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PROBLEMS, PROSPECTS & ATTITUDES IN ENSURING WATER SECURITY IN ARID AND SEMI ZONES

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ABSTRACT

There are debates in India about whether rainwater harvesting is a panacea for the current water crisis. The answer really lies in how one looks at it. Rainwater being the only source, in particular for arid and semi-arid regions, holistic rainwater management is the need of the hour. Management here obviously includes capture, treatment, storage and recovery. And, importantly, the demand side management. Thus, a holistic approach on the above lines is essential.

Adoption of a holistic rainwater management calls for appreciation of the water problem in the first place. Appreciation involves awareness and understanding of the scientific and social dimensions of the problem and a will to implement a set of perceived solutions. This is where role of the NGOs becomes important and that of the State as a facilitator by providing appropriate policy environment.

The paper briefly looks at the competing demands on water, urban-rural linkages, the demand-supply gaps, and the potential of rain water to address the current water crisis in India. As part of rainwater management, ground water plays an important role especially in providing water "on tap" in favourable hydrogeological conditions due to its characteristics of enormous storage capacity and yields. In addition, the natural filtration that happens in the course of ground water recharge and movement facilitates quality enhancement. However, this has to lie within the "carrying capacity" of the earth, including geological aspects. That is exactly why ground water has become the most dependable source in many states of India for drinking, irrigation and industry purposes while the surface storages are becoming less effective.

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INTRODUCTION

According to the estimates of National Commission on Integrated Water Resources Development Planning, Government of India, the total surface water availability in all the river basins is 1953 BCM (billion cubic metres), out of which only 35% (that is, 690 BCM) is utilizable. Similarly, out of the total replenishable ground water estimated by Central Ground Water Board (CGWB) at 432 BCM, the utilizable groundwater is only 342 BCM. Thus, a total of 1032 (690+342) BCM, only 605 BCM water is presently used, which amounts to 44% of the utilizable water resources.

Over the past few decades, groundwater has emerged as the most dependable source for drinking, irrigation and industry in India. The contribution of groundwater to India's GDP is 9%. The single-most beneficiary has been the agriculture sector wherein huge public investments were made in the form of irrigation projects during the past 5 decades. This was as high as 70% of the four-fifths of the total outlay allocated to agriculture (Vaidyanathan 1999).

Alongside, there has also been increasing private investments for tapping the groundwater for various purposes such as for Irrigation, Domestic, Drinking Water Supply (urban and rural), Industry and Energy.

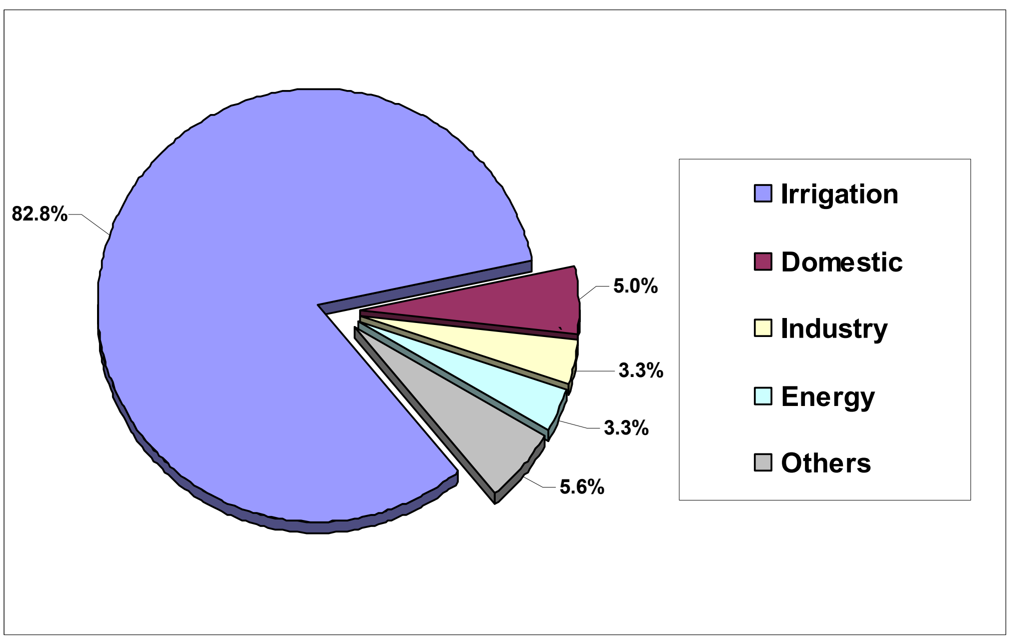

Figure 1: Sectorwise utilization of water in India

Source:*Report of Task force on Microirrigation, 2004*

"Non-Performing Assets"

Till about three-four decades ago, open wells used to provide plenty of water for irrigation, industry or drinking water. Gradually, as demographic pressures upped alongside "wasteful" water use approaches, there was more and more demand for water. Open wells transformed into dug-cum-borewells, and then to borewells, and now to deep borewells of unprecedented depths. In particular in hard rock areas, which comprise 60% of India's geographical area, the rate of well failure is alarmingly high as the borewells have reached the unfractured bed rock which is not capable of yielding. Thus, a huge number of such water extraction structures have simply gone "out of use" due to deep water levels creating (to borrow a term from the banking sector) "Non Performing Assets". The only difference is that these structures belong to individual farmers and represent the story of poverty for a majority of those small and marginal farmers who borrowed money and invested in energizing their wells which is reflected in the tremendous increase of Water Extraction Mechanisms (pumpsets) from less than one million in 1960 to almost 26-28 million in 2002.

In short, whether it is drinking water, irrigation or industry, the approach has always been to increase the water supply. This increase has to come broadly from two types of sources-the surface storage structures and the ground water. The common approach whether by the government or by the private individual has always been to tap into these sources.

It may be pertinent to note that the major gap is in terms of demand side management by and large in India. In a review conducted, we examined 28 case studies from all over the country to explore how water management is approached. It was quite revealing that in almost all the cases, hardly any attention was paid to the demand side management (give reference). Water demand management implies optimizing utilization of water-for drinking, agriculture or industry. The endeavour of all the case studies was to increase the supply.

DRINKING WATER, QUALITY AND STATUS

Further, over the past two decades or so, water quality has emerged as one of the most serious concerns, in particular for ground water. Two types of groundwater pollution are generally recognized: (i) contamination due to geological formation itself such as excess fluoride, arsenic, iron and salinity; (ii) contamination due to anthropogenic causes: such as excess use of chemical fertilizers, biological contamination due to untreated domestic sewage, discharge of untreated industrial effluents, excess pumping of ground water in coastal areas and water logging and soil salinity in canal command areas.

Out of the 14.23 lakh habitations in the country, nearly 2.17 lakhs (approx. 15%) are reportedly affected by different quality problems of chemical origin such as excess fluoride, arsenic, iron, nitrate and salinity. A recent survey undertaken by states based on the stratified sampling block wise indicated a general increase in the number of quality affected habitations in the states of Rajasthan, Tamil Nadu, Karnataka, West Bengal, Punjab, Haryana, Uttar Pradesh and Madhya Pradesh (Panda RC, 2002). In West Bengal, for instance, high levels of Arsenic are found in water supplies underlying nearly 39% of the state and, within the affected area, millions of people may be affected (Bhattacharya, Chatterjee et al. 1996).

According to the Census of India (1991), only 55.50 per cent of the population had access to safe drinking water. However, in terms of water supply coverage, 92% of the urban population and 86% of the rural population has been covered by AD 2000. While this is impressive, there are issues related to equity, regularity, adequacy and sustainability of the supply.

Pattern of urban water use-the case of Ahmedabad city

Let us consider the case of Ahmedabad city. 56% houses have access to private borewells and 24% houses receive water from both private as well as public water supply system. The average water consumption was found to be 450 lpcd, which varies from 385-514 lpcd. Consumption of water across various building typology also varied considerably. It was highest in bungalows at 604 lpcd, 369 lpcd in low-rise buildings, 494 lpcd in high-rise buildings and 332 lpcd in tenements. Water usage mainly depends upon the type of supply. It was 339 lpcd in the houses which depended only on public water supply, 469 lpcd in the houses having access to private borewells and 533 lpcd in the houses having access to both public as wells as private water supply system.

A strong correlation exists in water consumption and groundwater extraction in Ahmedabad city. As the city has very limited source to surface water reserves, higher the water consumption more will be the groundwater extraction. Total water consumption in Ahmedabad city was 1002MLD or 375 MCM per annum, out of which, more than 675 MLD (which is 67.5%) is from groundwater source (VIKSAT 2004).

It may be easily inferred from the above example, that the case may not be much different for other urban areas in India; perhaps it might be worse. The implication of such a high rate of water supply/consumption, which defies logic, has multidimensional effects such as given below:

- Difference in access to various sections of the people in particular to those economically poor;
- Emerging Pockets of areas with serious quality problems such as high saline content, fluoride and chloride.
- Depleting water levels extending to tens of kilometers in all directions, affecting the rural areas;

- Depriving rural areas by either subsurface withdrawals or by piped water supply schemes for cities/towns by sourcing from borewells located in rural areas.

Quality problems have come to fore in many places as described above mainly due to overexploitation and highly depleted water levels. Therefore, rainwater harvesting would also help improve water quality, if done at a scale.

Single Source-Multiple Demands

The above attempts to bring out the fact that there is the single source-rainwater-which is available in the form of surface and ground water. All our needs need to be met from the surface and ground water, the interlinkage of which is becoming weaker. We have to hasten our efforts towards water harvesting to check the multifaceted problems arising due to the increasing demand-supply gap. A combination approach of water harvesting, demand management and use efficiency is required. In this approach, storage option of storing rainwater under ground seems to gain pre-eminence due to non-availability of land surface for water bodies due to increasing competition for various landuses in the era of rapid urbanization.

RAINWATER HARVESTING AND ARTIFICIAL RECHARGE

Rainwater harvesting is increasingly seen as a viable option. However, the terms “rainwater harvesting” and “artificial recharge” are often used interchangeably; hence, it might help to distinguish between these two terms. Artificial recharge implies using techniques for putting rainwater into the ground almost immediately thereby giving less scope for generating run off or evaporation through streams, rivers or tanks/ponds. This may mean “conveying’ water into the ground through a recharge borewell.

Rainwater harvesting is often used to denote impoundment of water in structures such as check dams, ponds and tanks, and in streams and rivers. In this case, there is an enhanced time span available for facilitating recharge, under conditions of natural infiltration.

In government parlance, the term ‘rainwater harvesting’ is applied to convey a generic meaning of capturing rainwater where it falls; in urban context or in rural context, the term ‘rooftop rainwater harvesting’ is used to describe specific efforts for collection of water drinking purposes. In this paper, the generic meaning is preferred to maintain uniformity.

Potential of Rainwater harvesting

To illustrate, let us consider the potential of rainwater harvesting in addressing the drinking water requirements of Ahmedabad, a rapidly growing city with a population of about 3.6 millions (2001 census).

Computation of Potential of Rain Water Harvesting in Ahmedabad City					
Description		**Area**	**Potential in Ltr.**	**Unit**	
Total area of Ahmedabad Municipal Corporation(AMC)		190.84	190840000	sq km	
Total roof area (25% of total area as per official records)	25%	47.71	47710000	sq km	
Average rainfall in A'bad	0.7			m	
Effective roof water (70%)	70%				
Total roofwater available in Ahmedabad			23,377,900,000	Lts.	**2338 crores**
Ahmedabad Population	3,600,000				
Daily drinking water @ 5 lts/person	5				
Annual drinking water demand of A'bad			6,570,000,000	Lts.	**657 crores**
Rainwater available for groundwater recharge	30%		40,076,400,000	Lts.	**4000 crores**
			40,076	Cu. m	

Fig.2 Computation of Potential of Rain Water Harvesting in Ahmedabad City

From the above table, it is clear that against the annual demand of 650 crore litres at the rate of 5 litres per person per day, 2300 crore litres of water is available from the rooftops, throughout the year. The rest of the rain water could be harvested for recharge.

The above table demonstrates that the rainwater has potential to alleviate all the drinking water problems of a given city. However, while this might sound exciting, can it be achieved in practice, and if so what are the limitations and constraints? What are the problems that we might encounter in achieving this?

The first and foremost is the pattern of distribution of rainfall itself. In India, we have either a unimodal or bimodal rainfall pattern. The rainfall is variable and rainy days are few: 50 % of the rain is incident in about 15 days and less than 100 hours, out of a total 8,760 hours in a year. The total number of rainy days is as low as five days in a year in the arid regions of Gujarat and Rajasthan to 150 days in the Northeast, although there could be high-intensity rainy events in some days. Therefore, it is very important to capture this rainwater, which just comes and goes in a few hours.

In other words, storage is a big issue in view of the highly variant and intense rainfall, and especially in the highly crowded city environs. Reservoirs and tanks created historically have either silted up or have disappeared due to demand on land in urban areas. For instance, the number of lakes in Ahmedabad has reducded by half in the past 25 years.

However, if the rain water can be stored in a decentralised fashion, by individual households, public institutions, corporate, entertainment units and educational institutions, then this becomes feasible. To realise this, we need both policy as well as commitment from the people who are the users.

It is well demonstrated that all the drinking water needs can be stored at individual household both in rural and urban areas. Surely, there will be problems related with covering each and every individual household. In slums or in very backward villages, for instance, there may not be adequate, proper roof available. In multi-storeyed buildings too, and in low rainfall areas, it may not be possible to have significant rainfall collected. Yet other areas related to industrial areas where the environmental pollution might cause contamination of rainfall leading to harmful effects such as the acid rains. Barring these and similar areas, the rainwater harvesting can be a major, significant option.

VIKSAT has also proved that at least year round drinking water security can be achieved in a public institution of over 100 employees. Harvesting just 3.5 lakh litres out of the potential of 24 lakh litres against drinking water demand of 50,000 litres, the system is easily expandable to supply to many other users (VIKSAT 2003). Many agencies have worked for promoting household level rainwater harvesting systems which have ensured drinking water security for at least two years.

A question could be raised as to how can one stop the entire rainwater incident in an urban situation. It may be noted that given the pattern of rainfall, there are always 3-4 events of high intensity rainfall events where water does overflow any domestic rainwater harvesting system. Secondly, generally all the rainwater incident in an urban environment just flows down the gutters into the sewage system; such a sewage often causing damage to the groundwater quality.

Several studies have shown that the centralised systems of water supply suffer from reservoir sedimentation problems of at least 30 percent making its economics unviable (Naidu, Chandrababu and H.P. Singh. 2004).

In the case of individualised systems, the maintenance efficiency is expected to be high due to personal stakes. Hence most of the systems established by VIKSAT in both rural and urban areas are completely taken care of and are functioning very well years after installation (VIKSAT Annual Report 2003-04).

DRINKING WATER AND DEMONSTRATION MODELS

With increasing water scarcity in both rural and urban areas, combined with ever increasing demand, degraded natural environment, changing landuse and "vagaries" of nature, there is an urgent need for decentralised approach to water harvesting.

Water harvesting and recharge have always been talked about in the context of rural areas while urban areas have brought forth change in land use thereby decreasing the net area available for natural recharge. Traditional recharge structures such as tanks have disappeared in urban areas, leave aside creating new ones. This when combined with deep water levels has led to natural recharge becoming less effective, thus increasing the demand-supply gap.

Piped water supply schemes which cater to urban towns and cities often impart a false sense of "water sufficiency". The water sufficiency tends to make people more indifferent to demand management upsetting the water balance. The schemes, which source either surface water (which depends on the rainfall during the particular year) or ground water, have inherent limitations due to rainfall variability, sedimentation, *inter alia*. And, in case of ground water, the estimates of ground water reserves are based on methods of estimation of components of water balance which are themselves limiting in many ways. The limitations include obsoleteness, insufficient equipment and data uncertainties. Thus, sustainability of such schemes tends to suffer.

The need of the hour therefore is for artificial recharge systems that *convey* the fresh rainwater to the "aquifer".

VIKSAT has during the past four years developed working models on a range of units such as bungalow, residential quarters, hospital, industry, large campuses and public institutions. The results have been very encouraging. The following are some key points in this context:

- Drinking water security on individual houses and large public institutions can go a long way in ensuring water security;

- In urban areas, it is preferable to recharge rainwater which otherwise gets "drained"; such recharged water is available "locally" as the ground water can be treated as a “dog on leash”. This will benefit not only those who conserve directly but also the neighbours. Such options will have a significant impact when carried out on a scale.

- Recharge efforts in large institutional campuses prove that there is a local water mound created benefiting considerable area all around. Such efforts in large premises in an urban environment help improve the groundwater situation.

- People have a lot of interest but do not know how to go about it. There is a need for professional organizations dealing with water as also some NGOs to provide technical expertise.

Rainwater Harvesting for Irrigation[2]

Groundwater being the major source for drinking water (more so in summer months and in particular during droughts that characterise the arid and semi arid regions of India) cannot be looked at in isolation, as it is an integral component of environment, with un-delinkable forward and backward linkages (Mudrakartha S, 1999). One such linkage is the heavy dependence of ground water for irrigation as already discussed in the foregoing.

In many villages in India, people still depend upon wells/ hand pump borewells/ borewells for drinking water. During droughts, certain farm wells are earmarked for drinking water purposes even at the expense of critical irrigation needs and are available for anyone irrespective of caste or class.

These well structures tap the same set of aquifers as the irrigation wells/ borewells which tap 83% of the total water utilised in the country, thus lowering the water levels resulting in drinking water scarcity. Therefore, there is a dire and immediate need for simultaneous large scale harvesting of rainwater through water bodies to enhance recharge to ground.

[2] This section is largely drawn from Mudrakartha S., 2002 & 2004.

In Gujarat, VIKSAT carried out artificial recharge on an existing village tank in a peri-urban area called *Sargasan* in Gandhinagar district. The experiment involved building social capital, setting up institutional norms and physical implementation. It has also demonstrated that both drinking water and irrigation water security are a possibility as described below.

It was shown that a significant proportion of water could be met by storing water beneath the ground. In one day, the panchayat supplies 0.1 million litres to 4,000 people of Sargasan. The top aquifers in this region have all dried up in leaving the water table 70 metres below ground level. If water could be stored in a shallow aquifer and not tapped by irrigation tube-wells, then the wells could be rejuvenated. The well could thus meet the domestic and drinking water needs of the village for the whole year. This approach would work even if rainfall was low.

The study estimates that recharge efforts, if properly planned, can effectively contribute to closing the existing gap between extraction and natural recharge. According to the Central Ground Water Board, Government of India, Gandhinagar has an annual ground water draft of 130.35 MCM from 2382 borewells and a natural recharge of 111.57 MCM leaving a gap of about 19 MCM which is 15%.

In fact, rainfall in 2001 was just 70% of the average annual, but the system in Sargasan recharged 23 million litres of water. During a year of normal rainfall, the tank could harvest 2.5 times or 57.5 million litres. If all 520 tanks in Gandhinagar District were used then the regional water level could be raised. Compared to evaporated losses from surface storage, losses from an underground aquifer are very low. Although this recharge method performed satisfactorily in an alluvial area, one needs to experiment in hard rocks areas through suitably adapted designs and implementation.

Blocking run-off for downstream

Some people have warned that artificial recharge blocks run-off water from reaching downstream section of a watershed. Two reassurances can be offered. The first is that in most peri-urban and urban areas, run-off water 'goes down the drain' and is contaminated anyway. Thus tapping it would make no difference/ loss. The second is related to the volume of water. The potential amount of water that can be recharged annually from all the tanks in Gandhinagar is about 29,900 million litres while the total rainfall of the district obtained by multiplying the area of Gandhinagar and the average rainfall is 1,298,000 million litres. In other words, the harvestable volume is 2.4 percent of the rainfall and represents only a small fraction of the run-off. For this reason, it is unlikely that rainwater harvesting will cause upstream-downstream disputes.

Further, systematic development of water bodies would lead to rising of water levels which in turn would address the quality problems through the water dilution route. The livelihood change that can come about by proper investment on water resources cannot be ignored. Furthermore, the study establishes an empirical relationship on spacing between any two artificial recharge structures as 2 km implying that financial resources available can be best utilised.

Unless such conservation efforts are made on a large scale, they will not be able to make an impact.

ATTITUDES

It is often seen that the attitudes become a stumbling block for implementation success of any policy. In particular, in urban areas, people tend to ask : Why should I invest in a rainwater system when I am getting water on my tap? Alternatively, I can buy “bottled” water without any hassles. Why should I install a system and worry about its maintenance? How am I sure that the water I put in is available for me and not drawn away by my neighbour? Can I get financial support like the house construction loans? Who will provide me with the technical designs and implementation guidance?

The other set of questions relate to a totally different realm, often reflecting the total misconception. Can rainwater harvesting supply my full year’s requirement of my family? Can I get rainwater twenty-four hours on my tap? Often, experts look at rainwater harvesting as an “alternative” to the regular water supply, twenty-hours a day. The perceptions vary so much that sometimes the very purpose of rainwater harvesting as an option to reduce the load on the conventional drinking water supply systems is lost.

The solution for the above attitudes seems to lie in raising awareness and developing demonstration models to communicate the right type of information and knowledge. Further, there is a need to develop a stake in the individuals to harvesting and using water judiciously. Enabling policies combined with incentive and reward system, which has often proved to work (such as payment of telephone and electricity bills, property taxes within a stipulated time has benefited the department through revenue mobilisation and discounted savings for the consumer), need to be evolved. A series of consultations should precede such policy formulation which would then have higher degree of acceptance by the people.

In the absence of a carrot and a stick approach, policies of Rainwater Harvesting introduced by the civic bodies, however laudable they are, have found to be not effective.

Another strategy is to create a people's platform to facilitate discussion, debate and experience sharing with a view to establishing a two-way communication between the policy makers and the policy "beneficiaries". Sabarmati Stakeholders Forum is one such form evolved during 1998-99 by VIKSAT in Gujarat to facilitate emergence of stakeholder sub-groups to enable their participation in the planning & implementation of water management interventions to address water scarcity & pollution problems in the Sabarmati River Basin in Gujarat. Twelve sub-groups have been formed under the Forum, in addition to Industry and Agriculture Core Groups, and an Ahmedabad Urban Forum.

One of the key activities facilitated by the Ahmedabad Urban Forum, focusing on urban water issues, as part of the Sabarmati Forum, is to enhance awareness on the need for water harvesting. As a pre-cursor to the awareness campaign, VIKSAT has taken up establishment of working models of Rainwater Harvesting in a range of building units as described in the foregoing. These models have also been captured in a CD ROM format as part of an educational material with the support of UNESCO, New Delhi and distributed to all South Asian Countries. Similarly, Process Document of establishment of a full-fledged Rainwater Harvesting system on a couple of public institution buildings has been distributed to UN offices and government departments in South Asian countries dealing with water. These efforts are part of many other posters, documents, and publicity material brought out by through VIKSAT.

A senior engineer (Shri Himanshu Thakkar of Ahmedabad Urban Development Authority) says that "he got motivated to take up water harvesting as part of its efforts to address water problems by interacting with the Sabarmati Stakeholders Forum promoted by VIKSAT for the past 4-5 years". The Authority has now started developing artificial recharge through 22 city water bodies (tanks) by interlinking them with each other and transporting excess rain water from one tank to the other through pipelines. The effort seems to pay off as the water levels are coming up near such water bodies.

POLICY IMPLICATIONS[3]

1. Water conservation must become the buzz word and every developmental activity must take cognizance of the fundamental role of water. Clear policy guidelines to be formulated keeping this fundamental importance of water whether it is a drinking water, irrigation or industrial policy. Further, institutional arrangements for holistic water management to take care of use, conservation and harvesting dimensions as against the predominantly exploitative sectoral policies need to be made.

[3] This section is partly drawn from the Task Force recommendations on Water Resources for Government of Gujarat by Mudrakartha, S, and SK Gupta, 2004.

2. Rainwater harvesting for drinking purposes should be encouraged through incentives at household level in rural areas; similarly, public, corporate and other institutions in rural and urban areas should be encouraged to harvest rainwater. These disaggregated efforts go a long way in reducing the load on the piped regional rural water supply systems and the costs associated with it.

3. The catchment areas of surface water bodies of captive RRWSS should be declared as “protected areas” and use of water for purposes other than drinking water should be prohibited. In these areas, potentially pollution causing activities should be barred. Further, government schemes such as Swajaldhara, total sanitation campaign, afforestation, watershed development and check dams may be dovetailed to ensure sustainability of the source. The total sanitation campaigns must include components of waste water renovation and recycling wherever possible such as through soil-aquifer treatment.

4. In addition to carrying out artificial recharge as part of the captive source augmentation, certain large water bodies may be identified and developed for recharge. Such an effort would help raise the general water level in the area catering to irrigation needs also which is essential as the drinking water and irrigation water often source the same under ground water.

5. Reservation of certain aquifers to store clean, safe rainwater for present and future use as ground water sanctuaries is the need of the hour to tackle the present and impending future water crisis. Targeted, time-bound programmes are necessary to achieve this in consultation with ground water specialist organisations.

CONCLUSION

In conclusion, rainwater has great potential for ensuring drinking water security at family level (including livestock). It has also great potential for reducing the irrigation water scarcity. In spite of variability, rainfall is generally available everywhere, and hence it addresses equity. However, all these efforts need to be combined with proper demand side management. A holistic policy support that facilitates know-how and do-how, will hasten the process of proper water management.

More research is needed to develop models that will have minimal maintenance and longer term functioning capacity. There is a need to carry out research and develop models to suit different hydrogeological conditions. Further, how these models, at individual and at cluster level (residential society, or a given area in urban context, or a cluster of houses to an entire hamlet or a village that has undertaken rainwater harvesting) depicts (positive) changes on health, livelihoods, gender and poverty needs to be studied.

Water harvesting in urban areas is a challenge that needs to be addressed through a variety of awareness-cum-incentive strategies. Drinking water security on public premises is another area of focus. Further, increasing recharge to ground water in an urban area where demand on land is high requires proper town planning and strict implementation. In other words, water should become one of the key parameters in a town planning exercise, not from exploitation point of view, but from management point of view that includes conservation, use and development. Necessary policy changes should be brought out through a consultation process.

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