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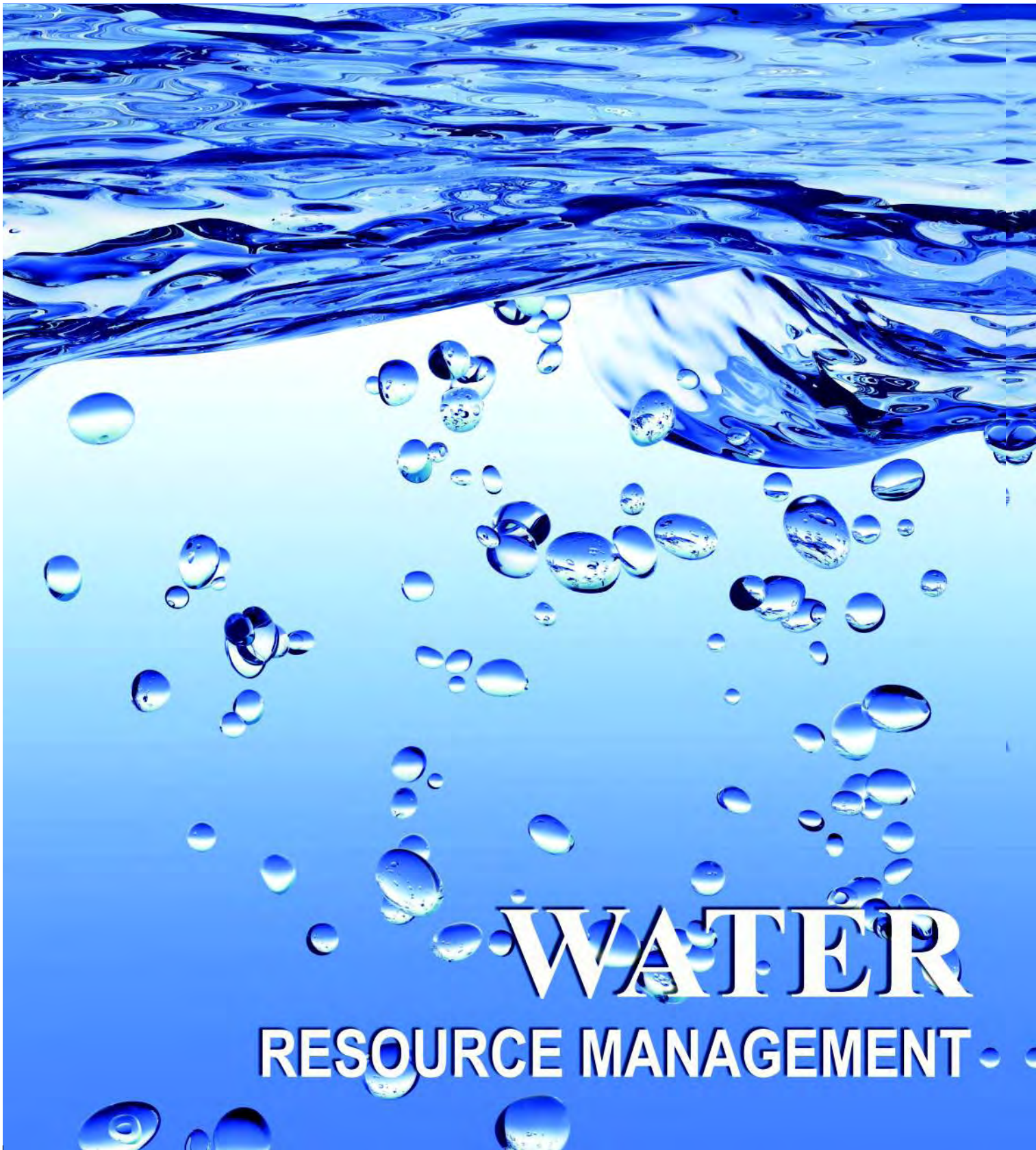

WATER RESOURCE MANAGEMENT

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Let noble thoughts come to us from every side
Rig Veda

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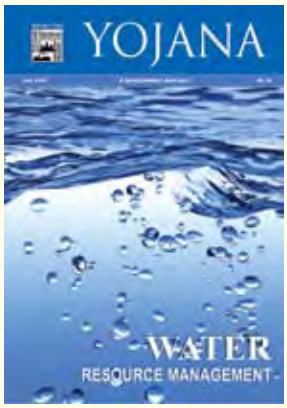
About the Issue



In a report on India's water economy, the World Bank has pronounced that India faces a turbulent water future. Even without this pronouncement, the fact stares us squarely in the face. Every dry water tap, every media report of water conflicts in different parts of the country, every image of thirsty man and beast and parched and cracked earth is a warning signal. Water is scarce. Our growing population, expanding cities, villages, industry, agriculture are unable to meet their water requirement and are engaging in indiscriminate extraction of literally whatever bit of the resource that they can lay their hands on. The changing global climate, as reflected in the receding glaciers of the Himalayas and the fluctuating patterns of the monsoons are worsening the problem.

The supply-demand gap for water is projected to rise to about 50 % by 2030, with demands doubling from current levels of 700 billion cubic metres to around 1498 billion cubic metres, and supply barely reaching 744 billion cubic metres. Per capita availability of water, as it were, is coming down sharply. Indiscriminate exploitation of groundwater has caused the water table to decline sharply in many areas, severely affecting its quality. It is not just a matter of adequacy in terms of quantity - the quality of water available to much of India is again a matter of concern. Even after years of work on Ganga and Yamuna Action Plans, and crores of rupees spent, we have not managed to clean up these rivers. The fate of our other rivers is no better. Our cities do not seem to be equipping themselves fast enough to deal with the increased waste generated by increasing populations and rapid industrialization.

As things stand today, our water management system is not sustainable. We need to make major changes in the way we manage and develop this scarce resource today. Fortunately for us and for the future of our country, the challenge of managing water sustainably has been taken up in right earnest by all stakeholders. The government has put in place many policy initiatives in the area and is constantly fine tuning them. The NGOs are supporting community action and have already managed to turn around many lives in extreme water scarce regions of the country. And most important of all, people are themselves waking up to the severity of the problem and trying to do their bit for conserving water and using it judiciously.

The current issue of Yojana brings to you articles from experts in the field who discuss major challenges in the sector and steps being taken to address these. ❑

Efficient Water Management : Challenges and Initiatives

Umesh Narayan Panjiar

All sections of the society have to join hands and contribute to addressing the challenges in the water sector – be it the centre, the states, Panchayati Raj Institutions, Urban Local Bodies, industrial houses, or the civil society

WATER IS not only an essential element for our survival but is also an important vehicle for economic development of the nation. Although water is a renewable resource, its reserve in nature is limited and therefore, we have to plan for its sustainable development and efficient management so that the growing demands of a rising population, expanding industries and rapid urbanization are adequately met .

Available and Utilizable Resources of Water

The average annual rainfall in the country has been estimated to be about 1170 millimeters (mm). This, along with the total snowfall and glacier melt in terms of volume works out to about 4000 billion cubic meters (bcm). However, due to losses through evaporation and evapo-transpiration, the water availability in the country has been assessed to be about 1869 bcm. Even this available water cannot be fully utilized due to topographical constraints and hydrological features and utilizable water has been estimated to be about 1123 bcm comprising of 690 bcm of surface water and 433 bcm of replenishable ground water. This availability is further marked by very large temporal and spatial variations .

Development Potential and its Realization

Development of water resources in the country has revolved largely around creation of irrigation potential, providing safe drinking water to people, meeting industrial water demands, and addressing environmental issues.

Irrigation

Only about 62 million hectare (mha,) or about 44% of the cropped area in the country is reported as irrigated today. This is despite an

The author is Secretary to the Government of India, Ministry of Water Resources

estimated irrigation potential of about 140 (mha. Although creation of irrigation potential has increased way above the 22.6 mha at pre-Plan stage in 1951, there is an urgent need to expedite the harnessing of balance available irrigation potential through better water management practices. This is a challenging task, more so in view of the fact that easy and best options for the development of water resources have since been tapped and the new water resources development projects are bound to come up against major hydrological and topographical constraints. However, some way out could be found by interlinking of rivers to utilize surplus water and by artificial recharge of ground water. The former is expected to create an additional irrigation potential of about 35 million hectares, while the latter can make about 36 bcm of water available for use.

Drinking water supply

The access to safe drinking water sources in urban areas of India was about 90% in the year 1990 and 93% in the year 2000 and this has improved to about 96% by the year 2008. In rural India, access to safe drinking water sources has increased from about 58% in 1990 to about 73% in the year 2008. Similarly, as per the reports of the Joint Monitoring Programme of World Health Organization and UNICEF, the use of improved sanitation coverage in rural areas of India was 7% in the year 1990 and this increased to about 21% in 2008. The urban sanitation coverage was 49% in 1990 and increased to about 54% by the year 2008. Obviously, a lot more needs to be done in this regard, especially since we aim to achieve the Millennium Development Goal (MDG) of improved sanitation facilities in the rural areas by the year 2013.

Hydropower

India is endowed with estimated hydropower potential of more than 1,50,000 mega watts. However, only about 21% of the potential has been developed so far, and a further 10% is being developed. Among the main reasons for the slow development are difficult potential sites, rehabilitation, environment and forest related issues and inter-state issues. In addition, long gestation periods and geological surprises are important issues which need to be addressed so that this eco-friendly and renewable form of energy which also has comparatively lower running and maintenance costs can be developed to its maximum potential.

Flood management

The total flood prone area in the country has been estimated to be about 46 million hectares. However, the area provided with reasonable degree of protection through structural measures is about 19 million hectares. Along with structural measures, efforts have also been made to adopt non-structural measures. A network of 175 flood forecasting station is also maintained which provide reasonably accurate forecast to help in warning and advance actions to reduce the damages from incoming floods. There is need for adopting the non-structural measures like flood plain zoning etc.

Projections for future water requirements

The National Commission for Integrated Water Resources Development (NCIWRD) has assessed that about 83% of water in the country is used for irrigation and the remaining for domestic, industrial and other purposes. The Commission has assessed the projected demand as 1180 bcm for the high demand scenario for the year 2050, assuming improvement in the efficiency of both surface water and ground water systems and also in the efficiency of water use in agriculture and other sectors. Although the requirement for irrigation water would increase over time, its share in the overall demand has been estimated to reduce from the present level of about 83% to about 69% by the year 2050.

Challenges in Water Sector

The water sector in the country is faced with challenges like reducing per capita availability of water due to increasing population, deterioration in quality, over-exploitation of ground water resources leading to decline in the ground water table in many areas , sub-optimal utilization of the created facilities and relatively lower efficiency of the facilities for water utilization. The per capita availability of water in 1951 was assessed to be 5177 cubic meter. Due to increase in population, urbanization and industrialization this has come down to about 1650 cubic meter. Unplanned development, and lack of proper laws to govern extraction of ground water has led to its over-exploitation and a resultant decline in ground water table in many areas. About 15% of the Blocks / Talukas / Mandals in the country are presently in the category of over-exploited. Another challenge relates to over-use of surface water

which has resulted in irrigation drainage problem causing water logging in some areas. Pollution of rivers and deterioration in the quality of ground water are well known. A large share of pollution is caused by untreated sewage from the urban areas and effluent from the industry. Excessive use of chemicals, fertilizers and pesticides is also a major cause of pollution.

Further, water is also central to another major challenge of our times, namely climate change. Although precise quantitative assessment of the impact of climate change on water resources is yet to be made, various reports indicate that there could be further intensification of the temporal and spatial variation in the availability of water and particularly the extreme events of flood and drought. Therefore, there is an urgent need for taking up research for assessment of the impact of climate change in quantitative terms and plan adaptation measures. The Ministry of Water Resources has initiated such studies involving apex organizations like Central Water Commission, Central Ground Water Board, National Institute of Hydrology, Brahmaputra Board and academic institutions.

A **National Water Mission** has also been constituted under the National Action Plan on Climate Change launched by Hon'ble Prime Minister in June 2008. The objectives of National Water Mission is conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within states through integrated water resources development and management. The five goals identified for the National Water Mission are:

- Comprehensive data base in public domain and assessment of impact of climate change on water resources;
- Promotion of citizen and state action for water conservation and augmentation;
- Focused attention to vulnerable areas including over-exploited areas;
- Increasing water use efficiency by 20%; and
- Promotion of basin level integrated water resources management.

The Ministry of Water Resources has taken up the development of a web-enabled Water Resources Information System in cooperation with the National Remote Sensing Centre of Department of Space.

Initiatives for Water Resources Development

As per the Indian Constitution, water supplies, irrigation and canals, drainage, water storage come under the purview of state governments. One of the very important roles of the union government is, therefore, to ensure utmost coordination with and among the state governments and resolve the issues of inter-state rivers in the best possible and consensual manner.

With a view to accelerate the pace of water resources development and address the various water related issues, the Ministry of Water Resources has been implementing some important programmes and schemes which include Accelerated Irrigation Benefits Programme (AIBP), Command Area Development & Water Management (CAD&WM) Programme, Flood Management Programme, Scheme for Repair, Renovation and Restoration of Water Bodies etc. A scheme related to the artificial recharge of ground water through dug wells has also been taken up.

In order to overcome temporal variations in water availability, we have to resort to various means of conservation of water resources through storages in reservoirs, ground water aquifers and traditional water bodies. The high spatial variation can be addressed through various measures for diverting water from surplus basins to deficient basins or regions. Government of India has already taken up the works related to preparation of feasibility reports or detailed project reports in respect of projects identified under National Perspective Plan for interlinking of rivers which aims at utilizing the surplus flood water by diverting the same to deficient regions. The Ministry also promotes rainwater harvesting and various means of ground water recharge and demonstrative schemes have been taken up by the Central Ground Water Board.

Improved Management

Adoption of better management practices and proper regulation, budgeting and auditing of water uses is very important in increasing the water use efficiency. One of the major factors for relatively poor maintenance of the created facilities is the inadequate funding for operation & maintenance (O&M). It is necessary to ensure financial sustainability of irrigation facilities through rationalization of water

charges and adequate provision for O&M of irrigation facilities. 13th Finance Commission has considered this aspect and provided special water sector management grant of Rs 5000 crores for four years i.e., from 2011-12 to 2014-15, which is subject to setting up of a Regulatory Authority and achieving the normatively assessed state-specific recovery of water charges.

Optimizing utilization of created facilities

The sub-optimal utilization of the created facilities is yet another challenge. Only about 85% of the created potential has repeatedly been utilized. The gap has continuously increased over time. Some of the factors which contribute to the under utilization of created potential include (a) lack of proper operation & maintenance (b) incomplete distribution system (c) non-completion of command area development (d) changes from the initially designed cropping pattern, and (e) diversion of irrigable land for other purposes. Obviously, the modern tools for system improvement in the form of hardware and better management practices in the form of software can play very important role.

Improving the efficiency of the water facilities

The present level of efficiency of the irrigation system in India is relatively low and there is considerable scope for improvement. The National Commission for Integrated Water Resources Development has assessed that irrigation efficiencies from surface water in India can be improved from the present level of 35 to 40% to about 60% and ground water from 65% to about 75%. With the improvement in efficiency – both through efficient end water use as well as by improving the efficiency of facilities created for irrigation. Measures such as proper operation and maintenance, extension, renovation and modernization of projects, repair, renovation and restoration of water bodies on the one hand and use of agricultural practices such as moisture conservation, micro-irrigation etc. on the other hand are required to be adopted urgently. Simultaneously, it is necessary to ensure financial sustainability through regular revision of water rate and promoting participatory management by encouraging formation of Water Users' Association etc. It is very important that best technologies and practices are transferred to the farmers to enable them to translate the slogan "More Crop and Income per Drop of Water" into reality. Ministry of Water Resources is implementing "Farmers' Participatory Action Research Programme (FPARP)" through Agriculture Universities and agricultural research institutes to demonstrate available technologies for increasing productivity / profitability of agriculture. Interim reports indicate that there is very good response from farmers and the programme has helped in increasing yield and saving in water. Apart from measures for improving the efficiency of larger water facilities, due emphasis has to be given to measures like waste water treatment, reuse of water, rainwater harvesting and ground water recharge, watershed development etc.

Participatory management

Participatory management is very important. The government encourages participatory irrigation management and promotes formation of Water Users' Associations (WUAs). So far about 57,000 WUAs have been formed. They have to be made operational and effective. Draft bill for participatory irrigation management (PIM) has also been circulated to States and 13 States have already enacted appropriate legislation. The matter is being pursued with other States.

Conclusions

There is an urgent need to ensure sustainable development of the water resources and its efficient management. We need to take up necessary measures for optimal utilization of the available water resources. Apart from taking up necessary measures for comprehensive and integrated development of available resources, water management strategies are required to be carefully designed so that they lead to overall development of the country benefitting each and every member of the society. We need local and distributed water resources infrastructure. All sections of the society have to join hands and contribute to addressing the challenges in the water sector – be it the centre, the states, Panchayati Raj Institutions, Urban Local Bodies, industrial houses, or the civil society - so that the demand for water by different sectors can be adequately met. While doing so, it is necessary to ensure that environmental issues are properly addressed. ❑

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Water Security in India

Bedanga Bordoloi
Etali Sarmah Bordoloi

Unless local and national communities come together and dramatically improve the way we envision and manage water, there will be many hungry villages

WATER SECURITY is said to exist when all people of the country have access to water in sufficient quantity and quality to meet livelihood needs throughout the year, without prejudicing the needs of other users. The availability and access to water will be the pre-eminent issue affecting global economic development and the livelihoods of the poor, given the fact that they often suffer the most when resources are scarce. India is not isolated from these drivers and hence will need to address these issues as it emerges from a developing to a developed nation. India accounts for 2.45% of land area and 4% of the water resources of the world but represents 16% of the world population. With the present population growth-rate (1.9 per cent per year), the population is expected to cross the 1.5 billion mark by 2050. The ever-expanding water demand of the India's growing population and economy, combined with the impacts of climate change, are already making water scarcity a major threat in many parts of the country and with it we are witnessing severe damage to livelihoods, human health and ecosystems. The United Nations Human Development Report 2006 "Beyond scarcity: Power, poverty and the global water crisis" identified water availability per person (supply) was decreasing, while at the same time the amount of water that each person was using (demand) was increasing.

Water Security Status:

At 2,518 billion m3, the total water resource base for India, including surface and groundwater, is substantial but highly variable as during the monsoon season 50 % of the annual precipitation falls in

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less than one month and 90 % of river flows occur in only 4 months of the year. The ability of the current infrastructure to safeguard that variability is low, making it difficult for accessible, reliable supply to meet projected demand and thus putting water security of India at stake. With only 200 m3 of water storage capacity per person, compared to 2,200 m3 per person in China and some 6,000 m3 per person in the United States, India's accessible, reliable supply of water amounts to 744 billion m3, or 29 percent of its total water resource.

According to the report "Charting our Water Future" by the 2030 International Water Resource Group (IWRG) released in 2009, in India the low agricultural water productivity and efficiency, combined with aging supply infrastructure, would make severe supply-demand gaps likely in many basins with currently planned crop choices. India's aggregate water demand is expected to double from the current level of about 700 billion cubic metres to 1498 billion cubic metres by 2030. With an estimated supply of about 744 billion cubic metres by then, the water gap is estimated to be 50 per cent. This gap would be driven by a rapid increase in demand for water for agriculture, coupled with a limited water supply and storage infrastructure. One key uncertain factor that may affect the size of this gap is climate change. Its most direct effect is likely to be an accelerated melting of the Himalayan glaciers upon which several of India's river systems depend, particularly the western rivers such as the Indus, which relies on snowmelt for approximately 45 percent of its flow. Though in the immediate future increased snowmelt should actually increase flow of these rivers, in the long run the impact is very likely be a decrease of flow between 30 to 50 percent.

Water Consumption in Indian Agriculture

India is one of the world's leading crop producers. Over the years, there has been an increase in water consumption in the agricultural sector. The volume of water used for irrigation in India is expected to increase by 68.5 Trillion(Tr) liters between 2000 and 2025. A number of demographic and economic factors are driving the use of water in agricultural production. The rise in demand in domestic and export market for food grains is one important factor. India's demand for food grain will grow from 178 MM mt in 2000 to 241 MM mt by 2050.Value of agricultural exports of India have tripled from $5.6 Bn in 2000 to $18.1 Bn in 2008 .Change in consumption pattern of agricultural products is also driving increase in water usage. Demand for agricultural products with high water footprint is projected to rise with increased disposable income and urbanization. Contribution of non-food grain (sugarcane, fruits and vegetables, etc.) and animal products in daily food intake for an individual is expected to grow from 35% in 2000 to 50% 2050.Rice; wheat and sugarcane together constitute nearly 90% of India's crop production and are the most water-consuming crops. India has the highest water footprints among the top rice and wheat producing countries (China, US, Indonesia, etc.).States with the highest production of rice/wheat are expected to face groundwater depletion of up to 75%, by 2050. Agriculturally based industries such as textiles, sugar and fertilizer are among the top producers of wastewater. Thus ,in totality water conservation and management in the agriculture sector hold the key to water security in India.

Food security of India is closely linked to its water security. Studies suggest that irrigated agriculture has dominantly underlain the significant increase in food availability of India. During the last six decades, the gross irrigated area increased from 22 million hectares to 85.8 million hectares (MoA, 2010).Given the fact that water withdrawals for irrigated farming represent 85-90 % of total water usage of the nation, a rigorous assessment of the current irrigated agriculture is needed in order to develop an effective strategy to ensure water security for the future. Higher reliability of water supply through tube wells and water pumps coupled with the policy of massive under-pricing of electricity to the farming sector has resulted in an explosive growth in groundwater irrigation. Overexploitation has resulted in serious depletion of groundwater tables in many parts of the country. It is estimated that in 15 % of irrigation areas of India, the annual extraction of ground water exceeds annual recharge. In Punjab for instance,

Table 1: Level of efficiencies from different types of irrigation			
Factors	**Sprinkler Irrigation System**	**Drip irrigation**	**Surface irrigation**
Overall irrigation efficiency	50-60%	80-90%	30-35%
Application efficiency	70-80%	90%	60-70%
Water saving	30%	60-70%	N.A

Source: Present Status and Future Requirement of Farm Equipment for Crop Production, M.M. Pandey, Central Institute of Agricultural Engineering, Bhopal

while the net annual replenishable groundwater is 21.44 BCM, the groundwater draft stands at 31.16 BCM - indicating utilization of 145 per cent of annual replenishment levels. These trends are also visible in states such as Rajasthan and Haryana where annual groundwater draft is 125 per cent and 109 per cent of annual replenishment respectively. Highly subsidized water use tariffs charged to farmers has accentuated this deteriorating situation by limiting the funds available for operation and maintenance. Consequently, the current water use efficiency of canal irrigation is about 35 per cent - among the lowest in the world. It is estimated that a 10 percent increase in water use efficiency can bring about an additional 14 million hectares under irrigated cultivation.

Clearly, the irrigation strategy of India needs a relook with a focus on sustainable use of water resources. Policy makers should focus on the importance of managing demand and reducing water loss along with increasing supply of water by optimizing the use of natural resources.

As the water crisis manifests itself in the form of depleting water tables and water related conflicts between states, it is high time that water use efficiency becomes a focal agenda in the irrigation management policy of India. Proper management of existing irrigation systems is critical for the success of this agenda; it would also require integration and adoption of multidimensional approaches that can manage demand by increasing water use efficiency in agriculture. While the most obvious way to increase water use efficiency would be to increase crop yields through development of high yielding varieties and efficient use of farm inputs, revision of electricity pricing to farming sector and re-use of waste water in agriculture can be also looked upon.

Water Consumption by Other Sectors:

Apart from agricultural sector, the industry and domestic sector consumes approximately 11% of the available water in India. The drivers for the growth of the water-intensive industries in India have been primarily been multifaceted. FDI equity inflow in the industrial sector has grown from $1.93 Bn in 2004–2005 to $17.68 Bn in 2007–2008. Steel and electricity dependent industries are expected to grow in the coming years. Between 2006 and 2010, investment in infrastructure development was approximately 7.7% of India's GDP. While the 11th Plan projected that infrastructure investment has increased from $408 billion to $514 billion, it is expected to double to the tune of $1 trillion during the 12th Plan. Thermal power plants (the most water-intensive industrial units), constituted 64.6% of the installed power capacity in India during 2009.Annual per capita consumption of power is expected to grow from 704.2 Kwh in 2008 to 1,000 Kwh by 2012 .About 75% of the total planned power capacity expansion is projected to come from thermal power. A combination of these above facts promises to put the necessary strain on the water resource of India.

Industrial water consumption is expected to quadruple to between 2000 and 2050; by 2050 industrial water consumption will reach 18% of total annual water consumption, up from just 6% in 2000 .Industrial wastewater discharge causes pollution and reduces available Freshwater reserves. Almost 6.2 Bn liters of untreated industrial wastewater is generated every day. Thermal power plants and steel plants are the highest contributors to annual industrial wastewater discharge.

Gross Demand Projections:

Several studies have projected the annual demand for water in

Table 2: Annual Current and expected requirement of water in India (in BCM)					
Different uses of water	**1990**	**2000**	**2010**	**2025**	**2050**
Domestic	32	42	56	73	102
Irrigation	437	541	688	910	1072
Industry	-	8	12	23	63
Energy	-	2	5	15	130
Others	33	41	52	72	80
Total	**502**	**634**	**813**	**1093**	**1447**
BCM:billion cubic metres					

Source: Compendium of Agricultural Statistics, 2002, MoSPI

India .These projections strike the alarm for a relook at the water management policy of the country.

Water Management

Water management techniques in India followed are Subsidized Micro-Irrigation, Mandatory Rainwater Harvesting, Community-Based Watershed Management and promotion of water conserving practices like System of Rice Intensification. System of Rice Intensification has the potential to address the problems of water scarcity (32% water saving), high-energy usage (40 per cent saving) and environmental degradation leading to higher yields (40-80%) and lesser seed utilization (85% reduction). It is estimated that if the SRI is adopted even on just 25 per cent of the irrigated rice area in India (5.3 mha), there would be a saving of paddy seed worth Rs 500 crore. However, if we take a deeper look at these management practices, it is revealed that these are not followed across the country and thus have not been able to bring about the required impact .For example Government subsidies of up to 50% on Micro-Irrigation equipment are being utilized, but only by 8 states. Similarly, laws have been enacted for rain-water harvesting on the roofs of all new buildings, but in only 10 states. Between 1997 and 2007, innovative cultivation programs (e.g. spacing between plants, transplanting younger seedlings) were implemented to reduce the need for flood irrigation in water-intensive crops, but only across 6 states. There is a need to manage the existing water reserves in order to avoid future water strain. Government policy transformation would ensure that water management techniques and initiatives are executed at a national level across all the major sectors. In the Agricultural Sector, adoption of techniques such as rain-water harvesting and watershed management; reduction of subsidies on power and implementation of customized pricing models to counter groundwater exploitation through excessive withdrawal are some options. Waste water re-use in agriculture should be encouraged. The Government has targeted to bring 17 million ha under Micro Irrigation by the end of the 11th Five Year Plan period. This indeed is a laudable effort as this alone is expected to result in an annual water savings of about 59 billion cubic metres. In the Industrial Sector, investment in recycling and treatment of industrial wastewater through regulations and subsidies for water treatment plants need to be encouraged. In the Domestic Sector rain-water harvesting need to be made mandatory in all cities of the country with new construction projects .Propagation of efficient water usage practices through community based education programs with participation of local institutions and NGOs would help.

Conclusion

Unless local and national communities come together and dramatically improve the way we envision and manage water, there will be many hungry villages and degraded environments and the economic development of the country will be put at risk. Stakeholders that include farmers, industries, policy makers, administrators, non government organizations etc will need to come together to formulate an integrated road map towards water resource security in India. Some resolution in this road map may require potentially unpopular policy changes and the adoption of water-saving techniques and technologies. The dialogue needed amongst stakeholders, then, is about India's economic and social priorities and the challenges that are worth tackling to deliver or achieve water security, when every child in India would have easy access to water of the right quality,in the right quantity and at the right place. ❑

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Vigil Over Water Quality

S P Gautam
R M Bhardwaj

In view of increasing population and expansion of urban centers there is need to cover additional point sources in the form of drains from cities as well as new industrial establishment

WATER QUALITY monitoring is an important exercise which helps in evaluating the nature and extent of pollution control required, and effectiveness of pollution control measures already in existence. It also helps in drawing the water quality trends and prioritising pollution control efforts. The pollution control boards in India are responsible for restoration and maintenance of wholesomeness of aquatic resources.

Water quality monitoring is performed with following main objectives in mind :

- For rational planning of pollution control strategies and their prioritisation;
- To assess nature and extent of pollution control needed in different water bodies or their part;
- To evaluate effectiveness of pollution control measures already in existence;
- To evaluate water quality trend over a period of time;
- To assess assimilative capacity of a water body thereby reducing cost on pollution control;
- To understand the environmental fate of different pollutants.
- To assess the fitness of water for different uses.

National Water Quality Monitoring Network

Central Pollution Control Board (CPCB) has established a network of monitoring stations on rivers across the country. The present network comprises of 1700 stations in 27 States and 6 Union Territories spread over the country. The monitoring is done on monthly or quarterly basis in surface waters and on half yearly basis in case of ground water. The monitoring network covers 353 Rivers(979 Stations), 107 Lakes (117 Stations), 9 Tanks, 44 Ponds, 15 Creeks/Sea Water, 14 Canals (44 Stations), 18 Drains and 491 Wells. Water samples are

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being analyzed for 28 parameters consisting of physico-chemical and bacteriological parameters for ambient water samples apart from the field observations. Besides this, 9 trace metals and 28 pesticides are analyzed in selected samples. Biomonitoring is also carried out on specific locations.

Concept of Water Quality Management in India

The water quality management in India is performed under the provision of Water (Prevention and Control of Pollution) Act, 1974. The basic objective of this Act is to maintain and restore the wholesomeness of national aquatic resources by prevention and control of pollution. The Act does not define the level of wholesomeness to be maintained or restored in different water bodies of the country. The Central Pollution Control Board (CPCB) has tried to define the wholesomeness in terms of protection of human uses, and thus, taken human uses of water as base f or identification of water quality objectives for different water bodies in the country.

It was considered ambitious to maintain or restore all natural water body at pristine level. Planning pollution control activities to attain such a goal is bound to be deterrent to developmental activities and cost prohibitive. Since the natural water bodies have got to be used for various competing as well as conflicting demands, the objective is aimed at restoring and/or maintaining natural water bodies or their parts to such a quality as needed for their best uses. Thus, a concept of "designated best use" (DBU) was developed (Table 1). According to this concept, out of several uses a water body is put to, the use which demands highest quality of water is termed as "designated best use", and accordingly the water body is designated. Primary water quality criteria for different uses have been identified.

The entire water resources of the country were classified according to their designated best uses and a "Water Use Map" was prepared. For identification of the water bodies or their parts where water quality is at variance with water quality criteria, it was felt important to measure water quality of that water body or its part. It would help in preparation of "Water Quality Map" of India. The idea was to superimpose "Water Quality Map" on "Water Use Map" to identify the water bodies or their parts, which

Table 1: Primary Water Quality Criteria for Designated Best Uses

Designated best use	Class	Criteria
Drinking water source without conventional treatment but after disinfections	A	Total coliform organisms MPN/100ml shall be 50 or less.
		pH between 6.5 and 8.5
		Dissolved oxygen 6 mg/l or more
		Biochemical oxygen demand 2 mg/l or Less
Outdoor bathing (organised)	B	Total coliform organisms MPN/100ml shall be 500 or less
		pH between 6.5 and 8.5
		Dissolved oxygen 5 mg/l or more
		Biochemical oxygen demand 3 mg/l or Less
Drinking water source with conventional treatment followed by disinfection	C	Total coliform organisms MPN/ 100ml shall be 5000 or less
		pH between 6 and 9
		Dissolved oxygen 4 mg/l or more
		Biochemical oxygen demand 3 mg/l or less
Propagation of wild life, fisheries	D	pH between 6.5 and 8.5
		Dissolved oxygen 4 mg/l or more
		Free ammonia (as N) 1.2 mg/l or less
Irrigation, industrial cooling, controlled waste disposal	E	pH between 6.0 and 8.5
		Electrical conductivity less than 2250 micro mhos/cm
		Sodium absorption ratio less than 26
		Boron less than 2mg/l

are in need of improvement (restoration). Subsequently through a wide network of water quality monitoring, water quality data are acquired. A large number of water bodies were identified as polluted stretches for taking appropriate measures to restore their water quality. Today almost all policies and programmes on water quality management are based on this concept including the Ganga Action Plan and National River Action Plans.

Water Quality at a Glance

Water quality of 353 rivers in major, medium and minor basins is observed in the country. The details of identified polluted rivers/ segments of rivers is as follows:

- Andhra Pradesh: River Musi- Hyderabad to Rangareddy; River Nakkavagu- D/s Medak; River Manjira- D/s Gowdicharla a/c with Nakavagu; River: Krishna- Wadepally (a/c with River Musi); River Godavari-D/S of Rajamundary and River Maner- along Warangal
- Assam: River Bharalu- D/s Guwahati; River Kalong- D/s of Nagaon (Elangabeel System Pond)
- Delhi: River Yamuna- Wazirabad to Okhla and downstream
- Gujarat: River Sabarmati- Ahmedabad to D/S of Vautha; River: Amlakhadi- Along Ankeshwar; River Bhogavo- D/s of Surendranagar; River Damanganga- Vapi D/s to Confl. with sea; River: Khari- along Lali village (Ahemdabad); River Tapi- Rander Bridge to Surat; River Kim-D/s Surat
- Haryana: River Ghaggar- Entire length in the State; River Markanda- Kala Amb to Narayan Garh; Western Yamuna Canal- D/s of Yamuna Nagar; Gurgaon Canal- D/s of Delhi
- Madhya Pradesh: River Khan – along Indore; River Chambal- Nagda D/s; River Kshipra- Ujjain to confluence with Chambal; and River: Betwa- Mandideep to Vidisha
- Maharashtra: River Bhima- Pune (Vithalwadi) to Takli; River Godavari- Nashik D/s to Paithan River Mula & Mutha -D/s Pune city; River Pawana - Pune-Sangavi Gaon, River Indrayani: Alandi to confluence with Bhima; River Koyna- Karad D/s; River Mithi- Mumbai Stretch; River Kundalika-Are Khurd to Roha city; River Tapi-M.P. Border to Bhusaval; River Girna-Malegaon to Jalgaon; River Nira-D/s of Jubilant Organosis Pune; River Weinganga- D/S Ashti River Wardha-Along Rajura village; River Bhima- Narsinghpur D/s; River Krishna- Dhom dam to Kolhapur; River Purna- Andura village; River Nira- Along Pulgaon; River Chandrabhaga- Along Pandharpur Town; River Venna - Varye, Satara D/s; River Kalu-Atale village to Confl. with Ulhas; River Kanhan-D/S Nagpur; River Kolar-Along Kamptee; River Ulhas–Mohane; River Panchganga- Kolhapur; River Patalganga- Khopoli to Esturaine region; and River Rangavali- Along Navapur.
- Punjab: River Satluj- D/S of Zenith Paper Mill to Bridge Harike, Amritsar; River: Ghaggar- Mubarkpur to Sardulgarh (Entire length in Punjab)
- Tamilnadu: River Adyar- Along Chennai; River Coovum- Along Chennai; River Vaigai- Along Madurai; River Tambiraparani- Along Ambasamudam; River Cauvery- Tiruchirapalli to Grand Anaicut; River Bhavani -Bhavani Sagar & Bhavani; River Noyyal- Along coimbatoor, Tirupur, Palyanakotti.
- Uttar Pradesh: River Yamuna- Kosi Kalan to Juhika; River Hindon: Saharanpur to confluence with River Yamuna; River Kali (West)- Muzaffar Nagar to Confluence with Hindon; River Kali (East) – Meerut to Kannauj; River Bagad- D/S of Gajraula; River: Ganga- Kannauj upstream to Varanasi D/S; River: Gomti- Lucknow to Jaunpur; and River Ramganga- Moradabad to Kannauj
- Karnataka: River Bhadra- D/s of Bhadravathi to confluence with Tunga; River Tunga- D/S of Shimoga; River Tungabhadra- Harihar to Haralahalli Bridge & Ullanur; River Laxmantirtha- D/s of Hunsur Town; River: Kali- Along Dandeli Town, River Krishna- Reaches of Ugarkhurd Barrage
- Manipur: River Nambul- Heirangoithong & Hump Bridge
- Rajasthan: River Jojari-Along Jodhpur; River Bandi- Along Pali; River Berech-D/S Udaipur; River Chambal- D/S Kota city
- Uttarakhand: River Kosi-D/S of Kashipur, River Dhela &

Kichha- D/S of Kashipur; River Bahalla- D/S of Kashipur

- Jharkhand: River Subarnrekha- D/s of Ranchi (Tatisilwal)
- Chattisgarh: River Arpa- D/S of Bilaspur; River: Seonath-along Rajnandgaon
- Meghalaya: River Kharkhala- Along Sutnga Khlieri; River Umtrew-Along Byrnihat East
- Himachal Pradesh:River Markanda- D/S of Paonta Sahib
- Orissa: River Kathjodi- Along Cuttack
- Puducherry: River Arasalar- Along Karaikal
- West Bengal: River Damodar- Along Asansol

Water Quality Trend

The water quality monitoring results obtained over a decade indicates that the organic and bacterial contamination continue to be critical in water bodies. This is mainly due to discharge of domestic wastewater mostly in untreated form from the urban centres of the country. The municipal corporations at large are not able to treat increasing load of municipal sewage flowing into water bodies without treatment. Secondly the receiving water bodies also do not have adequate water for dilution. Therefore, the oxygen demand and bacterial pollution is increasing day by day. This is mainly responsible for water borne diseases.

Strengthening of Water Quality Monitoring Network

The Planning Commission decided to strengthen the water quality monitoring network of CPCB and fixed the target of 2500 monitoring stations under water quality monitoring programme during 11th plan period. The present network of monitoring stations under National Water Quality Monitoring Programme is inadequate and does not cover all the water bodies in the country. The average distance between the stations on rivers is about 55 Kms and in view of increasing population and expansion of urban centers there is need to cover additional point sources in the form of drains from cities as well as new industrial establishment.

Identification of Polluted River Stretches

Monitoring locations at which the presence of pollutants exceeds the stipulated criteria are identified as polluted locations. The polluted stretches are then accorded to five priority groupings depending on the risk that each such location poses. The risk in turn depends on the following formula:

Risk= Frequency of Violation of Criteria Xconsequence (Magnitude)

Through such an analysis it has been found that 35 river stretches in our country fall under priority 1 group, 15 under priority 2, 26 under priority 3, 38 under priority 4 and 36 under priority 5 group.

Constraints in improvement of water quality

- Rivers are dammed in upper reaches for irrigation requirements resulting in negligible flow in long stretches.
- All the dry weather flow is diverted in Canals.
- Regenerated flow has also reduced due to declining water table.
- Rapid growth of population and development of sewerage system is causing increased inflow of wastewater in the rivers.
- Sewage Treatment Plants commissioned under various plan activities are not operating to their design capacity. They are either under loaded or over loaded.
- Dedicated power for operation of STPs is not available.

Strategy for improvement of water quality

- Renovate all the existing sewage pumping stations and sewage treatment plants.
- Installation of new sewage treatment plants (STPs) in all the towns discharging sewage to rivers to bridge the gap between generation and treatment.
- Intercept all the drains not yet covered and divert to STPs.
- Ownership of assets by State Public Health Deptts.
- Augmentation of river flow.
- Tightening of standards for sewage treatment and industrial effluents in view of reduced flow.
- Alternatives to be explored for geogenic/non point sources of contamination either through piped surface water supplies or improved onsite treatment technology in rural areas. ❑

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Artificial Recharge of Groundwater–the Indian Experience

B M Jha
R C Jain

There is an urgent need to upscale the efforts for ground water recharge augmentation and to take it up as a national mission

THE DEPENDENCE on ground water as a reliable source for meeting the requirements for irrigation, drinking and industrial uses in India has been rising rapidly during the last few decades. Ground water development has occupied an important place in Indian economy because of its role in stabilizing agriculture and as a means for drought management. In some parts of the country, ground water withdrawal has already reached a critical stage, resulting in acute scarcity of the resource. Over- development of the ground water resources has resulted in declining ground water levels, shortage in water supply, intrusion of saline water in coastal areas and increased pumping lifts. Worsening ground water quality has also adversely affected the availability of fresh ground water in some areas. These have serious implications on the environment and the socio-economic conditions of the populace. Hence, urgent steps for augmentation of ground water resources are called for to ensure their long-term sustainability. Artificial recharge to ground water has a very important role to play in our endeavor to augment the ground water resources in aquifer systems to tackle the challenge of ground water level depletion and associated environmental and socio-economic impacts.

Water has been harvested in India since antiquity. Evidences of this tradition are available in ancient texts, inscriptions, local traditions and archaeological remains. There is some evidence of advanced water harvesting systems even from pre-historic times. Traditional rain water harvesting structures were meant for collecting

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runoff and utilizing harvested water for irrigation, drinking and domestic purpose. Majority of the traditional harvesting structures, being on open area, were prone to evapotranspiration and contamination. The concept of artificial recharge to ground water to augment the ground water resources in aquifers and to check the depleting ground water levels emerged subsequently.

Government Initiatives:

The Central Ground Water Board, Government of India has been in the forefront of government initiatives for augmenting ground water resources through scientifically designed artificial recharge structures for harvesting non-committed surplus water which otherwise runs off into sea. The diverse nature of the terrain and complexities of hydro-geological settings prevailing in the country makes this a challenging task.

Studies to ascertain feasibility of artificial recharge to ground water through surface spreading techniques, injection wells and induced recharge in Ghaggar River Basin, Haryana and Mehsana Area & Coastal Saurashtra, Gujarat were taken up by CGWB during 1976-78 with UNDP assistance. These studies gave encouraging results and established the feasibility of augmenting ground water resources through various techniques of artificial recharge. Subsequently, demonstrative artificial recharge projects, aimed at popularizing cost-effective technologies of recharge augmentation suitable for diverse hydrogeological settings were undertaken during VIII Plan in Gauribidanur and Mulbagal taluks of Kolar district, Karnataka, orange and banana growing areas of Amravati and Jalgaon districts of Maharashtra and UTs of Delhi and Chandigarh, wherein construction of percolation tanks, cement plugs, check dams, recharge wells, recharge shafts, roof top rain water harvesting structures etc. was taken up. Sub-surface dykes were constructed in the states of Madhya Pradesh, Tamil Nadu, Kerala and West Bengal and bandharas were constructed in Maharashtra. During IX Plan, 165 such demonstrative projects were implemented in 27 States in the country. During the period 2006-2009, construction of artificial recharge to ground water and rainwater harvesting structures was taken up in 8 identified areas in the states of Andhra Pradesh, Karnataka, Madhya Pradesh and Tamil Nadu.

The demonstrative artificial recharge schemes have been implemented by the Government of India with active association of various State & UT Govts. /Voluntary Organisations and Community based organizations. Impact assessment studies of

Sl. no.	Recharge structure (Nos.)	Area of implementation	Benefits
1.	Percolation tanks (21)	AP, Karnataka, Kerala, MP, Maharashtra, Tamil Nadu, West Bengal	Water recharged 2 -225 TCM Area benefitted 10 -500 Ha Rise in water level <1 up to 4 m
2.	Check dams (13)	AP, HP, Kerala, MP, Maharashtra, Delhi, Rajasthan	Water recharged 1 -2100 TCM Area benefitted 3-30 Ha Rise in water level <1 – 2.5 m
3.	Recharge trench /shaft / well (10)	AP, Chandigarh, Haryana, Kerala, Punjab	Water recharged <1-1550 TCM Rise in water level 0.25-0.7 m
4.	Sub-surface barrier/dyke (11)	Kerala, MP, Rajasthan, TN, West Bengal	Water recharged 2– 11.5TCM Rise in water level <1- 3.8m

TCM = Thousand cubic meters

the schemes have revealed that percolation tanks, check dams, recharge shafts and sub-surface barriers are effective artificial recharge structures in hard rock areas while recharge trenches and recharge tubewells are effective in alluvial areas. In case of urban areas and hilly terrains with high rainfall, roof top rain water harvesting structures are effective. During the studies carried out to evaluate the efficacy of the recharge schemes, the impact of different types of artificial recharge structures was also studied and a state wise summary in respect of some of the different types of structures is tabulated below.

The Impact assessment studies of various artificial recharge schemes implemented has shown encouraging results in recharging of run-off, increased sustainability of extraction structures, increase in irrigation potential, revival of springs, improvement in environment through increase in soil moisture, rise in water levels/ arrest of rate of decline in ground water levels and improvement in ground water quality.

During XI Plan, artificial recharge projects are being taken up by the CGWB under the ongoing Central Sector Scheme of Ground Water Management & Regulation in priority areas viz. over-exploited and critical areas, urban areas showing steep ground water level decline, drought prone and water scarcity areas, coastal areas, sub-mountainous/hilly areas etc. The civil works are being carried out by state govt. departments through implementing agencies on cost deposit basis. A provision of Rs. 100 crores has been made for the purpose. So far, projects under the scheme have been approved in the states of Andhra Pradesh, Arunachal Pradesh, Karnataka, Kerala, Punjab, Tamil Nadu, Madhya Pradesh, Uttar Pradesh and West Bengal.

A state sector scheme of Dug well recharge has been launched by the Government of India in Over- exploited, Critical and Semi-Critical assessment units of seven states viz. Andhra Pradesh, Maharashtra, Karnataka, Rajasthan, Tamil Nadu, Gujarat and Madhya Pradesh to provide sustainability to the dug wells during Xl Plan. The scheme is being implemented in 1180 over-exploited, critical and semi-critical blocks in these states. The scheme aims to facilitate improvement in the ground water situation in the affected areas, increase the sustainability of wells during lean period, improve quality of ground water and community involvement in water resource management in the affected areas.

In addition to demonstration of technologies for ground water augmentation, activities aimed at creation of awareness on water conservation & augmentation and capacity building of stakeholders are also being taken up by the Ministry of Water Resources through Central Ground Water Board. These include dissemination of technical information related to ground water in the form of reports, maps etc and also through the web site and Ground Water Information System of CGWB. The Government has constituted an Advisory Council on Artificial Recharge of Ground Water in the year 2006 under the Chairmanship of Hon'ble Minister (WR) with the main objective of popularizing concept of artificial recharge among stakeholders. Ministry of Water Resources has also instituted annual awards namely Ground Water Augmentation Awards (*Bhoomijal Samvardhan Puraskars*) and National Water Award to encourage adoption of innovative practices of ground water augmentation by rainwater harvesting and artificial recharge, promoting water use efficiency, recycling & re-use of water and creating awareness through people's participation. Central Ground Water Authority (CGWA), constituted under the Environment (protection) Act, 1986 is also playing an active role through various initiatives for augmentation of ground water resources in the country.

Artificial recharge of ground water is now a national priority and many states are implementing artificial recharge schemes to augment the water resources. The states of Andhra Pradesh, Gujarat, Maharashtra, Karnataka, Chhattisgarh, Madhya Pradesh, Delhi and Tamil Nadu have taken up several initiatives for implementation of artificial recharge schemes. In Andhra Pradesh, a large number of artificial

recharge structures have been constructed under the *NEERU-MEERU* Programme and good success has been reported. In Tamil Nadu, TWAD Board is instrumental /leading in the implementation of artificial recharge schemes in association with other concerned departments.

The Government of Gujarat has been lauded for adopting an aggressive recharge strategy through people's participation that has made Saurashtra region of Gujarat a role model for other states to follow. It has enthusiastically made common cause with farming communities in undertaking decentralized rainwater harvesting and groundwater recharge work. For the state as a whole, by December 2008, nearly 500,000 structures have been constructed, which included 1,13,738 check dams, 55,917 *bori bandhs*, 2,40,199 farm ponds, besides 62,532 large and small check dams constructed under the supervision of the Water Resources Department of the Government of Gujarat, all in a campaign mode. Impact evaluation of the benefits accrued include rise in ground water level by 3-5m around the check dams, rejuvenation of dried-up dug wells and improvement in ground water quality.

Initiatives by NGOs/VOs

Several NGOs/VOs in various states are also actively engaged in promoting artificial recharge/ rainwater harvesting techniques for ground water resource augmentation. Hiware Bazaar village in Ahmednagar district, Maharashtra, under the leadership of Shri Popat Rao Pawar established the Yashwant Agricultural Development trust for implementing Watershed Development Programme. Under this programme, structures for ground water augmentation and soil conservation such as contour bunding, nalla bunding, construction of village tanks, check dams, continuous contour trenching, farm bunds, percolation tanks, boulder check dams etc. were undertaken. These efforts resulted in raising the ground water levels, increase in area under protective irrigation, increase in fodder availability, increase in milk production and overall positive change in social activities, which won the panchayat the coveted National Water Award for the year 2007. Comprehensive watershed treatment measures aiming at soil and water conservation taken up by various voluntary agencies in the state have yielded excellent results by improving availability of ground water leading to increased agricultural productivity. These experimental measures won a *Padma Bhushan* Award to the guiding spirit of the project, Shri Anna Hazare. *Tarun Bharat Sangh* has taken up desilting and deepening of village ponds and built water harvesting structures and *johads* with the help of villagers in Alwar District, Rajasthan. The efforts of this organization have received international attention and Shri Rajendra Singh of *Tarun Bharat Sangh* received Magsaysay Award for these efforts. Innovative solutions for ground water conservation and augmentation fetched the National Water Award for 2008 to *Vruksh Prem Seva Trust*, Upleta, Rajkot district, Gujarat. Similar path-breaking initiatives are being taken up by several organizations in various states of the country.

Way Forward

The efforts of Central and State Governments and NGOs/VOs over the years have succeeded in creating awareness among the population of the importance of ensuring the long-term sustainability of our limited ground water resources. Various studies / demonstrative projects have also established the importance and efficacy of artificial recharge as a viable means for ground water resource augmentation in diverse hydrogeological settings. However, considering the increasing stress on the available resources and the complexities of the hydrogeoloical regime in the country, there is an urgent need to upscale the efforts for ground water recharge augmentation and to take it up as a national mission. There is also need to recognize artificial recharge as a component of a holistic process of integrated water resources management and not as a complete solution in itself. Concerted efforts of all stakeholders involved and participation of the user community in water management initiatives hold the key for a water-secure India of tomorrow. ❑

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J&K WINDOW

BUMPER CHERRY PRODUCTION

Cherry growers of Kashmir are expecting a bumper crop this year following timely rains and snowfall. The state horticulture department is expecting a considerable growth in production in comparison to last year's 10885 metric tons. The cherry production continues from May-June till July 15. The horticulture department spreads awareness amongst cherry growers. They interact with them and try to increase the area under cherry production and ask them to plant more trees.

Kashmiri cherries are always in high demand and enjoy a virtual monopoly, as the fruits from the state are preferred across the country for their taste and quality. This year the production is much higher and the farmer expect greater dividends. The Horticulture Department tells Farmers about new pesticides and new technology. Harwan, Dara, Kangan, Nilshad, Tanmarg and Sopiyan are the regions of Kashmir where extensive cherry cultivation is witnessed.

Cherry requires a conducive climatic condition for proper blooming and fruition. The temperature should be perfect for better crop. It should have a maximum temperature of about 30-35 degree Celsius and above 25 degree Celsius. Horticulture production of fruits like apples and cherries are the primary economic activity of the Himalayan State. The horticulture sector is a major contributor to the economy of Jammu and Kashmir. Besides cherries, other fruits such as apples, pears, walnuts and almonds are the major commercial crops of the State. ❑

GOLF TOURISM IN KASHMIR

Jammu and Kashmir is rolling out the best golf greens for tourists to come and call it 'a paradise on earth' once again. The state sees golf as the fastest way to boost the hospitality sector battered by 20 years of insurgency. Following in the footsteps of European nations, the tourism department is trying to make the state a Mecca of the sport by developing a golf circuit-with six 18-hole courses-at a cost of some Rs 750 million.

Golf can only add to its many attractions, from lofty mountains and lakes with houseboats to spicy wazwan and delicate hand woven embroidery. This is being done to lure high-spending tourists back to the Kashmir Valley, which has been batling a bloody separatist war but is slowly but steadily moving towards peace.

According to official figures, over 500,000 tourists, including 25,000 foreigners, visited the valley last year, and the officials aim to double the figure this year.

The Kashmir Valley has five golf courses, including the 18-hole par-72 Royal Springs in the heart of summer capital Srinagar. Located on the eastern banks of Dal lake with Zabarwan hills serving as a backdrop, turfs in the 300-acre glof course are set with cool-weather grass of different shades and tall poplar trees bordering the fairways. A dream course for any golfer. It is the best in India and among the best in the world.

There are three more courses, which are equally world class. The course at the Gulmarg hill resort, situated at an altitude of 2,650 metres, is said to be the highest green golf field in the world. More than a century old and having natural slopes, the course is under-going a major renovation for being readied by June end.

The story is ditto for the hilly course in Pahalgam, a tourists' paradise, 100 km from Srinagar. There is one more coming up in Dodhpathri (some 40 km from Srinagar) in central Kashmir and Srinagar's heritage golf course is also being upgraded.

And the sixth one is in Jammu, being laid at a cost of Rs. 440 million, that will be opened in September this year. Golf tourism is the fastest way to boost lodging bookings. Hotels, restaurants, shoping malls and art galleries can all benefit dramatically by making Kashmir a perfect golfing destination. ❑

Kharamal– A Green Spot in a Brown Belt

Ranjan K Panda

As Orissa's agriculture fields starve for water once again, and farmers in the rain-fed areas commit suicides, Kharamal has had better luck, thanks to its efforts in restoring traditional water harvesting structures through collective community action

KHARAMAL IS a forested village at the foothills of Gandhamardan hills in Paikmal block of Bargarh district in Orissa. The village houses 410 people of whom majority are tribals. Drought is nothing new for the villagers since the area is now facing it in regular succession. The impacts are however coming in new and newer forms with increased heat and distorted monsoon caused by climate change. So, the traditional coping mechanisms of the villagers are proving inadequate in fighting drought now a days forcing people to migrate in search of job at brick kilns of Andhra Pradesh and other such hazardous and low paying occupations. Things have however started to change ever since a local NGO intervened and organized the villagers to understand drought better and recall their traditional coping mechanisms which were earlier successfully helping them in fighting drought and in which the people have lost faith in the recent years. In just five to six years, with large scale awareness and concerted community action, the village is emerging as a green spot in a brown belt. Things have started to look positive and people have resumed hope in their traditional wisdoms in water conservation and management. Meeting Kurmila Bhoi would show how.

From Migrating Out to Settling In

In September 2009, when senior correspondent of NDTV 24x7, one of India's leading TV news channels, visited Kurmila in her village, she was overwhelmed. She realized the real potential of her transformation from a migrant labourer to a land owner. By village standards she possessed a good amount of land and qualified to be called a rich woman. In fact her 8 acre land yielded enough for her family a decade and half ago. "Things changed in the last about

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Reviving Traditional Systems of Water Harvesting

15 years when weather became more erratic and forests denuded fast. We started to migrate to brick kilns and suffer", rues Kurmila. Out of her eight acres, only two acres were low land which yielded more compared to the six acres of upland. Still her family managed with what they got from the rain-fed crops and forest produces. Drought became a regular feature in the last 15 to 20 years and forest degradation added to their woes. Erratic rainfall made agriculture almost impossible as she suffered heavy crop loss almost each year. The land also got severely eroded, sand cast and infertile. "Even with that much of land we were living in penury and subsisted with high interest loans by pledging domestic utensils and valuables. Agriculture failed as cultivability of the land eroded with high intensity runoff causing sand cast, creating gullies. Further, as soon as the rain the rain stopped , our lands would face soil water (moisture) scarcity", informed Kurmila. This resulted in difficult conditions to cultivate the land. "We found a succor in migrating out. We went to Ayodhya and many places in Maharashtra and Andhra Pradesh to work as brick kiln labourers where we were exploited", recalls a pained Kurmila.

Things changed in 2004-05 when MASS, a local NGO, helped her think about her survival strategy afresh. "We found sense in the points raised by people from this organization and organized village meetings to understand drought situation; its history and impacts; and finally to plan out strategies to fight this", says Dhanu Bhoi, Kurmila's husband. That year, with help of MASS, they constructed a 'chahala' (a small water harvesting structure) to save their crop in one acre. "After many years, that was the first year when we were not required to borrow loans or advances from elsewhere; we got direct employment in land treatment and chahala works in our village. We stayed back and a new era began", she informs. "MASS gave me a direct cash assistance of two thousand and seven hundred rupees. In fact that year MASS started several other activities in the village to restore our traditional water bodies and local ecology. I received training in eco-agriculture, preparation of organic manure and pesticides on my own in a cost effective manner", she says . To stop migrating and starting agriculture afresh in the village several other measures like formation of a 'seed bank' was taken up with the support of MASS and Kurmila received one bag of paddy seed as loan from this bank to be able to start her agriculture. The chahala that stored rain water for her started showing good results very soon and Kurmila used it for vegetable cultivation. She earned a good profit and bought two goats.

Kurmila and her family members, as well as many others in the village have stopped migrating to other places in search of work. She has got money and she has brought back all her land into agriculture again. Not only this, she has constructed a new house and lives a dignified life. From a migrant labourer to a dignified settler, Kurmila is now reaping the benefits of water harvesting. Many other families of Kharamal, this tribal dominated nondescript village, have also fought drought successfully and have proved that reviving traditional systems of water harvesting with new inputs in technical skill building and organic agriculture could be really beneficial. Kharamal has not looked back ever since then and the movement is spreading to other villages. ❑

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Unraveling India's Enduring Urban Drinking Water Indigence

Shubhagato Dasgupta

Given the variety of institutional histories of different states in this sector, policy makers need to understand the key issues affecting the choice of institutional reforms

THIS PAPER presents some of the early findings from a study on the policy questions around India's drinking water supply being undertaken at the Centre for Policy Research, New Delhi. It briefly documents the significant central government efforts inspite of which the situation today is far from satisfactory and focuses on the current policy framework for urban reform and its impact on the urban drinking water sector. Although currently there seems to be a realization of the challenges that face the sector, and some consensus on the key elements of reform at the policy level, much of this reform is yet to be implemented. The paper asks why implementation is lagging and poses that independent research on the subject to needs to be stepped up if the urban drinking water sector is to better seve citizens in the future.

Background : Central Government assistance to the urban drinking water sector in India

Since the first Plan the central government has consistently focused on funding the drinking water sector and has increased outlays significantly in every plan period. Also, among the water and sanitation sectors, the urban water sector has had the highest growth in the amount of resources targeted to it. This can be seen from chart 1 on the next page.

Inspite of the 74th Constitutional Amendment which delineated the role of local governments, the primary responsibility for providing drinking water and sanitation facilities in the country is still retained by the State Governments. The Centre provides and allocates funds and also ensures that funds are provided in State budgets. As

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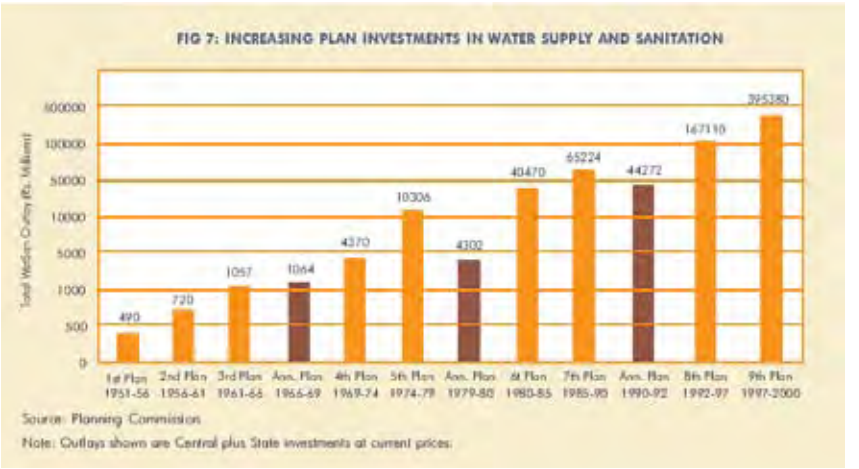
Chart 1: Increase in Planning Commission outlays for the sector



Source: Planning Commission, GoI 2002

mentioned above progressively larger allocations have been made for water supply and sanitation in the various Five Year Plans.

In the recent past the national policy guiding India's approach to water supply and sanitation since the Eighth, Ninth, Tenth and now the Eleventh Plan broadly follow the guiding principles of the New Delhi declaration, adopted by the United Nations General Assembly in December 1990. These include (a) protection of the environment and safeguarding of health; (b) organisation of reforms, promoting an integrated approach; (c) community management of services, backed by measures to strengthen local institutions in implementing and sustaining water and sanitation programmes; and (d) sound financial practices, achieved by better management of existing assets.

The Tenth Plan envisaged 100 per cent coverage of rural and urban population with safe drinking water as per the stipulated norms and standards (40 lpcd of safe drinking water within a walking distance of 1.6 Kms or elevation difference of 100 metres in hilly areas, to be relaxed as per field conditions; at least one hand pump/spot source for every 250 persons). The Tenth Plan also clearly advocated management of water as an economic asset rather than a free commodity. Coverage was an important agenda, and the highest priority is being accorded to remaining 'not covered' and 'partially covered' habitations having a supply level of less than 10 litres per capita per day (lpcd) as also those affected severely with water quality problems.

As per the National Sample Survey, National Health Survey and census figures, `coverage' of water and sanitation services in both rural and urban areas is improving steadily, and that the levels have improved significantly from the 30% and 70% coverage levels in the late 1970's to 2001. As per Joint Monitoring Group projections by the end of the Tenth plan the coverage could be expected to go up to 94-5 percent and not really the 100 percent that the plan had targeted

Urban water sector outcomes on the ground

Inspite of the proclaimed expansion of water supply over the years not one city or town in India provides 24 hour, 7 days a week water supply. Even some large cities such as Hyderabad and Chennai provide water for only 3 hours every two days. Delhi on an average provides water for only 6 hours a day that to at very low pressure.

Slum and squatter settlements often do not have connections to a piped water system and many depend solely on purchasing water from vendors at high prices, when at the same time, most middle class areas / neighborhoods connected to organized piped water systems pay extremely low user charges for water. Other than this, unaccounted for water is often over 50%, making water systems in cities and towns essentially, large `leaking buckets'. Along with this cost recovery of the water service itself is very low, at an average of around 20% of operation and maintenance expenditure. Capital expenditure is completely funded from general taxes. Lack of funds and incentives for O&M have lead to decaying infrastructure. Even where there is a network in place there is very little reinvestment undertaken which is essential to keep the system efficient. The poor outcomes in the sector presented above have set the sector into a vicious cycle, pushing service

Table 1: WHO UNICEF JMP Water and sanitation data (2002)					
Source	**Sector**	**Code**	**Year**	**% Urban pop covered**	**% Rural pop covered**
India National Sample Survey 1996	Water Supply	NSS 96	1996	93	75
	Sanitation	NSS 96	1996	50	6
India National Health Survey, 1998-1999; Special *tabulation;*	Water Supply	DHS 99	1999	94	75
	Sanitation	DHS 99	1999	61	17
Multiple Indicator Survey 2000	Water Supply	MICS00	2000	94	80
	Sanitation	MICS00	2000	76	18

Source: WHO/UNICEF, 2008

quality down further and making the recovery path more tedious and difficult.

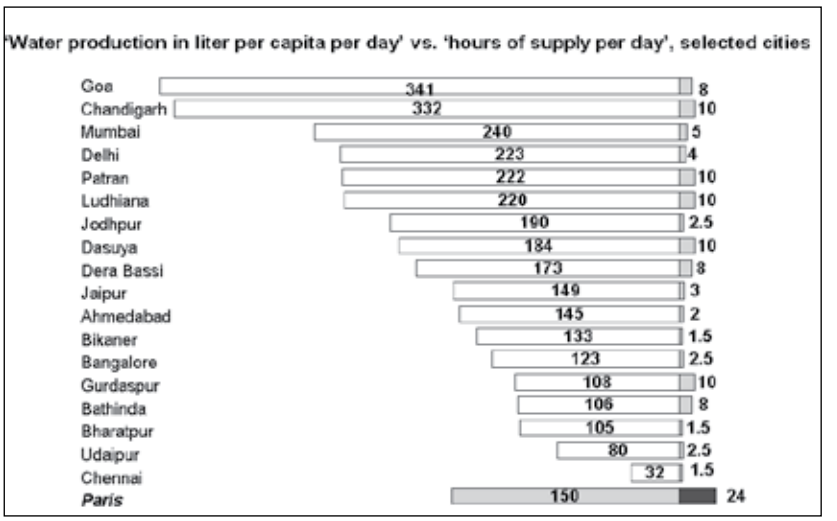
Refocusing Central Assistance to the urban drinking water sector

It is only recently during the implementation of the Tenth Plan and then in the Eleventh plan that the Government of India is better appreciating the need to improve governance and service levels in urban India with a special reference to the drinking water sector. This is manifested in terms of a) greater amounts of funds from the Planning Commission being targeted to urban areas and b) a deeper strategic engagement with urban sector reform as witnessed in the Tenth and Eleventh plans with the creation of reform incentive funds such as the Urban Reform Incentive Fund (URIF), the City Challenge Fund (CCF) and now most recently the Jawaharlal Nehru Urban Renewal Mission (JNNURM).

The JNNURM is the flagship program of the government of India that is aiming to catalyze investment of close to 20 billion dollars into urban sector in India. The JNNURM aims to incentivise state and local governments to improve services and quality of life in cities by undertaking a set of mandatory and optional reforms. Based on the compliance to reform plans developed by the city in their City Development Plans (CDP), part funding for projects is made available to the cities and state government agencies.

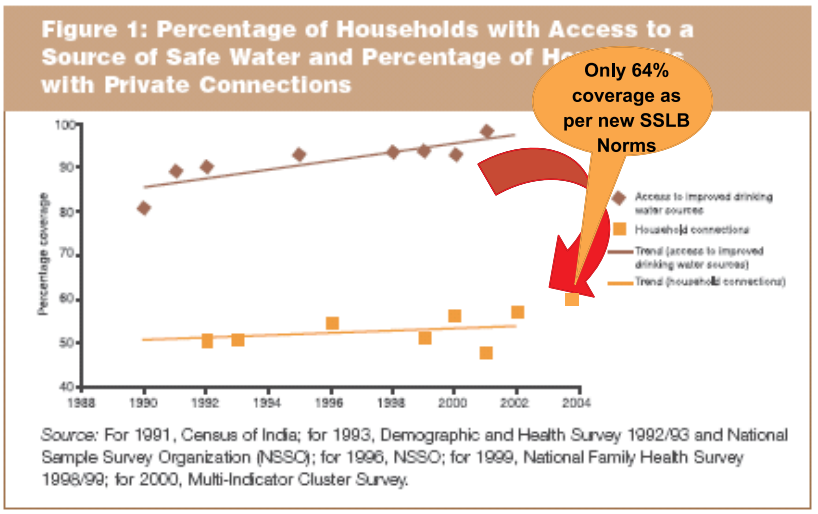
On the reform front at the central, state and local level there seems to be a broad consensus of the key elements of reform which is now articulated clearly as a long list of reforms under JNNURM. This consensus is developed out of a better and more nuanced understanding of the pitfalls of service delivery in cities in India today. In an attempt to better monitor the progress made by cities and state governments in achieving the objectives of improved service delivery the Ministry has recently developed the Standard Service Benchmarks (SSB). These are essentially goals, which can be measured so that the changes in quality of services delivered can be monitored over a period of time. This is an important shift from the past when water service delivery was measured by a singular measure of `coverage', where the definition of coverage did not incorporate a modern benchmark. The SSB have changed the definition of coverage of water supply from

Chart 2: Poor levels of service in Indian cities



Source: Water and Sanitation Program – South Asia analysis

Chart 3: Change in definition of `coverage' of drinking water service in urban areas



Source: WHO/UNICEF 2008, own analysis

the earlier census based definition to now include direct household connections for each household. If the national surveys, census etc, were to apply the new definitions and standards of service delivery which better reflect the aspiration and user needs, the level of coverage as an example will come down significantly from 90 percent to 64 percent.

Is the new approach of the Central Government working?

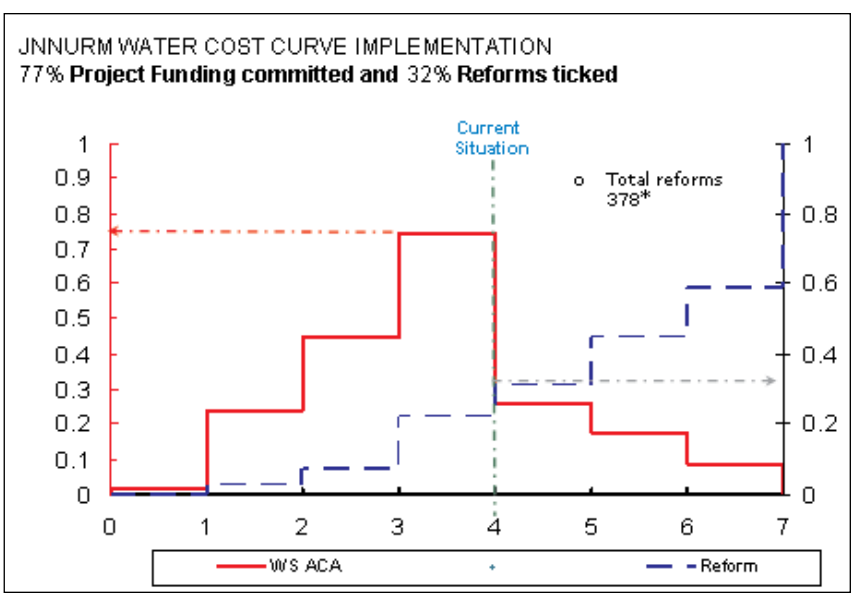
While this is an important new development, a quick look at the JNNURM program reveals that as with other plan investments in the past, while the largest number of projects and investment have been flowing into the drinking water sector, with more than 200 projects, the incorporation of reforms by the State and Local bodies seem to be lagging.

An analysis of drinking water supply related reforms under JNNURM reveas that while more than seventy five percent of the project funding allocated to water supply had been sanctioned by the central government in 2009, only thirty two percent of the reforms had been undertaken by the states and local bodies. Please see chart 4 which places the expenditure and the reform achievements till 2009 and then projects the trajectory if the initial objectives of JNNURM are to be met.

What still needs to be well understood especially at the state and local level is that going from 15-16 hours of water a day to 24 hours, or increasing efficiency by 10% is a matter of money and technical solutions: it's a *managerial* problem. However, improving services dramatically such as improving hours of supply from 3 hours every other day to 24 hours, or increasing efficiency by 40% is not a matter of money and technical solutions, it is, an *institutional* problem

Inspite of the 74th Constitutional Amendment as well as the JNNURM no state so far has fully transferred the responsibility to local bodies for a mix of reasons ranging from limited technical and financial capacity of local bodies to jurisdictional and staffing concerns related

Chart 4: Urban water sector investment vs water related reform under JNNURM



….. . *Source: Own calculations*

to restructuring state agencies. Solutions for each of these critical issues need to be addressed if the state and local agencies are to be able to provide improved demand oriented services especially in drinking water supply and achieve the goals of moving from 64 percent coverage to 100 percent; from 70-90 lpcd supply to 135 lpcd at the tap; from 20 percent metering to 100 percent; from two hours of supply to 24 hours and reduce non revenue water to 15 percent from current levels which are close to 50 percent.

The need for independent research on the subject.

As per the WHO and Unicef "No comprehensive studies, organised data sources, or even literature surveys exist on the economic value of the water and sanitation sector in India. As such, there was no readily usable data on values of existing infrastructure, generation of employment, exchange of goods and services, development of small industries, etc."

Other than this, given the variety of institutional histories of different states in this sector, policy makers need to understand the key issues affecting the choice of institutional reforms - ones that ensure that the *institutional relationships* between key players in service delivery chain are such that they empower poor people to monitor and discipline service providers as well as raise their voice in policymaking, strengthen incentives for service providers to serve the poor and also strengthen the *compact* in urban water networks

As one can imagine, with limited research in the sector, policy making is plagued with amateurism, with a wide range of people who make context-less suggestions, without any rigorous determination of their effectiveness and feasibility. This leads to a cacophony of ideas, mostly bad, which drive out the well reasoned good ideas. ❑

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DO YOU KNOW?

RAIN WATER HARVESTING

What is rainwater harvesting?

Rainwater harvesting is the storing and collection of rain water that runs off from tops of roofs, open spaces like parks and roads or especially prepared ground. This water can be used variously for purposes like drinking (after treatment), household use, livestock or even irrigation. It is also used for recharging groundwater, that is replenishing the water that has been extracted from the aquifers.

Why should rainwater be harvested ?

Much of the water that we receive as rain simply runs off and gets wasted. In a country like ours where there is so much of pressure on water resources due to growing population pressures, it makes immense sense for us to store up this water and put it to good use. This water can be a useful supplement to the water available from other sources, thereby augmenting the total water availability. In fact, in some regions, rain is the only source of water available, and that too, in highly erratic spurts. In such regions harvesting of rainwater is the best option available to people, and has been known to bring about marked betterment in their living conditions, for example in many parts of Gujarat and Rajasthan.

Rainwater harvesting is also very important for recharge of groundwater as there has been massive over extraction of ground water in many parts of the country. Rainwater harvesting not only replenishes the store of underground water, it also improves its quality by effecting dilution of pollutants and other harmful substances.

Besides these, rainwater harvesting also prevents local flooding in many areas, caused by the run off water.

How can rainwater be harvested ?

A major point in favour of rainwater harvesting is that the structure for this can be made from inexpensive, locally available material. It works both in individual households and for small communities. Rainwater harvesting structures can be made anywhere – individual homes, apartments, offices, institutions, slums, cities, villages – and by anyone – individuals or small communities.

Rainwater harvesting structures can be simple or complex. The main components in a rainwater harvesting system consist of a *catchment area* from where water is collected - this could be either from the ground like parks, playgrounds, roads, pavements, agricultural field etc, or from the rooftops - the *channel or conduit* through which water passes from the catchment structure into the storage area - these could be drains, pipes, rectangular or semi circular gutters or channels made of PVC material, galvanized iron sheets or even bamboo trunks cut vertically into two and the *storage tank or other structure*s where the water gets collected. The size of tanks would depend on the amount of water available and the amount needed for use. The tanks can be made from RCC, plastic, galvanized iron etc. Even dried bore wells, tube wells etc can be used for collecting water. If rainwater is being harvested for recharge purposes, there need to be appropriate structures for this, for example subsurface dykes built into an aquifer, recharge of abandoned wells, service tubewells, recharge pits etc. Besides these the rainwater harvesting structures also requires arrangements to maintain the quality of water. Thus, there have to be

arrangements to ensure that the first flush of rainwater which would contain contaminants, is allowed to flow out. Filters made of cloth, charcoal, sand etc are put in place to filter out pollutants.

Is rainwater harvesting a new concept in India ?

No, Indians have been harvesting rainwater since ancient times. Some of the traditional systems include *Tankas* which were small underground tanks built in houses in Rajasthan, especially Bikaner; *Khadim or Dhora*, which are embankments built along low hillslopes lying under rocky uplands for collecting water that runs down the slopes and using it for agricultural purposes later on; *Baolis* or stepwells of Gujarat and Rajasthan, The *Ahar Pynes* of South Bihar- *Ahars* are catchment basins embanked from three sides and *pynes* are channels leading off from the third side; canals of West Bengal; Tanks, *Phads and Bhandaras* of of Maharashtra, *Keres* or tanks of Karnataka or Zings of Ladakh which were tanks for collecting melted glacier .Most of these traditional structures are now defunct, but efforts have been initiated by many communities to revive these.

What rainwater harvesting technique is most popular in urban areas ?

The technique for collecting rainwater from rooftops is most popular in urban areas. Many state governments have passed laws making rainwater harvesting mandatory for all new buildings/ apartments etc. Some are even giving incentives in the form of rebate on property taxes.

How is rainwater harvesting being done in rural areas?

The stress in rural areas is on community based water harvesting systems with the revival of traditional systems. Communities are creating or reviving structures like checkdams and johads to collect water. ❑

Are we Suffering from the Flush and Forget Syndrome?

Sakshi C Dasgupta

The mindset of equating sewerage system and water using flush with hygiene has to be changed. Only then tangible progress could be made towards reducing water pollution, treatment cost and water borne diseases

IT IS official now! The leading contributor to the water quality degradation in rivers of India is untreated or partially treated sewage, as stated by J.M. Mauskar, Chairman of the Central Pollution Control Board (*Publication of Envis newsletter, Volume 1, issue 1, January-March 2008.*) Although this has been known widely, the official newsletter of CPCB established and reaffirmed this stark reality of our country's worsening river systems. (*Water Quality Management in India, Envis Newsletter Parivesh, Volume 1 Issue 1, Envis Centre on Control of Pollution, CBCB, January- March 2008)* According to the newsletter, around 33,000 million litres of sewage is generated everyday but the treatment capacities exist for only 21% or 7000 million litres per day including capacity created under the various National River Action Plans.

To trace the roots of this menace, one doesn't have to travel long back in time. Many of the present towns and cities that came up on the banks of rivers never conceptualized or gave a serious thought to the problem of waste disposal, especially urban sewage that would be generated from the residential areas. For them river water was a convenient source for discharging and diluting sewage, thus reducing their workload of treating wastewater or reducing waste generation in the first place. But, during those times the country was taking its first few steps towards urbanization. Therefore, whatever little sewage treatment networks and plants that were designed and constructed, were based on conservative population estimates. As a result only a small percentage of Indian towns and cities had sewage treatment plants and numerous other smaller cities/towns sprung up unplanned

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virtually with no sewerage system. Today, it is manifested in state of rivers especially along the urban areas, which have become highly polluted or even dead because of sewage overload, along with industrial pollutants and agricultural runoff.

To save the rivers from endless pollution, the most promising solution in sight for the authorities was to invest crores in treating the polluted rivers and thus colossal programmes like the Ganga and Yamuna Action Plan got formulated. But the bitter truth is that we have not been able to work on these rather straight forward solutions even after decades of their initiation. The evidence of the two most prominent river clean-up action plans namely, the Ganga Action Plan (GAP) and Yamuna Action Plan (YAP) lies in their present status. The highly revered Ganga still figures in the list of India's most polluted rivers according to CPCB, while Yamuna is often referred to as nothing more than a sewage drain. Apart from occasional media attention and civil society focus, the only two components that have shown steady growth in these programs are financial allocations and sewage discharge in the rivers.

Nearly fifteen years ago when the country's Supreme Court, suo motu started monitoring the river quality of Yamuna, it had to revise its deadline three times for the authorities to atleast meet the lowest potable standards during the course of time (Mahapatra. D, Legally Speaking- Will Ganga be Clean in the next 11 years, December 7, 2009, Times of India) One look at the river and it's very clear that we are far away even from this lowest standard, but have managed to spend a massive 1800 crores on the mission. The similar story for Ganga has been lingering on for almost 25 years now, but with little tangible achievements.

According to Sunita Narain (Narain Sunita, The flush toilet is ecologically mindless, February 28, 2002, down to Earth, CSE publication), Director of Center for Science and Environment (CSE), the present strategy of investing heavily in the massive river action plans and on building sewage treatment infrastructure, is in fact a narrow and short sighted engineering perspective. The rate at which our cities are growing and expanding, it is virtually impossible for the authorities to cover the entire cities with sewage network and continue building Sewage Treatment Plants (STPs). The reality is that the cities are outgrowing and increasing in numbers at a much more rapid rate than the government's ability to build these systems both logistically and financially. This is more or less the sordid state of affairs in every city, small or big, situated along the river banks.

In Delhi for example, treatment capacity increased 7-fold (from 300 mld in 1960 to 2,330 mld in 2008) in the last 40 years, as compared to a twelve fold growth in wastewater generation. River Yamuna, enters Delhi at Wazirabad, from where the city draws its water supply to feed some 14 million people (according to 2001 census) and dumps in around 4,300 million litres of wastewater per day (mld), of which 65% is untreated. In fact, Delhi has the largest sewerage infrastructure in India, with about 6,000 kms of sewers and 2330 mld sewage treatment capacity. But even after this, just about 50% of the city is connected to the sewerage network which has come at a cost of whopping 1500 crores. These Sewerage Treatment Plants (STP) are highly energy intensive and require large land area to be constructed which again is in dearth. But there is more in store, with the Delhi Jal Board (DJB), the prime agency handling sewage in the city, planning for another major hardware investment of about Rs. 2454 crores to construct the Interceptor Sewer Project to clean up the 22 km Delhi stretch of Yamuna. The plan is to tap minor drains discharging sewage into three of Delhi's largest drains, apart from augmenting the existing capacity of STPs, rehabilitation of two major trunk sewers and construction of new sewage treatment plants (STPs). But CSE in its 2009 report on the Review of the interceptor plan for the Yamuna, has placed serious doubts on the efficacy and viability of this ambitious project in cleaning up the wasted

river. Even if Delhi builds all the STPs, it would still be short of sewage to treat since the drains carrying it are choked and silted thus preventing wastewater from reaching the treatment plants. As a result, sewage from these choked lines is diverted to functioning lines and subsequently ends of these lines are overloaded, leading to untreated sewage flowing into the river. Often the drains are so designed that treated sewage gets mixed up with untreated waste thereby diminishing the purpose of sewage treatment.

So then what is the logical means to achieve the envisaged goal of cleaning up the polluted rivers? The clue lies in what the founder of CSE, Anil Agarwal called the political economy of defecation, simply stated, the more water we use, more the investment is needed to clean it up.

There is little doubt left that there is an urgent need to look at cost effective and non sewerage paradigm of human waste disposal, which forms the majority of urban sewage. Thus the need to explore and promote technologies and systems which use extremely low amounts of water or no water at all and where wastewater and solid waste could be recycled effectively. The modern flush toilet and the sewerage system have become symbolic of personal hygiene and sanitized environment, but they are in fact a part of the environmental problem and definitely not the resolution. A standard toilet installed in homes across India uses about 10-12 litres of treated fresh water to dispose a small quantity of excreta. Thus to keep our waste out of sight we require fresh water, for which we spend crores to build storage dams and pipelines. Then to carry the wastewater generated, we again construct large sewer systems and networks to dispose it in the very same river from where the water was sourced in the first place. Toilet water used for flushing constitutes about 40-45% of total water used in households, institutional and commercial units. A family of five who uses flush toilets contaminates 150 thousand litres of water to transport 250 litres of human waste in a year.

Urban Indians especially from the middle and upper class have developed a mindset of flush and forget! But, the real story starts after the lever on the cistern is pulled for flushing excreta. According to Sunita Narain, urban sewage system is a linear process, wherein, large amount of water in the cistern pushes excreta and dilutes urine down the commode into the wastewater pipe. This black water then mixes with the greywater from kitchen sinks, bathrooms to enter the pipeline leaving the house and then joins the pipes coming from other houses of buildings in the neighborhood. This then empties into a hierarchy of sewers starting from a municipal sewer and ending in the large trunk sewage drain. During the process varying quantities of water is added to keep the sewage running in these lines as they enter the STPs for treatment before being disposed off as treated water in the rivers or seas. But, rarely this sequence of event is followed either because of limited STP connections, underperforming plants or chocked drains. As a result, the untreated sewage loaded with dangerous pathogens find its way into rivers, polluting them and creating enormous environmental and health threats. Every year, millions of people, especially children die or fall sick after consuming polluted water from these rivers. The real tragedy is that people dying and suffering from consuming polluted water are poor and often unserved with safe water and sanitation facilities.

Therefore, the mindset of equating sewerage system and water using flush with hygiene has to be changed. Attitudes have to be constructed towards understanding the three key facts, namely, that water is precious and scanty; waste should be managed as close to the source as possible and human excreta has a resource value, only then tangible progress could be made towards reducing water pollution, treatment cost and water borne diseases.

One of the proven ways that can help address the above stated issues is through decentralized effluent treatment, wherein a building, block or colony could

have its own sewage plant at a low cost and more importantly using less and recycling water for low grade uses. There are options ranging from conventional to mechanical systems. The conventional decentralized technology would include components like cesspools, septic tanks, stabilization tanks, rootzone treatment, tricking filter together addressed as DEWAS systems. A DEWATS system can treat 100 KLD of waste and uses less power. On the other hand mechanical technologies would include upflow sludge blanket reactor, rotary biological contractors, fluidized aerobic bioreactors etc. which are low on energy consumption and can treat 500-1000 KLD of wastewater.

At the user end, low water efficient flush toilets can be installed that use 40-60% less water to dispose the same amount of waste effectively. The dual flush, vacuum based and pressure assisted flush designs are some of the examples of the new and emerging technologies which are now being promoted by the Indian sanitaryware manufacturers. In addition low flush urinals using less than half the amount of water than in the standard models and waterless urinals are also widely available in the Indian market. To reduce basin water use, low flow faucets along with a variety of add ons like aerators and flow fixtures are also making their mark in the Indian market. These technologies, if promoted adequately can help save valuable yet substantial amount of water, literally going down the drain. Human excreta in the form of urine have valuable nutrients which can be directly used as fertilizers, while faeces can be sanitized and used as a soil conditioner. This is what in the *ecosan* approach is called closing the loop, wherein nutrients we eat from the plants in the soil are thus returned to the soil.

Thus, managing and abating river pollution is not bounded to huge investments in River Action Plans and massive sewerage treatment plants. It is in fact, linked to our toilet flushes, therefore next time don't just flush and forget! ❑

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Impact of Climate Change on Water Resources

R D Singh
Manohar Arora
Rakesh Kumar

In order to minimize the adverse impacts of climate change on water resources and attaining its sustainable development and management, there is a need for developing rational adaptation strategies

IN INDIA the distribution of rainfall is highly non-uniform both in terms of time and space. As a result water is required to be stored and utilized for meeting the demands of different sectors throughout the year. Efficient water management requires sustainable development of the available surface and ground water resources and their optimal utilizations.

Although specific regional effects in this regard are still uncertain, climate change is expected to lead to an intensification of the global hydrological cycle and can have major impacts on regional water resources, affecting both ground and surface water supply. In its Fourth Assessment Report, the IPCC suggests that average temperatures will climb 1.56 to 5.44°C in south Asia by 2099. Dry season rainfall will drop by 6 to 16 percent, while wet season rains will increase by 10 to 31 percent. Such shifts in temperature and precipitation patterns could carry major repercussions for India's freshwater resources and food production. Rising surface temperatures appear to be contributing to melting of snow and ice pack in the Himalaya, thus threatening the water supplies on which hundreds of millions of people depend. As per IPCC analyses India could suffer from outright water stress – annual availability of less than 1,000 cubic meters per capita - by 2025, and gross water availability could fall as much as 37 percent by mid-century. In addition to the implications for drinking water and sanitation, this could considerably diminish crop yields in the region. Temperature increase of as little as 0.5 to 1.5°C might trim yield potentials for Indian wheat and maize by 2 to 5 percent. For greater warming, above 2.5 degrees centigradee , the losses in non-irrigated wheat and rice yields in south Asia could cut net farm-level revenues by 9 to 25 percent.

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Even under the most conservative climate change scenarios, net cereal production for south Asian countries is expected to tumble by at least 4 to 10 percent.

Where some parts of India will face shrinking water supplies, others will face rising seas. Average global sea levels are projected to rise at a rate of 2 to 3 mm per year over the coming 100 years. Low end scenarios estimate sea levels in Asia will be, at a minimum, 40 cm higher by the end of the 21st century. The IPCC calculates that this would expose from 13 million to 94 million people to flooding, with about 60 percent of this total in South Asia. In India, sea level rise of 100 cm would inundate 5,763 km^3 of the country's landmass. Because of their high population density, susceptibility to coastal flooding and saltwater intrusion form sea level rise, and exposure to storm surges, the IPCC has specifically designated several of India's low-lying coastal river deltas – the Ganges (shared with Bangladesh), the Godavari, the Krishna, and the Mahanadi – as particular " hotspots" of climate change vulnerability.

Utilizable Water Resources Potential of India

Surface Water

The utilizable water potential of the country has been variously estimated in the past. The Central Water Commission estimated the utilizable surface water in each river basin considering the suitable sites / locations for diversion and storage, as 690 BCM. The National Commission for Integrated Water Resources Development Plan (NCIWRDP 1999) as well as the Standing Sub-Committee for 'Assessment of Availability and Requirement of Water for Diverse Uses in the Country' constituted by the Ministry of Water Resources (Augest,2000) have adopted this value.

Ground Water

The annual replenishable ground water resource for the country was estimated at 433 billion cubic maters (bcm) as on March 2004. The sources of replenishment include rainfall (67 %) and other sources like canal seepage, return flow from irrigation, seepage from water bodies and artificial recharge due to water conservation structures (33 %).

Static Ground Water Resource

An assessment of the quantum of static water resource available in the country has been carried out by CGWB on the basis of the depth of availability of ground water and the productivity of deeper aquifers. The total estimated static ground water resource is 10,812 BCM.

Per Capita Availability

The average annual per capita availability of water taking into consideration the population of the country as per the 2001 census, and the population for the year 2025 and 2050 is as under:

Year	Population (in Million)	Per capita availability (in Cubic Meter)
2001	1027 (2001 census)	1820
2025	1394 (projected)	1340
2050	1640 (projected)	1140

Eight river basins viz. Cauvery, Pennar, Mahi, Sabermati, Tapi, east flowing rivers between Mahanadi and Pennar, East Flowing Rivers between Pennar and Kanyakumari and West Flowing rivers of Kutch and Saurashtra including Luni are already water scarce. i.e. having per capita water availability less than 1000 m^3 per year. By 2025 three more river basins viz. Ganga, Krishna and Subarnarekha may add to the list of water scarce basins taking the total water scarce basins to eleven by 2025. By 2025 Indus basin may also become water scarce while Godaveri basin may be close to water scarce level.

Presently, the total live storage capacity of the dams completed in the country has gone up to 225 BCM. Besides, dams under construction will create an additional live storage capacity of 64 BCM and Dams which are under formulation/ consideration will create around 108 BCM additional live storage. Taking the population as 1027 million as par 2001 census, the par capita storage in the country is about 219 m^3.

Climate Change: Assessment Studies and Major Threats

With respect to the global climate change scenarios, impact on water resources has been summarized as below:

- With unmitigated emissions, by the 2080s, large changes are predicted in the availability of water from rivers, with substantial decreases in Australia, India, Southern Africa, most of South America and Europe, and the Middle East and increases across North America, central Asia and central eastern Africa
- An emissions scenario where CO_2 stabilizes at 750 ppm slows

down the rate of change in river flows by about 100 years (more in Asia, slightly less in Europe). Stabilisation at 550 ppm delays the change still further, particularly in South America and Asia.

Any climate change impact assessment on water resources study requires the down-scaling of the precipitation and other variables such as temperature, relative humidity, solar radiation, wind direction and wind speed from the global scale to the regional scale. The future predictions are described in terms of SRES (Special Report on Emissions Scenarios) storyline scenarios (IPCC, 2007) which are labeled A1, A2, B1 and B2, describing the relationships between the forces driving greenhouse gas and aerosol emissions and their evolution during the 21st century. Each scenario has made assumptions that are dependent on demographic, social, economic, technological, and environmental developments.

The predictions made on the future scenarios through the regional level downscaling are used by researchers to quantify the impacts on water resources. At the national level the NATCOM (NATional COMmunication to the United Nations Framework Convention on Climate Change, 2004) project has been the first one in this direction.

The latest high resolution climate change scenarios and projections based on Regional Climate Modeling (RCM) system applied IPCC scenarios A2 and B2 to show the following:

- 3 - 5 degrees annual rise in mean surface temperature by the end of century, under A2 scenario and 2.5 to 4°C under B2 scenario, with warming more pronounced in the northern part of India.
- A 20% rise in all India summer monsoon rainfall over all states except Punjab, Rajasthan and Tamil Nadu, which show a slight decrease.
- Increase in extremes in maximum and minimum temperatures and precipitation particularly over the western coast and west central India.

However, studies by the Central Water Commission (Thatte, 2000) and, Gupta and Deshpande, 2004 have predicted that per capita availability of water will go down drastically by 2050, even without considering climate change, due to population growth.

A case study by Roy et al (2003) on the impact assessment of climate change on river water availability in the Damodar basin concludes that decreased peak flows would hinder natural flushing of stream channels leading to loss of carrying capacity and decreased production of non-monsoonal crops.

A comprehensive study carried out to quantify the climate change impact on majority of Indian river systems (Gosain et al, 2003) has concluded that although there is an increase in precipitation in some of the river systems for the Green House Gas scenario, the corresponding runoff for these basins has not necessarily increased due to increase in evapo transpiration on account of corresponding increased temperatures. Two river systems which are predicted to be worst affected from floods are Mahanadi and Brahmani. Decrease in precipitation may be experienced in other river basins like Sabarmati and Mahi to the extent of two thirds of prevailing runoff. This may lead to severe drought conditions in future in these basins.

There has been widespread retreat of glaciers worldwide during the current century (IPCC, 2007). If current warming rates are maintained, Himalayan glacier could decay at very rapid rates, shrinking from the present spread of 500,000 km^2 to 100,000 km^2 by the 2030s. Retreat of the Himalayan glaciers and its impact on the water availability are important issues which are debated from time to time. Indian Himalayas have nearly 9575 glaciers covering an area of about 38000 km^2 (GSI, 2007).. Kulkarni et al. (2007) have studied glacial retreat of 466 glaciers in Chenab, Parbati and Baspa basins from 1962 using Remote Sensing technique. It is found that there is overall reduction in glacier area from 2077 km^2 in 1962 to 1628 km^2 at present, an overall deglaciation of 21%. Study of Geological Survey of India (GSI) have revealed that glaciers are receding at an alarming rate viz. Gangotri (17.5 m/yr), Dokriani (17.5 m/yr), Milam (13.3 m/yr), Pindari (23.5 m/yr) and Zemu (13.2 m/yr). This would lead to increased summer flows in some river systems for a few decades, followed by a reduction in flow in case glacial retreat continued.

The National Institute of Hydrology has conducted sensitivity analysis on some of the Himalayan basins i.e. Sutlej, Spiti and Dokriani basins and found that under warmer climate, there was reduction in melt from the

lower part of the basin owing to a reduction in snow covered area and shortening of the summer melting season and, in contrast, an increase in the melt from the glacierized part owing to larger melt and an extended ablation period. Thus, on the basin scale, reduction in melt from the lower part was counteracted by the increased melt from upper part of the basin, resulting in a decrease in the magnitude of change in annual melt runoff. The impact of climate change was found to be more prominent on seasonal rather than annual water availability.

Sea-level rise could raise a wide range of issues in coastal areas. The potential impacts of one metre sea-level rise include inundation of 5,763 sq km and 2,339 sq km in India and in some big cities of Japan, respectively (TERI, 1996; Mimura and Yokoki, 2004).

India, China and Bangladesh are especially susceptible to increasing salinity of their groundwater as well as surface water resources, especially along the coast, due to increases in sea level as a direct impact of global warming (Han et al., 1999). For two small, flat coral islands off the coast of India, the thickness of the freshwater lens was computed to decrease from 25 m to 10 m and from 36 m to 28 m for a sea-level rise of only 0.1 m (Boba et al., 2000).

An analysis of satellite images of fourteen of the world's major deltas (Danube, Ganges-Brahmaputra, Indus, Mahanadi, Mangoky, McKenzie, Mississippi, Niger, Nile, Shatt el Arab, Volga, Huanhe, Yukon and Zambezi) indicated a total loss of 15,845 sq km of deltaic wetlands over the past 14 years (Coleman et al., 2005). Increasing shoreline retreat and risk of flooding of coastal cities in Thailand, India, Vietnam and the United States have been attributed to degradation of coastal ecosystems by human activities, illustrating a widespread trend. Large-scale conversions of coastal mangrove forests to shrimp aquaculture have occurred during the past three decades along the coastlines of Vietnam (Bing et al., 1997), Bangladesh and India (Zweig, 1998), Hong Kong (Tam and Wong, 2002), the Philippines (Spalding et al., 1997), Mexico (Contreras-Espinosa and Warner, 2004), Thailand (Furakawa and Baba, 2001) and Malaysia (Ong, 2001).

IPCC Projection

The IPPC Report -2007 states that "the gross per capita water availability in India will decline from about 1820 m^3 per year in 2001 to as low as about 1140 m^3 per year in 2050. India will reach a state of water stress before 2025 when the availability falls below 1000 m^3 per capita. The report also mentions that "the per capita availability of fresh water in India is expected to drop from around 1900 m^3 currently to 1000 m^3 by 2025 in response to the combined effects of population growth and climate change. The report has also predicted more intense rain, more frequent flash floods , increase in drought-affected areas and extreme precipitation events in other areas. Water volumes stored in glaciers and snow cover are very likely to decline, reducing summer and autumn flows in the Himalayan river systems in the long run. At lower latitudes, especially the seasonally dry tropics, crop yield potential is likely to decrease for even small global temperature increases,.

National Action Plan on Climate Change

The National Action Plan on Climate Change(NAPCC) has laid down the principles and has identified the approach to be adopted to meet the challenges of impact of climate change. A **National Water Mission** finds place among the eight missions identified. Its objective is to ensure integrated water resources management helping to conserve water, minimise wastage and ensure more equitable distribution both across and within states. The Mission will take into account the provisions of National Water Policy and develop a framework to optimize water uses by increasing water use efficiency by 20% through regulatory mechanism and differential entitlements and pricing. It will seek to ensure that considerable share of water needs or urban areas are met through recycling of waste water, and ensuring that the water requirements of coastal cities with inadequate alternative sources of water are met through adoption of new and appropriate technologies such as low temperature desalination technologies that allow for the use of ocean water. The National Water Policy would be revisited in consultation with states to ensure basin level management strategies to deal with variability in rainfall and river flows due to climate change.

The Mission will seek to develop new regulatory structures, combined with appropriate entitlements and pricing. It will seek to optimise the efficiency of existing irrigations systems, including rehabilitation

of systems that have been run down and also expand irrigation, where feasible, with a special effort to increase storage capacity. Incentive structures will be designed to promote water neutral of water positive technologies, recharging of underground water sources and adoption of large scale irrigation programmes which rely on sprinklers, drip irrigation and ridge and furrow irrigation".

The Way Forward

It is a paradox that India possesses an apparently vigorous planning mechanism with sufficient investment and yet remains under-prepared vis-à-vis climate change impacts. The failing monsoon of 2009, followed by the unprecedented rains of early October in the southern states of India, has established once more that India must ready herself to address such anomalies more frequently than ever. Obviously, physical resources will remain inadequate to brace the country for the new challenge of climate change unless they are bolstered by necessary institutional arrangements and backed by a holistic vision. The way forward in this regard would need to take care of the following :

Promote Adaptation Strategies

In order to minimize the adverse impacts of climate change on country's water resources and attaining its sustainable development and management, there are needs for developing rational adaptation strategies. Thus, due consideration is required to be given to the effect of climate change while planning, designing and operation of the water resources projects. These would be reflected in proper assessment of water resources, developing suitable hydrological design practices and operational policies for water projects, putting in place effective flood and drought management strategies, developing water efficient irrigation practices etc.

Necessary Policy Changes

Key among the necessary policy changes are : (i) Regional and transboundary cooperation in water security – India must take the lead in consulting SAARC nations to foster information –sharing and joint management of transboundary water resources and perhaps shape a common stance on international climate change negotiations ; (ii) increased accountability by the different actors ; and (iii) decentralization of decision making.

Bridge Gaps in Knowledge

The studies done on the impact of climate change on various aspects of water availability in India are as yet very few and far between. As knowledge is a prerequisite for managing adaptive strategies, we need to bridge our knowledge gaps in all areas that are relevant to better planning . These would include having better observational data and data access , work on detection and attribution of present-day hydrological changes , higher -resolution climate models, with better land-surface properties and interactions, analysis of demand and supply of water on a monthly basis, process oriented models for studying impact of climate change on snow, ice and frozen ground, climate change impacts on water quality, impact assessment on ground water etc. ❑

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NORTH EAST DIARY

POWER PLANT IN NAGALAND VILLAGE

The mountainous state of Nagaland is rich in both flora and fauna. A visit to any village offers an insight into a unique way of life and of a people who undertake daily chores with a smile on their faces. Medziphema is one such village. It is the first in the State that has its own power plant, a plant that fulfills its energy needs. Blessed with fertile land, the village is a beneficiary of centrally-sponsored schemes. Located 45 kilometres from Nagaland capital Kohima, Medziphema is a serene and quiet place where 325 families live. Its fertile soil is suitable for pineapple cultivation and is a major source of livelihood for the villagers. Beekeeping and rearing of animals are other means of making a living.

Villagers lead simple lives, and they strive for more growth and development. Some government development schemes like the biomass gasifier power plant and road construction under Mahatma Gandhi National Rural Guarantee Scheme (MNREGS) are being implemented here. In addition, NGOs and civil organizations are also providing voluntary services like free medical camps in the village. The primary school of the the village has 130 students. Recently under the Sarva Shiksha Abhiyan (SSA) (or, education for all) scheme 2008-2009, the school's building was renovated. Students here avail free textbooks and at times a free mid-day meal.

Under wage employment schemes of the Mahatma Gandhi National Rural Employment Guarantee Act 2005 (NREGA), the villagers are given job cards. Not every villager has the below poverty line (BPL) ration card to get essential commodities at the subsidized rate, but they are fortunate that the villagers do get it from time to time along with the old age pension scheme from the center. With the availability of Government schemes and funds, the need of the hour is for the concerned authorities to ensure that they are implemented properly. This will ensure that the benefits of such Government help should reach villagers and ensure a positive change here. ❑

SUCCESS STORY OF MANIPUR'S VEGETABLE FARMERS

Villagers in Manipur are increasingly taking up vegetable farming and are reaping handsome profits from the venture, 65- year-old P Manaobi Singh of Wangoi Thoudam Leikai in Manipur is a successful vegetable farmer.

After taking voluntary retirement from the State Police, he has been managing his farm for the past 20 years. Manaobi's 1.5 hectares of land is under vegetable cultivation. He grows a variety of vegetables such as cabbage, cauliflowers, onion, peas and tomatoes. Manaobi also provides jobs to local people to help him and his wife during the peak-farming season. He pays Rs. 150 per day to those who work for him.

Aided by the State Department of Horticulture and Soil Conservation, other farmers in the village like, A Sanahal and L Dinamani have also taking up vegetable farming. Farming equipment like diesel water pump-set, UV films, community tank, organic fertilizers, pesticides, fungicides with sprayers and seeds are provided by the Technology Mission, Manipur to these farmers.

The State Horticulture Department provides seeds, insecticide, pesticide and fertilizers. But the only problem that the farmers are facing now is scarcity of water. Such endeavours by the farmers in the area have enabled them to generate an annual income of around Rs.2 lakh. Farming is another option for self-employment. If more families devote their time farming vegetables on a large scale, they can make more than 1.5 lakh annually by marketing their produce even outside the State. A vegetable farmer feels that such inspirational efforts will go a long way in motivating others to undertake new ventures to become self-reliant. ❑

(Courtesy : Newspapers)

Drinking Water for Rural India

Sankalp Chhabra

The evaluation of water supply schemes should not only evaluate the rate of progress of sanction, release of funds and construction etc, but also the performance and success of these schemes

THE ACCESS to drinking water in rural India has increased from an earlier 65 % of the population to about 90% in 2001. The government of India spends approximately one billion dollar on this each year. Going by figures it would appear as though India's problem of being able to provide safe drinking water to her people was soon going to be over. But figures, as we know, tell only half the story.

The first serious step towards provision of safe drinking water to rural India came in 1972-73 in the form of the Accelerated Rural Water Supply Programme. The programme was accorded Mission approach with the formation of a Technology Mission on Drinking Water, which was later renamed as Rajiv Gandhi National Drinking Water Mission in 1991-92. Drinking water supply is also one of the six components of Bharat Nirman. As brought out above, these schemes have greatly increased the coverage of safe drinking water in the rural areas of the country. However, while the increase in coverage is encouraging, studies have shown that the provision of drinking water, especially to rural areas, is fraught with problems. Many habitations which once came under the "covered" status have been found to slip down to the "partially covered" or even "uncovered" status, reflecting adversely on the effectiveness of the various schemes being run for this purpose. The supply of water is inadequate and irregular, the quality falls below the safe drinking water standards stipulated by the Central Pollution Control Board, the water supply infrastructure created under these schemes have been found to be badly maintained and often run at sub-optimum levels, forcing huge coping costs on the people - about an average of Rs 81 per month per household according to a World Bank study. The same study also points out that due to wastage and

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inefficiencies the total cost of piped water schemes per kilo litre of water consumed is also very high. Besides incurring expenditure on repairs and maintenance of the infrastructure, people also have to bear the cost of maintaining additional household equipment for water collection and purification and are forced to make arrangements for procuring water from multiple sources. The time and effort spent in this exercise translates into costs of lost opportunity, lesser productivity and hence lesser development in these areas. It is obvious that though these schemes have managed to create an access to drinking water in areas they cover, they have not been able to sustain the quality and quantity of supply required, and have thus not had the desired effect on the lives of the beneficiaries. Inefficiencies in the schemes have led to a situation where the benefits derived from them are not proportionate to the amount spent on them.

A careful review of the water supply schemes would reveal critical issues in their design and implementation. Most water supply schemes in India are supply - driven where the government plans, designs and installs a project without much participation from local communities. Theoretically such schemes have the advantage of sectoral planning which could help in optimal allocation of resources. But at the ground level, the effectiveness of supply driven schemes is low to moderate. The past few years have however, witnessed a growing emphasis on a demand- driven approach in the sector, for example the Swajaldhara scheme under which Village Water and Sanitation Committee (VWSC)/Panchayati Raj Institutions (PRIs) play a major role. They are not only consulted during planning and designing of the water supply schemes for their areas but also are continuously involved through cost sharing mechanisms and management of the infrastructure. This approach entrusts accountability among PRIs and local communities, thus ensuring better outcomes.

A recent study by the World Bank titled *Review of Effectiveness of Rural Water Supply Schemes in India* analyses the traditional supply- driven schemes and the more recent, decentralized demand-driven and community led schemes The study points out that supply-driven schemes are very high on institutional costs (about 24 %) like salaries and overheads. Further, such schemes also spend a significant part of funds towards Operational and Maintenance (O&M expenses. This leaves limited fund availability for building water supply infrastructure. In community managed programs, the institutional costs are much lower at about 11 %. Further, communities are expected to share around 10% of capital cost and complete O&M cost. When end users bear an increasing portion of O&M costs, effective utilization of government funds takes place. Also for piped water supply schemes, it has been seen that cost recovery mechanisms which are the basis for financial sustainability, perform well in case of demand driven schemes (71%) as compared to supply driven schemes (46%). Further, the supply-driven schemes have a higher cost per KL of water supply. Even if we look from the perspective of reliability and adequacy, demand driven schemes have faired better as compared to supply driven schemes. Reliability and adequacy here mean the regularity of supply and proportion of household water requirement met from the schemes.

Despite the obvious benefits of the demand driven schemes, supply driven schemes still account for a substantial portion of fund flows. Over 85% of the funds have been allocated to supply driven programs.

However, there are several limitations of demand driven approach too. Most demand responsive schemes are unable to take advantage of economies of scale because of their small size. In some cases the water sources which are available locally may not be sufficient to fulfill the requirements of the households, especially in the summer months.

In addition to these there have been problems on account of over provisioning, for example in states of Uttar Pradesh, Tamil Nadu and many others. When the schemes are over-provisioned, i.e. utilized by lesser number of people than targeted, there is an increase in per capita cost of the infrastructure. This acts as a burden on the financial sustainability of the scheme. Also, there have been several cases when a scheme has been supplemented by other schemes because it was not functioning effectively. Such multiple schemes for the same area increases the overall cost of service provision to the government.

The challenge lies in the successful implementation of the demand

driven approach. Only entrusting the roles and responsibilities to PRIs and local bodies is not enough. Eventually, the state, along with NGOs needs to play the role of a facilitator by helping build capacity of the local communities to manage funds and all functions. Community participation needs to be strengthened through formation of representational committees and direct involvement during all stages including planning, designing, construction and maintenance.

The good news is that the modification in the framework of the National Rural Drinking Water Programme (NRDWP) is expected to take care of several of these issues. The goal of the NRDWP is to provide every rural person with adequate safe water for drinking, cooking and other domestic basic needs on a sustainable basis. The modified program of RGNDWM focuses on achieving drinking water security at the household level instead of emphasizing only on achieving the target of average per capita availability. This is a step in the positive direction because achievement of the latter may not necessarily mean guaranteed access to safe drinking water to all sections of the population in the habitation

The new policies in the program have been designed to encourage community driven approaches because of their inherent benefits. The states shall receive incentives for decentralizing their systems of management. According to the decentralized approach, the PRIs and local community shall be responsible for management, operation and maintenance of water supply schemes.

The program stresses on the need to move from over dependence on one source to utilization of multiple water sources such as ground, surface water and rainwater harvesting including recharge/roof water collection and bulktransfer through pipelines.

The demand for quantity as well as quality of water supply is increasing in India. The modified program correctly realizes that the need of the day is to ensure the security of the available sources. The program focuses on optimisation of usage of both conventional and non conventional water resources. Steps are also included to protect the catchments of ground and surface drinking water from pollution through human and animal excreta.

Overlapping of roles and responsibilities under the current system reduces its transparency and accountability. To improve this, the roles of all participants including regulators, asset owners, policy makers, service operators, financiers, etc and the contractual relationships between them need to be clearly defined. The beneficiaries should be transformed to paying customers with the freedom to express concerns and willingness. This would help in establishing a transparent and accountable framework

With levels of groundwater decreasing in most states, the debate on the over-extraction of water for agriculture assumes great significance. It is estimated that agriculture uses around 80% of fresh water and various studies indicate that current farming practices waste 60% of this water. The modified programme identifies this problem as a critical issue and mentions steps that need to be taken to counteract the factors resulting in the deterioration of water supply facilities. Community ground water monitoring, crop water budgeting and improved agricultural practices are the ways forward for building sustainability in the system

Participation from private sector in rural water service delivery has been effective in the recent past. This should continue and the states should encourage private agencies, contractors and operators to become more active. Since a major issue is to improve efficiency of daily operations, main emphasis could be on service and management contracts.

To improve regulation and pricing, states should also encourage private sector in setting up of water quality treatment plants and supplying quality water at affordable prices.

And most important, the evaluation of water supply schemes should not only evaluate the rate of progress of sanction, release of funds and construction etc, but also the performance and success of these schemes in terms of quality of services provided and the impact on the lives of the beneficiaries. With these and many more such initiatives we can hope to address effectively, the bottlenecks of the rural water supply system. ❑

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Fighting Poverty Through Water Harvesting

Archana Gupta
Akanksha Shukla

But the success stories are still few and far between, given the vastness of our country. What rainwater harvesting did to this village in Gujarat, it can do to other areas of the country too

DESPITE ECONOMIC miracles, the incidence of poverty in India does not seem to be coming down. Among many other causes for poverty, scarcity of water is a major factor that affects the economic standing of an individual, a family or a community. Water is a key factor in changing the fundamental living conditions and bringing about the development of the poor. However, with our growing population pressures it is becoming increasingly difficult to satisfy the water needs of our people, of agriculture, industries and other sectors of our economy. India is at the threshold of a water scarcity situation. Six of the country's 20 major basins are already classified as those with less than 1000 cu. m. of water available per head per year. About one-third of the country's area is drought prone.

Poverty in India is closely related to over all agricultural productivity, which entirely depends upon water for irrigation. In many villages, poor agricultural output is directly linked to the absence of irrigation facilities. In most villages, lack of these facilities is identified as the "root cause" of poverty. The total cultivated area of the country is approximately placed at 193 million hectares, of which 161 million hectares is gross sown area and about 139 million hectare net sown area. The relation between net irrigated area and the levels of poverty show distinct inverse relation. In case of low poverty states of Punjab and Haryana the percentage of net irrigated area is 95.2% and 78.2% as compared to high poverty states of Orissa and Madhya Pradesh where the percentage of net irrigated area is only around 25 per cent. Net irrigated area largely implies the area which is not entirely dependent on the natural sources of water like rain, but also are irrigated by

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artificial sources like canal, tube well.

Likewise, the relation between poverty and ground water development also shows a distinct inverse relationship. The states which have higher levels of GW development also show lower levels of poverty. Punjab, which has only 6.16 per cent of its people under the poverty line, utilizes 93.34% of its ground water resources. Similarly, Haryana, which has only 8.74% of the people below poverty line, utilizes about 74.61%of its ground water resources (Singh, 2000). On the other hand in Orissa and Bihar where the proportion of people below the poverty line is more than 40% , the utilization of ground water is also very low at about 15.22% and 35.99%.

So the development of ground water has led to increased "drought proofing" of India's agricultural economy so that even in 1987-88 when rainfall was almost 18% below normal, food grain production declined only by 2% over the previous year's level. Much of this improvement can be attributed to the spread of irrigation in general and of groundwater irrigation in particular. As per the statistics, the number of dug wells has increased from 38.6 lakhs (1951) to 96.1 lakhs (2001) and the shallow tube wells from 3000 (1951) to 53.5 lakhs (2001).

However, despite the obvious benefits of having drought proofed agriculture, the indiscriminate exploitation of ground water have rendered many bore wells dry either seasonally or through out the year. Statistics reveal that about 85% of drinking water supplies and 50% of the irrigation supply in rural areas is met through extraction of ground water (Athavale). While this is so, not enough attention is being given to replenishing this fast decreasing resource through appropriate interventions, so that long-term decline of ground water levels is being observed in many areas, mostly in the states of Rajasthan, Gujarat, Tamil Nadu, Punjab, Delhi and Haryana. A scientific study based on space agency NASA's satellite imagery reveals that the country's entire northwestern belt is headed towards a severe water crisis. The satellite data shows images indicating that ground water is depleting faster than it can be replenished. According to Chairman, Central Ground Water Board, about 839 blocks across the country are being over exploited. There is far more water being extracted than can be recharged. In 236 blocks the situation is critical.

To overcome this alarming situation and for improving per capita water availability in the country, replenishment of ground water resources is a necessity which can be done very effectively through rainwater harvesting. Rainwater harvesting has been carried out in India even in the past and has served people by supplying water for domestic use and supplemental irrigation. It is also beneficial to the recovery of the ecosystem and environmental conservation in the arid and semi-arid regions. Rainwater harvesting can be used at the micro scale and we can store rain water which would normally have run off and got wasted, in small ponds, check dams and *johads* . This type of storage is usually done at a place where it can be utilized by the immediate neighborhood. A substantial quantity of the presently "unutilizable" surface water can also be transferred underground, to augment the aquifers and to improve their quality and also to save it from evaporation losses. Rainwater harvesting can bring the much needed balance between extraction and replenishment of water.

Natural recharge measurements carried out in about 20 river basins, well distributed over the various climatic and geomorphic zones obtaining in the country, suggest that only about 5-10% of the seasonal rainfall is contributed as annual recharge in the peninsular hard rock regions, whereas in the alluvial areas the figure is about 15 to 20% of the rainfall (Athavale et al 1992). It is estimated that by prudent artificial recharge schemes and waste water recycling, about 25% of India's water requirements in 2050 can be met. Care should be taken to ensure that rainwater harvesting continues to remain as a peoples program with full support of the government. Existing water recharge structures like ponds and tanks should be revived and collectively managed by the community. Recharge from rooftops should be encouraged.

Check dams and other recharge structures should be constructed.

Success Stories from India

Rainwater harvesting has brought dramatic betterment in many villages. For example the Jamkandorna taluka of Rajkot district in Gujarat experienced a complete changeover from a dry agricultural land to lush green fields when a Trust helped to construct a series of 1605 check dams in 27 villages. In addition, the Trust also constructed underground tanks, farm ponds and soak-pits to store harvested rainwater. Since 2001, the farmers of these talukas have been able to change their crop patterns. The community-based rainwater harvesting undertaken through check dams has completely changed the socio-economic lives of the villagers in these talukas. Lush green grass, brimming rivers and wells depict the success story of 27 villages in Gondal and Jamkandorna talukas of Rajkot district. Because of the increased availability of irrigation water, the land that was lying fallow came under cultivation and the total area under farming increased from 890 hectare in 1995-96 to 22,275 hectare in 2006-07. More than 5000 hectares of land was brought under irrigation. Farmers began to raise three crops per year and there is no shortage of drinking water. The average yield of cotton, groundnut, wheat and chilly increased substantially. The villagers reaped a profit of 15 crore at the end 2004 from agricultural products. Women now have to walk less for washing, cleaning or to fetch water. Families can have water during shortage periods, which can range from three to six months.

As the salinity of the soil decreased, the farmers can now grow cotton in almost 80 % of the cultivated area. The cotton production at the end of 2004 increased ten times in the villages under watershed project (Fig: 1). J. Patel, chairman of Watershed Committee says that in 2003, he earned only Rs. 50,000 from cotton and groundnut crops whereas in 2004, after water harvesting, his income shot up to Rs. 4 lakh.

The availability of the fodder has also increased the milk production (5 litres/day to 8 litres/day) from the cattle in the area. As a result about 16,000 litres of milk is produced per day in the areas under the watershed program

Newly constructed houses can be seen in almost all the villages under this watershed project. Villagers have purchased tractors and constructed pucca houses. More than 150 families have purchased motorcycles and admission in schools increased from 50 to 90%. More numbers of girl children are being sent to school.

The increase in agricultural activities are also providing employment to the neighboring areas. The villagers have gone back to their original profession of farming. The migration to nearby cities has completely stopped. Today not a single inhabitant of the village depends on drought relief.

Villages in other states also, like Rajasthan and Maharashtra, which were like deserts, have now turned into green areas. But the success stories are still few and far between, given the vastness of our country. What rainwater harvesting did to this village in Gujarat, it can do to other areas of the country too. The task however, is complex and requires an unswerving, collective, long-term effort, backed by sound strategies and the political will. Looking ahead to rainwater harvesting and groundwater management, we can achieve the overarching goal of water self sufficiency and poverty eradication. ❑

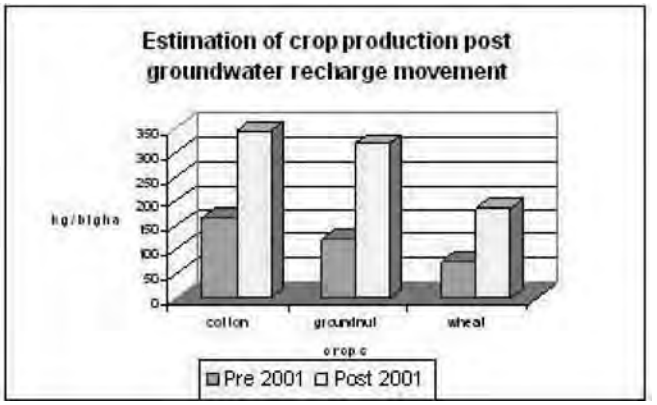

Fig: 1 Increase in Crop Production in Ambaredi Village
Source: VPSST

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Think, Plan and Act Locally, Support Nationally

Maisnam Bobo Singh

This effort will necessarily have to include effective policies and ground level initiatives to develop and manage efficiently, the available water resources of the region

CLIMATE CHANGE is at the zenith of the public debate and global agenda. However, to date, water resource issues have not been effectively addressed in climate change analyses and climate policy formulations. Today, people and governments across the world are discovering the costs of having ignored the real value of water in the past and are picking up the bill for the past practice of treating water as a resource to be exploited without limit.

India could face a massive 50% water deficit by 2030, the biggest globally, says the recent report of the Water Resources Group (WRG).The study finds that water demand would add up to nearly 1.5 trillion cubic metres then, more than double the 740 billion cubic metres today, driven by the demands of the growing domestic population, a large proportion of which is moving towards middle-class lifestyles. According to a study by Centre for Science and Environment's Green Rating Project(2009), the fresh water consumption will be more than triple in the next two decades and reach 18,075 million cubic metres in 2030-31. By 2030, the six sectors power, steel, cement, aluminium, fertilizer and paper, each of which are engines of India's future economic growth, and also the largest bulk emitters of greenhouse gases will be withdrawing more than 55,000 million cubic metre of freshwater. Currently, the daily water withdrawal by industries amounts to a billion peoples' water requirement. This will have social and environmental implications.

Water quantity is not the only yardstick for scarcity. Quality also has a bearing on the volume available for use. All of India's 14 major river systems are badly polluted. The pollution adversely affects the environment, threatens public health and reduces the flow of water available for human use. India's potable water quality is so poor that the country was ranked

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120th out of 122 countries in a 2003 UN report. Thus, access to water, and protection against water-related risks, are crucial to human well-being. The country has more than 3.5 million hand pumps and over 100,000 piped water supply schemes have been installed under the Rural Water Supply Schemes. However, majority of the schemes remain non-functional. Access to quality water supply is an important ingredient of quality of life, and water scarcity is a capability deprivation. While the capability approach is generally recognised, there is, however, to date not much evidence of policy-makers adhering to this approach. The United Nations has recognized access to water as a basic human right, stating that water is a social and cultural good, not merely an economic commodity. Today, due to increasing consumption patterns, water is becoming scarce and this scarcity is an emerging threat to the global population.

The North Eastern Region of India is one of the twelve-mega hot-spots of bio-diversity in the world. At the heart of the bio-diversity of the region are its tremendous land and water resources. The region consists of eight states having geographical area of 265200 sq.km of which 90,573 sq.km. is plain. NER is endowed with enormous water resources mainly because of its location in the high rainfall area with an extensive river system. The total surface water potential of the region (except Sikkim, for which data is not available) is 928,873 mm3. The region has a total ground water potential of 855 mm3 (excluding Sikkim). But the water resources are largely unutilized. The region has three main river basins namely,the Teests, the Brahmaputra and the Barak, which form part of the Ganga-Brahmaputra-Meghna river system. The combined annual flow of Brahmaputra and Barak rivers, before entering into Bangladesh is the highest among all river basins in the country. The Brahmaputra basin drains an area of 194,413 sq.km stretching through entire Arunachal Pradesh, the greater part of Assam. Meghalaya and Nagaland. The Barak and other basins, draining an area of 78,150 sq.km occupy the northern and western part of Manipur, southern part of Meghalaya and Assam. The Brahamaputra and Barak basins cover 86% of the geographical area of the NER. Per capita and per ha runoff are 21,060 m3 and 44,232 m3 from Brahmaputra and 7,475 m3 and 53,680 m3 form Barak basin respectively. The bulk of the annual rainfall in the region (65%) is received during June to September. Though the North-Eastern states have 5.60% of the total geographical area of the country, they receive 12.13% of the total precipitation in the country. There is considerable scope for exploiting ground water in Barak valley, Manipur valley and other isolated plains pockets. On the whole the ground water quality of the region is suitable for irrigation. The major curse for agricultural development of the region is poor water resources development and management.

Inspite of the high intensity rainfall in the area, the North Eastern Region of the country faces acute shortage of water particularly during dry season(January, February, March, April, May) every year due to want of conservation and preservation arrangements. Because of the very steep hilly terrain, a lot of the rain water is lost as run off. As a result the region faces scarcity of water

Table 1 : Household's Access to Safe Drinking Water: NER
Tap/Handpump/Tubewell (%)

State	1981			1991			2001		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
ARUNACHAL	43.9	40.2	87.9	70.0	66.9	88.2	77.5	73.7	90.7
ASSAM	na	na	na	45.9	43.3	64.1	58.8	56.8	70.4
MANIPUR	19.5	12.9	38.7	38.7	33.7	52.1	37.0	29.3	59.4
MEGHALAYA	25.1	14.3	74.4	36.2	26.8	75.4	39.0	29.5	73.5
MIZORAM	4.9	3.6	8.8	16.2	12.9	19.9	36.0	23.8	47.8
NAGALAND	45.6	43.4	57.2	53.4	55.6	45.5	46.5	47.5	42.3
SIKKIM	30.3	21.7	71.9	73.1	70.8	92.8	70.7	67.0	97.1
TRIPURA	27.3	22.2	67.9	37.2	30.6	71.1	52.5	45.0	85.8
INDIA	38.2	26.5	75.1	62.3	55.5	81.4	77.9	73.2	90.0

Source: Economic Survey 2009-10

every year as soon as the monsoon ends. Water scarcity forces people to rely on unsafe sources of drinking water. Poor water quality can increase the risk of diseases including cholera, typhoid fever, and other gastrointestinal diseases.

The distribution of households in India by safe drinking water clearly indicates that there is significant inequality in access to water. We can see from table 1 that on the average 48 per cent of the households of the NER as against 20 per cent of the country do not have access to safe drinking water. It suggests that progress towards Millennium Development Goals can be a daunting challenge for a country claiming to be a super power by 2020.

The 11th Plan allocated a total investment of Rs.80,000 crores for building structures for water management and water recharge in the country. The 13th Finance Commission has also recommended a total of Rs.5000 crore as grant-in-aid for water sector. However, the North East as a whole received only a meager amount of Rs.132crore or 2.6 per cent of the total Grants as can be seen from the Table no.2.

Table 2: Water Sector Grant-In-Aid

13th Finance Commission Recommendation on Water Sector Grant-in-Aid for NER

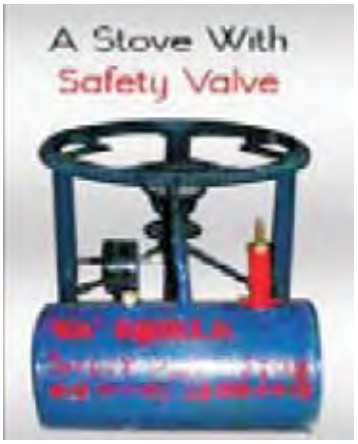
	Rs. crore	As % of Total (NER)
ARUNACHAL	8	6
ASSAM	88	67
MANIPUR	8	6
MEGHALAYA	4	3
MIZORAM	4	3
NAGALAND	8	6
SIKKIM	4	3
TRIPURA	8	6
NER	132	100
INDIA	5000	

Source: 13th Finance Commission

If the North Eastern Region of the country is to be a gateway to better trade and economic relations with the East and Southeast Asian countries and the Government's Look East policy is to be meaningful, the task of comprehensive development of the backward and long neglected region should be implemented in right earnest. And this effort will necessarily have to include effective policies and ground level initiatives to develop and manage efficiently, the available water resources of the region. ❑

(E-mail :mchinglen@gmail.com)

Toothbrush with Paste Dispenser



The toothbrush has a potential market among children who are curious and intrigued by its unique design and also people travelling frequently

AN INNOVATOR and an entrepreneur, Agastya Narayan Shukla has developed a toothbrush with an integrated toothpaste dispensing mechanism. The toothpaste is filled in the body of the brush and need not be applied separately.

Born in Delhi, Agastya used to assist his father in his factory even as a child. At the age of 12, he set up his own small factory in partnership with one of his friend. While other children of his age were busy studying and playing , he was engrossed in making spare parts in his factory.

Life changed its course when a tragedy struck in 1985. The untimely death of his father left behind huge debts to be repaid. Agastya had to sell his factory to pay off the creditors. With Rs. 20,000 left in his hand after clearing the dues fifteen years old Agastya decided to go to Mumbai to earn a living. However, after three years of doing odd jobs and trying to establish himself, he decided to come back to Delhi and revive his father's unit. This unit ran for sometime but was later closed down under strict environment laws. He then set up a low-cost unit wherein he outsourced all his production thereby bringing down costs and risk. With his new business, he got ample time to think about various ideas and applications, which could become potential businesses.

The string of ideas

In 2001, he saw an advertisement in the Navbharat Times soliciting entries for the national innovation awards. His curious mind started to tick and he started sending his ideas. His ideas included a device for spreading perfume during public performances, harnessing the energy generated while exercising, audio controlling device, using the energy of vehicle exhaust to keep food warm in food-delivery vehicles and an air vehicle dashboard to indicate air pressure.

Next, he made and tested a prototype of a safety valve for kerosene stoves. This safety valve

was built to prevent the explosion of stoves that killed or maimed a large number of users across the country. He also came up with an idea to prevent people from getting run over by trains while crossing the tracks. His solution consisted of hanging ropes dipped in used black engine oil at the unmanned crossings. Anyone jumping the tracks would have to go through the mesh of old oiled ropes which would soil his clothes. This was expected to be the deterrent to those in a hurry to attempt crossing the tracks.

In June 2003, he was travelling in a train when he noticed people looking for toothbrush and toothpaste in their luggage. He thought why can't the brush be fitted to the toothpaste tube itself. On his return, he started thinking about one such product. He made a study of the design issues related to the bristles, contours and grip. Next, he examined various material choices and developed the first prototype in December 2003 wherein he fitted a brush's head to a syringe. Apprehensive of his innovation, he demonstrated it to his family and friends. But they encouraged him to go ahead with it.

He then showed it to a group of students and Honey Bee Network members, whose encouragement boosted his spirits further. Improving the design, he developed a toothbrush with the toothpaste tube integrated into the handle itself. He had to struggle hard to make the toothpaste retain its character and flow on demand though the holes near the tip of the bristles. Proper design of the front portion with hollow bristles became difficult as he lacked the knowledge of proper injecting machines. Starting in 2003, it took him more than two years and around three lakh rupees to fine-tune the technology and develop commercial samples.

The Toothpaste Dispensing Toothbrush

The toothpaste dispensing toothbrush

The toothbrush has an integrated arrangement for providing toothbrush and paste in a single assembly. The knob at the bottom of the tooth brush is twisted to push the paste up and out near the tip of the bristles. The toothbrush is made from a suitable food grade material. All the individual parts are replaceable. The idea is to use the toothbrush for a long time and refill the paste when required.

Comparable toothbrushes are found in prior art, albeit with a modified configuration. But these differ in construction and design from the current innovation. The innovator has been granted a patent for this toothbrush in 2007. He has also received a Micro Venture Innovation Fund (MVIF) investment from NIF.

He has sold more than 250 such brushes at Rs. 125 per unit, through different outlets and got the user's feedback to improve it further. The toothbrush has a potential market among children who are curious and intrigued by its unique design and also people travelling frequently. The convenience of carrying the toothpaste and the brush in a single unit might attract them. ❑

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TWO SCHEMES OF RRR OF WATER BODIES APPROVED

Two state sector schemes for Repair, Renovation and Restoration (RRR) of water bodies have been approved by the Government of India, the first one with external assistance with an outlay of Rs. 1500 crore and another with domestic support with an outlay of Rs. 1250 crore for implementation during the XI Plan period. The state governments are required to prepare Detailed Project Reports (DPRs) for RRR of water bodies identified by them as per the guidelines issued by the Union Ministry of Water Resources, in this regard. Under the scheme with domestic support, projects benefitting special category states, undivided Koraput, Bolangir and Kalahandi (KBK) districts of Orissa and drought prone/naxal affected/tribal areas of other states are eligible for 90% of the project cost as central assistance. Other projects are eligible for 25% of the project cost as central assistance. Under the scheme with external assistance, the Union Government provides central assistance to the extent of 25% of the project cost whereas 75% state share is to be borrowed from the World bank by the concerned states.

The main objectives of the scheme are:

(I) Comprehensive improvement of water bodies including restoration.

(ii) Improvement of catchment area of water bodies.

(iii) Community participation and self-supporting system for sustainable management for water bodies covered by the programme.

(iv) Ground Water Recharge.

(v) Capacity Building of communities, user groups, standing committee for Panchayats and State Government/Central Government Agencies concerned with the planning, implementation and monitoring of the project.

(vi) Increase in storage capacity of water bodies.

(vii) Improvement in agriculture/horticulture productivity.

(viii) Environmental benefits through improved water use efficiency

(ix) Irrigation benefits through restoration of water bodies.

(x) Promotion of conjunctive use of surface and ground water.

(xi) Development of tourism, cultural activities, etc.

(xii) Increased availability of drinking water.

Regular monitoring of the project is to be carried out at each stage. Monitoring has to include the maintaining of both physical and financial progress and the outcome. Monitoring will be done with the association of the standing committee of the Panchayat at the appropriate level. The Water User Associations (WUAs) are to play an active role in the planning, implementation, supervision, maintenance of water body systems and

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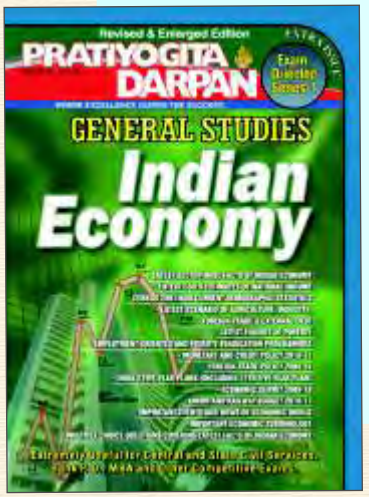

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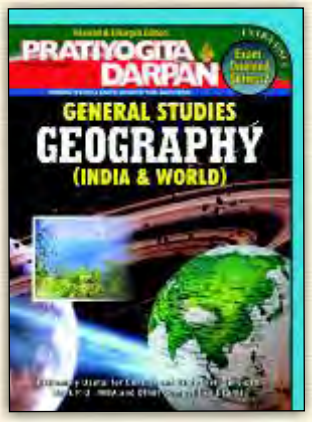

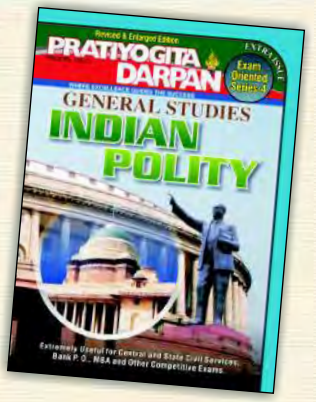

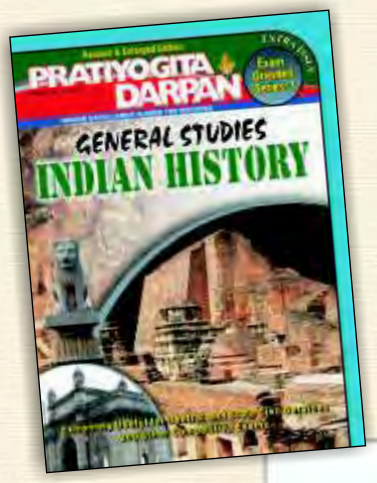

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