Myths about Small Water Harvesting Systems

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The article on water harvesting and artificial recharge in naturally water-scarce regions (30 August 2008) makes a number of assertions about small water harvesting systems that are based on faulty assumptions and inadequate information.

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We are writing in response to the article by M Dinesh Kumar, Ankit Patel, R Ravindranath, O P Singh "Chasing a Mirage: Water Harvesting and Artificial Recharge in Naturally Water-Scarce Regions" (EPW, 30 August 2008).

The authors have argued that runoff water harvesting does not offer any potential for groundwater recharge or for improving water supplies at the basin scale. They have, thus, concluded that the investments made on this sector are a colossal waste of scarce resources and also cause several negative social and environmental consequences. However, in the conclusion they say, "The foregoing analysis does not suggest that water harvesting and groundwater recharge systems do not generate benefits", thus indicating an iota of doubt.

In the process of analysis, some of the implicit underlying assumptions made by authors include:

(1) Comparison of annual rainfall with annual reference/potential evapotranspiration is the guiding principle/indicator for runoff water harvesting.

(2) Water harvesting is essentially and in all instances meant for groundwater recharge.

(3) Runoff is the amount in excess of the soil moisture storage and infiltration.

(4) Watershed programmes only have problems of quality of implementation.

(5) Water harvesting systems are, by and large, designed to capture the entire runoff and state government and central developmental agencies alongwith non-governmental organisations (NGOs) are promoting the concept.

(6) The existing storage and diversion capacities in river basins is close to utilisable flows.

(7) Water harvesting necessarily has to be profit-oriented and in order to make it happen it has to be utilised for high value crops.

(8) Reliability of supplies from water harvesting systems is very poor in arid and semi-arid regions of India, which are characterised by low mean annual rainfalls, very few rainy days, high inter annual variability in rainfall and rainy days and high potential evapotranspiration.

(9) In order to call water harvesting systems profitable, the incremental benefits by water harvesting systems have to be beneficial at basin scale but not at the local level.

In the light of these assumptions and the consequent analysis branding water harvesting systems as ineffective, we would like to offer our comments.

India has a long history of water harvesting which has been neglected after the creation of large storage structures and popularisation of borewell technology. However, the revival of the water harvesting systems by individuals, NGOs, and developmental agencies, has led to their importance being recognised particularly in arid and semi-arid rainfed areas. Water harvesting systems were started as part of catchment area treatment in river basin projects to act as complementary storage structures and to reduce the silt movement which otherwise would reach the reservoir leading to siltation and reduction in effective storage over a period of time.

Peter Taking Paul's Water?

Taking the ratio of annual rainfall and reference/potential evaportranspiration as an indicator for potential rainwater system is not correct. The authors have used reference and potential evapotranspiration as synonymous terms which is also incorrect. Reference evapotranspiration is an upper limit for climatic water demand and potential evapotranspiration primarily corresponds to total requirement of a crop during its growth period which may or may not be spread over the entire year. The crop season, in general, is limited to the rainy season for major rainfed areas in various basins except for a few locations. The crop season extends up to the *rabi* season in areas with assured irrigation facilities and in those areas which depend on residual moisture in the post rainy season (like the black soil regions in parts of Karnataka and Maharashtra among other states). For tree-based systems, comparison of annual rainfall and annual potential evapotranspiration may be appropriate. Under these circumstances too, comparison of annual rainfall with annual reference evapotranspiration is incorrect.

The extreme daily rainfall events in many cases exceed 200mm which justifies the micro level water harvesting and storage structures for possible use. Hence, in order to meet water demands throughout the year, it is essential to create storage structures and it is with this intention that major storage reservoirs structures were built across the country after independence.

The authors also argue that

> increasing cropping intensity production in upper catchments of river basins has two major negative impacts on available renewable water resources. First, it captures a share of the runoff generated from the area, and therefore, reduces the available surface water supplies. Second, increase in cultivated land increases water requirement for irrigation.

These statements need to be examined. In the river basins referred to by the authors, the spatial rainfall variability implies that only certain parts of the area contribute significant runoff to major reservoirs. In other parts of the river basin areas, the runoff could be generated at the plot/farm level and/or at scale of watershed but may not reach the major storage structures. This runoff is normally harvested within the water harvesting systems and is to be made use of for supplemental/critical irrigations only during the crop season and is not expected to provide full-fledged irrigation support throughout the year. Even in major irrigation projects, the gross irrigated area is about 80% of the potential and the net irrigated area is about 60% of the potential created.

Doubtful Assertions

Below we mention some of the statements made by the authors followed by our comments on each.

Runoff is the amount in excess of the soil moisture storage and infiltration: This is known as saturation excess flow. But in arid and semi-arid areas which normally have highly intense storms, it is the overland flow which prevails as runoff and tends to occur even before soil saturation if the rainfall intensity is more than the infiltration capacity of the soil. Therefore, the assumption that there is no generation of runoff before saturation of soil moisture is not necessarily a correct assumption.

Regarding "the upstream versus downstream conflicts" as mentioned by the authors, the scale at which analysis is carried out needs to be looked at more closely. The example given by the authors of the Ghelo-Somnath basin (rainfall-runoff) also needs to be analysed in a different perspective for different time periods. Instead of providing the information on regression of rainfall and runoff for different periods, it would be more appropriate to talk of the total rainfall, runoff, distribution characteristics of rainfall and runoff, storm intensities per day, and number of rainy days for different time periods under consideration (prior to 1995 and after 1995). Based on the information given by the authors in different sections, the Ghelo river basin (59.2 sq km area) had a built in reservoir capacity of 5.68 MCM and an upstream storage capacity created through water harvesting of about 0.15 MCM. The authors have failed to comprehensively analyse how an additional storage of 0.15 MCM, which is about 3% of existing storage reservoir could reduce the inflows to reservoir so dramatically and how an additional storage of this 3% could ensure the increased rainfall required for filling the reservoir from 370 mm to 800 mm. Further, as mentioned by the authors, if the existing storage of the Saurastra peninsula (5,458 MCM) is above the dependable flows (3,613 MCM), then the reasons behind the creation of such excess storage (to the tune of 50% above dependable flows) need to be analysed. Instead of condemning the small water harvesting structures as prohibitively expensive and useless , we need to look for causes of the creation of so much excess storage than the dependable flows.

Water harvesting is essentially and in all instances meant for groundwater recharge: This implicit assumption is intriguing. We feel that neither the government of India (Ministry of Agriculture/Ministry of Rural Development) guidelines on watersheds nor the proponents of water harvesting system promote water harvesting structures for groundwater recharge alone. The authors have mentioned at great length that these water harvesting systems do not enhance the groundwater recharge due to hard rock aquifers/improper geological conditions for recharge purpose. But they serve the purpose of holding the water nearer to the field boundaries in shallow reservoirs which could either be used for critical irrigation during the kharif season or for enhancing the cropping intensity in rabi season during the wet years. There is a lot of literature to show how these small-scale water harvesting systems help in overcoming the intermittent droughts during the kharif season and making the drinking water available for a prolonged period within the watershed.

The authors have not provided sufficient information on dug wells in Saurashtra region for a critical analysis. For example, the total storage capacity created through 300,000 dug wells needs to be translated to capacity created per ha of area based on the average size of a dug well. The assertion that a dug well can recharge as much as 4,000 m3 of water, based on the assumption that each well will have a storage capacity of 800 m3 on an average, and could receive five fillings also needs to be examined. Further, the probable runoff generated from one acre based on the authors' information (utilisable runoff in basin from earlier study) is also higher and the same information available at basin scale should not be used for the entire basin as there is large-scale variability within the basin.

The authors have mentioned that in hard rock areas, the aquifers get fully replenished during good rainfall without the water harvesting systems. Without mentioning the complete hydrogeological conditions, it is not possible to conclude that the major aquifer system would get filled up so easily within the monsoon. The recharge which is visible could be happening at the intermediate or shallow aquifer system but not at the main aquifer level.

Watershed programmes alone face problems regarding quality of implementation: Though the authors mention this in passing, it must be understood that the above problem persists with large-scale reservoir structures also.

Water harvesting systems, by and large, are designed to capture the entire runoff and state and central government developmental agencies alongwith the NGOs are promoting the concept: This analysis consists of maximum and minimum values for rainfall and runoff in the Banas and Ghelo basins, compares the minimum runoff to maximum runoff and estimates the cost of storage to tapping the maximum runoff available within the basin. The authors should have mentioned the guidelines followed by different agencies for dependable flows. The agencies concerned with reservoir storages at the state or central government level normally consider the dependable flows, which typically is 75% probability. In any case, creation of 100% storage capacity to store the maximum runoff is not reported in any river basin. Therefore, the estimation of costs for storing the 100% runoff recorded so far is farfetched and terming the water harvesting systems ineffective on the basis of this type of cost analysis is completely wrong. The conclusions thus drawn about the financial viability of water harvesting systems are not based on valid information.

Cost of water harvesting systems per cubic metre of water: The comparison of different water harvesting structures would be incomplete without comparing the unit cost incurred in case of large storage structures. The authors should also have given similar information for large storage structures and the cost of infrastructure that is needed to be created for transferring that stored water for long distances and total cost for providing irrigation to unit area considering the transmission losses, etc.

Water harvesting necessarily has to be profit-oriented and in order to make it so it has to be utilised for high value crops: The guidelines for water harvesting in watershed programmes also indicate that the harvested water in small storage structures be used judiciously to derive maximum benefit and ensure higher water productivity. The individual's entrepreneurial capability also plays a significant role in the utilisation pattern. On the other hand, even if stored water is to be used for foodgrains, etc, it would bring in the much needed stability in production in arid and semi-arid areas. The production contribution from these areas which are mainly rainfed regions would also be enhanced at the national level. Further, the stored water in small water harvesting systems could also be used for high value crops.

The authors say that reliability of supplies from water harvesting systems is very poor in arid and semi-arid regions of India, which are characterised by low mean annual rainfalls, very few rainy days, high inter-annual variability in rainfall and high potential evapotranspiration. The assessment of supplies reliability needs to be examined from the following angles:

- Expected amount of runoff during the monsoon season.
- Probability of harvesting system filled with water during the crop growing season.
- Probability of runoff generation during the critical growth stages of crop and comparison with water requirement at those stages.

The analysis of these factors would typically involve an account of water balance approach for different soils, crops and geographical locations and would be significant for low rainfall regions of less than 600 mm. If the runoff generation is not sufficient to meet the irrigation needs at critical stages or insufficient runoff is generated for storage in water harvesting structures, alternative ways to meet the irrigation demands have to be explored. In view of the climatic aberrations, which have a profound effect on rainfed areas, some of the low rainfall zones which were not expected to generate sufficient runoff for harvesting purpose, may generate the same under climatic changes necessitating the creation of water harvesting structures. Therefore, for the very reasons mentioned by the authors, there may be a need to create more small water harvesting structures in low rainfall regions with high variability.

Further, why do we need to be obsessed with reliability of supplies from water harvesting systems alone? The same question is never asked about the reliability of large-scale water harvesting systems. A case in point is that of the net irrigated area which is never beyond 60 Mha though the irrigation potential created is about 103 Mha. On the other hand, supporters of large storage structures expect the small water harvesting systems to provide reliable supplies and be more profit-oriented.

In order to call water harvesting systems profitable, the incremental benefits by water harvesting systems have to be beneficial at basin scale but not at the local level.

This implicit assumption made by the authors also needs a relook. How do they assume that the Ghelo basin which has about 3% (0.15 MCM) of upstream water harvesting compared to total storage created (5.68 MCM), makes a large-scale incremental effect at the basin scale in terms of positive financial impact? By the very nature of the geographical spread within the basin and owing to the small size, the effect could at best be seen in local scale if the augmentation is properly tied up with utilisation by a large number of farmers.

The authors argue that intensive water harvesting in basins of high degree of development leads to several negative externalities in the ecosystem leading to an overall negative effect and must be discouraged. But in view of the increasing population, the demands from farmers across the basin for better irrigation facilities, and the need to reduce regional disparities within the basin, small-scale water harvesting systems need to be promoted. In all likelihood this may ensure sustainable, if not enhanced yields in the rainfed regions and may also encourage farmers to adopt better application methods.

Inadequacies Need Attention

However, local water harvesting systems too have a few inadequacies. One of the major problems relates to the excessive importance given to water resource augmentation without promoting better utilisation. In the absence of this, only a few farmers tend to realise large-scale benefits in watershed programmes. Another scenario could be that stored water would simply evaporate without realising into consumptive use. Hence, storage should simultaneously be tied with efficient water use.

The other problems that are encountered in these systems are: (i) Inadequate information on water harvesting potential in watershed context; (ii) Improper identification and design of sites for water harvesting; (iii) Too many water harvesting structures within short reach of streams; and (iv) Lack of clear purpose for water harvesting system.

In order to make small-scale water harvesting systems profitable, complement the efforts through large storage structures and avoid the so-called upstream-downstream conflicts, the following need to be studied in detail:

(1) Optimising the level of water harvesting through small storage structures keeping in view the degree of water resource development in river basins.

(2) Assessment of water harvesting potential at local level considering the spatial and temporal distribution of rainfall, for different crops and for different soils and guidelines for storage structure capacities for individual and community-oriented ones.

(3) Linking the water resource development with utilisation pattern in deficit irrigation mode.

(4) Capacity building and awareness creation of communities at local level on the availability and use of stored water for judicious use of water.

(5) Demand side management of water in arid and semi-arid areas and irrigated areas. This is more crucial under irrigated areas to bridge the gap between potential created and net irrigated areas under river basins of closed categories.

Small-scale water harvesting needs to be advocated in the larger context of livelihood generation (in the natural resources management programme) as surface storage for supplemental irrigation rather than as merely the means for groundwater recharge.