground and underground, is as old as the irrigated agriculture in the arid- and semi-arid regions. In the olden days, the recharge movement initiated by the local communities was aided and supported by the kings; chieftains; philanthropists and by those who valued water and practiced conservation. There are numerous examples and stone inscriptions from as early as 600 A.D. citing that ancient kings and other benevolent persons considered the construction of '*ooranies'*, as one of their bounden duties in order to collect rainwater and use it to recharge wells constructed within or outside '*ooranies'* , to serve as drinking water sources. Even today, thousands of such structures exist and are in use for multiple purposes in the southern coastal towns and villages of Tamil Nadu, where underground water is saline (DHAN Foundation 2002).

More than 500,000 tanks and ponds—big and small, are dotted all over the country and more so in the peninsular India. These tanks were constructed thousands of years ago to cater for multiple uses, including irrigated agriculture, livestock and for human use such as drinking, bathing, and washing. The command area of these tanks has numerous shallow dug wells, which are recharged with tank water and are used for augmenting the tank water. Many drinking water wells located within the tank bed and/or on the tank bund are artificially recharged from the tank into these wells to provide a clean water supply throughout the year with natural filtering (DHAN Foundation 2002).

In traditionally-managed tank irrigation systems, when the supply of water to the tank is insufficient to raise a crop by gravity flow from the tank, it is not uncommon for the village community to decide to close all tank sluices and allow the tank to act as a percolation tank to recharge the wells in the command area. Subsequently, the recharged water is shared by the beneficiary farmers. This has been done to distribute the limited water to the crops without any line losses due to the gravity flow. This practice is in vogue even today in many traditionally-managed irrigation systems. With the water supply to many tanks dwindling for various reasons, this practice of converting irrigation tanks to percolation tanks to artificially recharge the wells in the command is increasing day by day. This practice has become a movement by itself, and even certain state governments such as Karnataka are encouraging this practice through the enactment of law and enforcement (Sakthivadivel and Gomathinayagam 2004).

Harvesting roof-water and storing it underground in tanks is a very common phenomenon in many Indian states, which are experiencing acute shortages of drinking water supplies. Similarly, pumping induced recharge water from wells located near water storage structures like tanks, irrigation canals and river courses, and transporting it to a long distance through pipelines for irrigation is a common sight in many water-deficient basins. These activities, which originated spontaneously and mostly due to necessity, are a movement by themselves. Further details on traditional water harvesting and recharge structures can be had from a publication entitled 'Dying Wisdom' by Anil Agrawal and Sunita Narain (2001).

The spread of Artificial Recharge Movement in India (ARMI) can be broadly classified under four phases. The first phase relates to the period before the green revolution when limited exploitation of groundwater was taking place i.e., before 1960; the second is the period between 1960 and 1990, where intense groundwater exploitation took place with signs of over exploitation; the third is the period from 1990 to -date, when water scarcity is increasing alarmingly and the groundwater level is declining in certain pockets of India; and the fourth phase is of recent innovation when large-scale pumping equipment and pipelines become available and affordable.

The first phase is the one when traditional water harvesting methods were given impetus through unorganized yet spontaneous movement by the local communities, aided by kings and benevolent persons to meet the local requirement at a time of crisis. During this period, there was very little knowledge-based input from the government, non-government organizations and the scientific community to provide assistance for understanding and putting into practice a systematic way of artificial recharging, and up-scaling. Yet, the local community used their intimate knowledge of terrain, topography and hydrogeology of the area to construct and operate successful artificial recharge structures, some of which have managed to survive even to -date. In this phase, there was little application of science related to artificial recharging; most of the experiences were based on local knowledge and perceived wisdom. Very little understanding existed about the consequences of and the knowledge required for artificial recharging of underground aquifers.

The second phase coincides with the period of large-scale extraction of groundwater resulting in many aquifer systems showing signs of overexploitation, especially in the arid- and semi-arid regions. During this phase, the curriculum relating to hydrogeology and groundwater engineering were introduced in many universities and the science of groundwater hydrology was better understood. Both the public and the government had started realizing the importance of recharging aquifers to arrest the decline in groundwater and maintain the required groundwater levels. As a consequence, pilot studies of artificial recharging of aquifers were carried out by a number of agencies including Central and State Ground Water Boards, Water Supply and Drainage Boards, Research Institutes such as National Geophysical Research Institute (NGRI), Physical Research Laboratory (PRL), National Environmental Engineering Research Institute (NEERI), agricultural and other academic institutions, and non- governmental organizations such as Centre for Science and Environment (CSE).

Pilot studies of different kinds have been carried out and the technical feasibility of artificial recharging and recovery of recharged water have been established. During this period, two important events with respect to artificial recharging took place that are of relevance to the movement. One is the synthesis of research and development works carried out in India in artificial recharging by a team of experts under the Rajiv Gandhi National Drinking Water Mission, constituted by the Ministry of Rural Areas and Development, Government of India, New Delhi. . The second is the effort provided by the Indian Standard Organization (ISO) to bring out technical guidelines and specifications for artificial recharging. These have given impetus for further experimentation on artificial recharging.

The third phase is the current phase where water scarcity, continuous droughts in certain pockets of India and the continuously declining groundwater levels in many parts of India have forced both the public and the government to become aware and take up artificial recharging on a war footing. Three major events that took place during this period are significant to the artificial recharge movement in India. One is the spontaneous uprising and co-operation from the public supported by religious leaders, philanthropists, and committed individuals to take up artificial recharging through dug and bore wells, check dams and percolation ponds, followed by the government joining hands with the local community in implementing such schemes on a mass scale (Shah 1998). The second is the action taken by a state government such as Tamil Nadu, in promulgating the groundwater regulation act pertaining to the metropolitan area and ordering the community to implement rainwater harvesting schemes and artificial recharging on a compulsory basis in the metropolitan area. The third event relates to the awareness created among the public by the non-governmental organizations such as the Centre for Science and Environment and Tarun Bharat Sangh and the media exposure to the importance of artificial recharging.

The fourth is the recent increasing trend of abstraction of induced recharge witnessed in many gravity irrigation systems in states like Tamil Nadu and Gujarat. Given the increase in water-scarcity faced in many irrigation systems, the availability of large-scale pumping machinery at affordable prices and subsidized power have led many enterprising farmers to resort to wells near the storage reservoirs, and on canal and riverine courses to create induced recharge in their wells. The induced recharge water is then transported through pipe lines to many km away from the pumping site to irrigate non-command areas with orchards and other high-value crops using drip and sprinklers. This practice of pumping induced recharge water outside the command area has had a very negative effect on managing large irrigation systems because of the siphoning of a considerable quantity of water to areas not originally included in the command. This occurs more so in the years when there is an inadequate supply of water to the reservoirs as well as in the drought years. This is a spontaneous movement, which is spreading like wild fire; if it is not controlled and regulated, many surface irrigation systems will suffer their natural death in the very near future. (Neelakantan 2003).

Artificial Recharge Methods

The following artificial recharge methods are in vogue:

1. Direct methods in which water from surface sources are conveyed or stored in- situ at places above the aquifer areas, where the water is made to percolate and recharge the groundwater.

2. Indirect methods in which the transfer of surface water is induced as a consequence of human activity and is effected by locating the groundwater abstraction wells near influent streams. Another type of indirect recharge is from the seepage of streams or canals or lake-beds and return flow from irrigation.

3. The combination of the above two methods, which are widely used to meet the topography and terrain condition.

In areas where rainfall is scarce and drought frequency is high, artificial recharging of rainwater is accomplished by employing an integrated series of techniques, which, for example, can include damming the gullies of minor streams, constructing subsurface dikes and/or percolation tanks along their tributaries, contour bunding and trenching on slopes, placing farm ponds in the foothills, and wherever possible, installing check dams-cum- minor irrigation dams on the main stream courses. Terracing and forestation of hillsides, which help to retain runoff and increase infiltration, may also form part of an integrated basin-scale water resources development plan. An important factor to be considered while designing an artificial recharge structure is the consideration of their stability during high flows and the minimization of accumulation of silt and organic matter within the structure.

In many parts of India, rural drinking water supply programs often witness shortages of supply from bore wells because of the increase in groundwater use for irrigation from bore holes in and around the drinking water bores. Enhancement of recharge to the groundwater has, therefore, become mandatory in areas where groundwater is the only source of drinking water supply. The methodology of Artificial Recharge and Retrieval (ARR) can profitably be used for recharging a well during the monsoon and using it for drinking water during the summer months. Two or three such wells may be declared as sanctuary wells for each village and the ARR scheme may be implemented (Muralidharan and Athavale 1998).

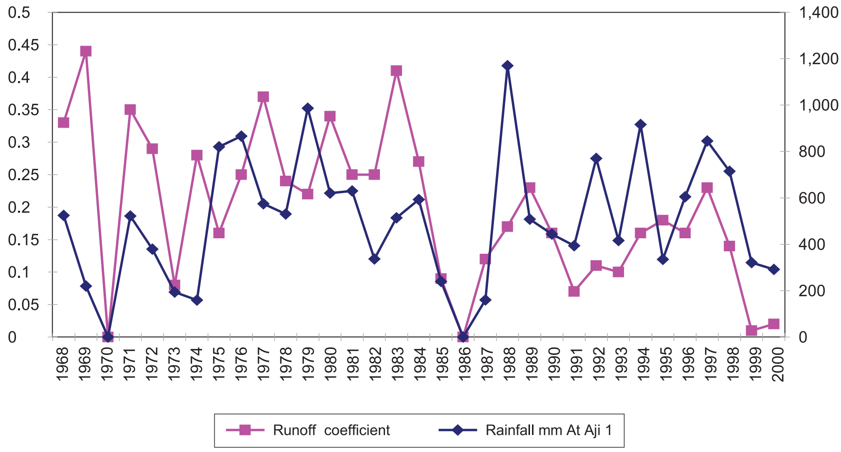
Impacts of Artificial Recharging

Two typical contrasting case studies to illustrate decentralized artificial recharging on the upstream and downstream impact and local level benefits accrued from recharging are illustrated here:

Upstream-Downstream Impact of Artificial Recharging

Upstream development of water harvesting structures in a basin/watershed context affects the inflow to the downstream storage impoundment. There are few who think that upstream impounding storage volume in micro recharge structures is only a very small fraction of the total massive volume of rainfall falling on a vast catchment and, as such, may not have a perceptible impact on the downstream flow. But, there is another school of thought arguing upstream development will have a marked effect given the innumerable number of check structures coming up in the catchment. Also, in many catchments experiencing marked inter- and intra-annual variation in rainfall, especially when the watershed is a closed one, supply to the downstream reservoirs is very much affected by the upstream development of artificial recharge structures. This point is brought out by the following example.

Figure 1. Rainfall and runoff variations in Aji1 watershed from 1968-2000.



Aji1 watershed in Saurastra is a water-scarce and closed subbasin with a very high variation of annual rainfall ranging from 200 mm to 1,100 mm. Aji1 reservoir is a water supply reservoir to the city of Rajkot, located at the tail- end of the Aji1 watershed. The flow to the reservoir was on the decline, especially after 1985 due to the construction of thousands of check dams and percolation ponds within the Aji1 watershed. The construction of these small water conservation and recharge structures is a result of a recharge movement initiated initially by Shri Panduranga Athvale, a religious guru of the Saurashtra people and later supported by the Government of Gujarat.

In order to verify whether there is a downstream impact due to the upstream development of check dams and percolation ponds constructed for recharging the groundwater aquifer, rainfall and inflow data to the Aji1 reservoir was collected for the years 1968-2000 and a simple analysis was made to compute the runoff coefficient. The computed coefficient along with rainfall is plotted in Figure 1. The x-axis represents the years starting from 1968 while the y-axis represents annual rainfall and runoff coefficients. As seen in the figure, the contribution to the reservoir storage was significantly reduced after 1985. The runoff coefficient was fairly high up to 1985 and thereafter it has reduced considerably. Nevertheless, the rainfall remained more or less the same before and after 1985. The average reduction in the runoff coefficient after 1985, which is almost 100 % of its original value, indicates the extent of impact of the upstream water harvesting structures on the downstream reservoir. Water harvesting in the upstream part of the watershed has definitely affected the downstream drinking water use of the Rajkot Municipality. This downstream impact on storage reservoir due to the upstream development of water harvesting structures need to be kept in mind while designing water harvesting structures for artificial recharge. Hence, before such structures are constructed, water accounting for the subbasin should be carried out (Molden and Sakthivadivel 1999).

Impact Evaluation of Check Dams

The year 2000 was an unprecedented drought year in the State of Gujarat. The water crisis in that year had created an intense awakening among the people of the Saurashtra and Kutch regions about the importance of artificial recharging of groundwater. Several social workers and service-oriented nongovernmental organizations (NGOs) had undertaken numerous water conservation projects in these regions by collecting voluntary contributions from the people for harvesting rainwater to recharge groundwater, which can be utilized for drinking and agricultural purposes. Their efforts and results have been overwhelmingly successful. As a result of these efforts, under Sardar Patel Participatory Water Conservation Program (SPPWCP), the Government of Gujarat had invested over Rs.1,180 (US$28) million in the construction of 10,708 check dams distributed over Saurashtra, Kutch, Ahmedabad and the Sabarkantha regions. These works were carried out with direct and indirect financial participation of beneficiaries, who contributed up to 40 % of the estimated cost, and the government paying the balance 60 %. The entire responsibility of managing the quality of construction work was undertaken by the beneficiary group/NGO.

An independent evaluation of the check dams in Gujarat was carried out in 2002 by the Indian Institute of Management (IIM), Ahmedabad, covering vital aspects like: a) total evaluation of the project; b) advantages of people's participation; c) benefits in agricultural production; d) drinking water supply; e) availability of fodder; and, f) socioeconomic cost benefits (Shingi and Asopa 2002).

Following the analysis of the survey data for over one hundred check dams, and after personal visits by the evaluation team to a large number of other check dams, and talking to more than 500 farmers, the team concluded that:

1. Localized rainwater harvesting systems in the form of check dams in Saurashtra contain a proven solution to water crisis by recharging rainfall runoff into an underground aquifer, offering a decentralized drought-proofing system, and allowing for the people's involvement in critical water management tasks, with simple, local skill based, cost-effective, and environmental friendly technologies.

2. The rainwater harvesting efforts initiated with the people's participation and support from SPPWCP should be re-launched and implemented on a larger scale.

3. The 60:40 scheme (60 % by government and 40 % by beneficiary) has six major features capable of attracting donor investments. These features include: i) rainwater harvesting is an ecologically sound proposition to recharge depleting groundwater sources; ii) the scheme is highly participatory as people contribute to the extent of 40 % of the cost by way of labor, equipment, and/or money; iii) the scheme is highly gender sensitive as women are the major beneficiaries of the alleviation of drinking water and livestock feed problems; iv) the project does not replace or endanger human and wildlife habitats; v) the scheme focuses on equitably using renewable resource like rainwater; and vi) the proposition is economically and financially very sound with a short pay back period.

The 60:40 scheme has been and should continue to remain as the people's program. Without the people's participation, the scheme is unlikely to survive. It is only the people's involvement that would ensure critical components like: a) quality of works; b) preventing the entry of undesirable contractor's into partnerships with the government; c) sustainable maintenance and supervision; d) speed of implementation; e) ingenuity and innovative way of implementation; and f) cost-efficient technical guidance, prompt clearing of bills and respectful encouragement, which are the kind of inputs that people need the most.

The Role of Artificial Recharge in the Overall Water Requirement of the Country in 2050

The total water resource availability in 2050 for high population growth is estimated by Gupta and Deshpande (2004) as given in Table 1.

Table 1. Water resources availability for 2050 (km^3)—(Based on low and high population growth).

Water available during 2001	Water required during 2050	Anticipated water deficit	Possible measures to meet the deficit				
			EUSW+GW in excess of 1998	Recyclable waste-water	Irrigation return flow	RAGWR	Water availability
500	973-1,450	473-950	SW = 420 GW = 202 Total = 550**	103-177*	33-133	125	1,311-1,485

Source: S.K.Gupta and R.D. Despande

Notes: * Ignored water quality issues
** After considering 17 % decline in storage for surface sedimentation

Table 1 shows that the largest increase of 550 km^3 per year in water supply comes from harnessing economically utilizable surface water (EUSW) from the conventional runoff of the river schemes and the untapped groundwater potential, followed by the return flow (RF) by developing full irrigation potential. It can also be noted from Table 1 that without the contribution from retrievable artificial groundwater recharge (RAGWR) and recyclable wastewater, the projected water requirement cannot be met, necessitating inter-basin transfer.

Cost of Artificial Recharging

For a wider adoption of artificial recharging and use of a particular method, the cost of recharge and recovery of various artificial recharge methods is an important parameter that needs to be determined. Full-scale artificial recharge operations in India are limited and as a consequence, cost information from such operations is incomplete. The cost of recharge schemes, in general, depend upon the degree of treatment of the source water, the distance over which the source water must be transported, and the stability of recharge structures and resistance to siltation and/or clogging. In general, the costs of construction and costs of operation of the recharge structures, except in the case of injection wells in alluvial areas, are reasonable. The comparative cost of recharged water per 1,000 m^3 in such cases works out to Rs. 40 to 120. On the other hand, the cost of using recharged groundwater for domestic water supply purposes, varying from Rs. 2 to 6 per person per year is very reasonable, especially in areas where there is a shortage of water (CGWB 1984). The initial investment and operating costs are many times less than those required for supplying potable water using tankers. Combining technologies can also result in cost savings. For example, in Maharashtra, the capital cost of combining a connector well and tank into a hybrid scheme was about Rs 40,000 (the cost of borehole) compared to the cost of a comparable percolation tank system needed to achieve a similar degree of recharge, which is estimated to be about Rs. 4,800,000. Table 2 summarizes the estimated costs of various artificial recharge methods:

Table 2. Economics of various artificial recharge methods.

Artificial recharge structure type	Capital cost (Rs.1,000m^3) of recharge structure	Operational cost (Rs.1,000m^3/ year)
Injection well (alluvial area)	Rs. 23,000	850
Injection well (hard-rock)	80	200
Spreading channel (alluvial area)	320	800
Recharge pit (alluvial area)	21,000	80
Recharge pond or percolation pond (alluvial area)	40	40
Percolation tank (hard-rock area)	200	40
Check dam	40	40

Source: UNEP International Environment Centre (2004)

Research and Development in Artificial Recharging

The problems associated with artificial recharging include aspects such as recovery efficiency, cost-effectiveness, contamination risks due to the injection of poor quality recharge water, clogging of aquifers, upstream-downstream impact, inequity in water distribution and a lack of knowledge about the long-term implications of the recharge process.

In India, various artificial recharge experiments have been carried out by different organizations, and have established the technical feasibility of the artificial recharge of unconfined, semi-confined and confined aquifer systems. However, the most important and somewhat elusive issue in determining the utility of this technology is the economic, institutional and environmental aspects of the artificial recharge. Experiences with full scale artificial recharge operations in India are limited and as a consequence, cost information from such operations is incomplete. Moreover, costs are a function of availability of water source, conveyance facilities, civil constructions, land, and groundwater pumping and monitoring facilities (CGWB 1994). Therefore, research on cost-related to artificial recharging needs to be taken up.

The importance of proper planning of groundwater recharge, conservation, optimum utilization and management of the recharged water is given least attention by the policymakers, managers and users of this precious resource. Proper harnessing of surface water through artificial recharging and judicious husbanding of recharged water assume greater significance in the present state of groundwater resources development and management in India. Therefore, the economic, managerial and institutional aspects of artificial recharge projects need to be studied further.

The studies on artificial recharge techniques are mostly site-specific and descriptive in nature, which gives little insight into the potential success of implementing this technology in other locations. Thus, there is a need for further research and development in artificial recharge techniques for a variety of conditions.

A Road-map for Long-term and Short-term Strategy for Artificial Recharge

To meet the growing requirements of water for various activities, it is imperative not only to develop the new water sources but also necessary to conserve, recycle and reuse water wherever possible. It is estimated that by prudent artificial recharge schemes and wastewater recycling, about 25 % of India's water requirements in 2050 can be met. Both these measures provide water at local scale, where people live and engage in productive activities. In the short-term, rainwater harvesting and artificial groundwater recharge where people and the community can directly participate, as in the 'recharge movement in Gujarat', must be given thrust and focus by all who are concerned with India's water. The gestation period for such projects can be a few months to a few years and because of the distributed nature of this activity, it is only through the involvement of local communities that sustainable groundwater augmentation can take place. This strategy is also evident from the importance given by the Government of India in water conservation and use through watershed development.

In the many densely populated areas of western and southern India, a rapid development in intensification of well-irrigation is taking place where rainfall precipitation is the only source of groundwater recharge. The number of groundwater wells has increased from less than 100,000 in 1960 to nearly 12 million today (Shah et al. 2004). With depleting aquifers and erratic rainfall, local communities as well as the government are turning to constructing local water harvesting and recharge structures at a massive scale with the primary objective of increasing groundwater availability for improved drinking water security, drought-proofing and protecting rural livelihood. Efforts should be undertaken to effectively use the existing structures as artificial recharge structures instead of constructing new structures.

There are some specific issues relating to decentralized artificial recharging, which need to be kept in mind while undertaking this activity:

1. Blue water investments are located mainly downstream in watersheds and basins, because they depend on the concentration of large volumes of stable runoff (in lakes and rivers). Large-scale irrigation, therefore, benefits predominantly the downstream communities, while water harvesting offers an appropriate water management complement for agriculture for wide spatial coverage across watersheds and basins. Capturing local runoff upstream in water harvesting systems addresses problems of frequent drought and prevailing poverty in upper watersheds.

2. Every increase in water used in agriculture will affect water availability for other uses, both for direct human use (water supply) and for eco-system use (terrestrial and aquatic eco-systems). In over-committed watersheds, upgrading rain-fed agriculture through investments in water harvesting and artificial recharging systems may result in a severe water trade-off with downstream users and eco-systems. Proper water balance and water accounting need to be carried out before initiating a recharge project.

3. Investing in water management through water harvesting and artificial recharge in rain-fed agriculture can have positive environmental impacts on other eco-systems as a result of reduced land degradation and improvements in water quality downstream.

4. Capturing water close to the source (where the raindrop hits the ground) as is common in upstream water harvesting systems, reduces evaporative losses of blue water during its journey from field to watershed to river basins. Basin-wide gains are possible from investments in upstream water harvesting and artificial recharging in rain-fed agricultural systems.

5. Groundwater recharge schemes should continue to remain as the people's programs. Without the people's participation, the program is unlikely to survive. It is only the people's involvement in the scheme that would ensure critical components like quality of works; preventing undesirable contractors' entry into partnership with the government; sustainable maintenance and supervision; speed of implementation and cost-efficiencies. Intensive efforts should be made to elicit support from: reputed NGOs; spiritual bodies; charitable organizations; donors; industrial houses; and spirited individuals who have unquestionable interest in the region and the well-being of the people, to promote, participate in and provide for the scheme. The involvement of the Panchayat administration up to district level is also necessary. An aggressive campaign approach is needed to educate and motivate rural collectivities using promotion tools like Jal-Yatra as was done highly effectively in Saurashtra.

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