Water woes in India

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Over the last thirty years, India has seen a shift from reservoirs to groundwater as the main source of irrigation. Major investments in watershed programmes have reduced soil erosion and runoff, but the unintended result has been that many watercourses are drying up. There is a need for catchment-wide planning that takes into account groundwater abstraction, water harvesting and downstream use of water.

One of the great contradictions of human nature is that we only value things when they are scarce. We appreciate water only when the wells run dry. At present the wells are running dry not only in drought-prone areas but also in areas not traditionally associated with water scarcity. The reasons for this are clear: greater demands on freshwater resources by burgeoning human populations; the diminishing quality of existing water resources because of pollution; and the additional requirements of servicing our spiralling industrial and agricultural growth. Each year, water consumption rises by 2 to 5 per cent, while the supply of fresh water remains constant.

With finite freshwater resources on one hand and increasing demand both in quantity and in variety of uses on the other, the need for water resources' protection and management has now become a major concern. Water problems can be tackled through integrated management of freshwater, by achieving greater efficiency and equity in the distribution and wise use of available water resources and improving water supply and sanitation.

In India, about 65–70 per cent of the population is dependent on agriculture for their livelihood. Agricultural growth and regional development in the country have been found to follow closely the growth in irrigation. Appreciating the urgent need to harness water for increasing agricultural production, the national planning process has accorded high priority to developing irrigation. The total potential of land under irrigation is 74.30 m.ha (million hectares), with 63.4 m.ha from groundwater sources and 11.9 m.ha from surface water resources. As a result of these investments there has been considerable improvement in crop yields, with output in rupees per hectare from irrigated land being double that from non-irrigated land in many states. This has provided the basis for achieving self-sufficiency in food-grain production and improving the affordability of food for all.

Today India has the capacity to store about 250 billion cubic metres of water, a gross irrigated area of about 90 million hectares and an installed hydro-capacity about 30 000 megawatts.

The era of groundwater exploitation

In the mid-1960s some critical changes occurred in water-related sectors in the country. The extension of electricity to rural areas, the invention of modest new modular well and pump technologies and the availability of subsidized credit prompted the farming community to use groundwater as an alternative and independent source of irrigation water that could be applied 'just in time', in contrast to the institutionally complex canal system. As a result there was a 'silent revolution' and groundwater irrigation developed at an explosive rate, from approximately 5 million hectares of land irrigated to over 30 million hectares. Over the last two decades, 84 per cent of the total increase in net irrigated area came from groundwater and only 16 per cent from canals.

Though the groundwater revolution brought immense benefits to India,

This tank is dry partly as a result of water harvesting upstream

A nearby check dam has flooded this man's maize field

playing a major role in India's irrigation and poverty reduction achievements, it has posed two major sustainability challenges. The first relates to the continuing provision of subsidized energy; and the second is the sustainability of the resource itself.

According to World Bank estimates, subsidies to farmers account for about 10 per cent of the total cost of water supply, which is equivalent to about 25 per cent of India's fiscal deficit and two and a half times the annual expenditure on canal irrigation. It is now clear that the use of energy for pumping is rising in most of the states, in part because of the greater and greater depths from which farmers have to pump water.

At the same time, across the country 14 per cent of all blocks (the institutional category for the area above a village) are either over-exploited for water abstraction or reaching a critical point. The number of blocks over-exploited is expected to reach 60 per cent in just 25 years' time. In Punjab, over-exploitation occurs in about 40 per cent of the blocks; in the case of Rajasthan, it has increased from 17 to 60 per cent in the last seven years. In Karnataka, 90 watersheds out of 234 have reached the critical stage, whereas in Andhra Pradesh, 445 basins out of 1229 are at the critical stage. The situation is similar in most states. Sooner or later abstraction is going to have to come into balance with the sustainable yield of an aquifer. This needs to be carefully considered and appropriate policies should be developed at the basin level for conservation as well as for abstraction to maintain economic growth.

Rainwater harvesting to create water bodies

In many parts of India that are classed as arid and semi arid, rainwater harvesting has been practised as a means of intercepting flows for immediate beneficial use that may otherwise be lost as runoff to the ocean. The first census on minor irrigation schemes (1986–87) in the country showed that there were about 500 000; the third census in 2001–2002 put this figure at 424 000, irrigating 4.8 m.ha. According to the planning department, the area under tank irrigation had declined from 4.78 m.ha in 1962 to about 3.07 m.ha in 1985, despite an increase in the number of new tanks (in the context of rural India, 'tanks' refer to open communal reservoirs typically with volumes of a hundred to several thousand cubic metres). The reasons for this decline in tank irrigated area include a shift from participatory irrigation practised by the community to a government-controlled system; encroachment and a 'free for all' entry onto the tank premises, which has cut down the very source of water supply to the tanks; improper management of the catchment, allowing the free flow of silt into the tank and reducing its storage capacity; and developmental activities without any consideration of upstream and downstream linkages.

Watershed development

The concept of integrated and participatory watershed development and management has emerged as the cornerstone of rural development in the dry and semi-arid regions of the country. Since 1980 there has been an annual investment of around Rs10–15 billion (US$1 = Rs 44 in 2006) in watershed programmes. Even more ambitious plans are being made for the future by setting a target of Rs760 billion for such programmes over the next 25 years. Though the watershed development programme created a positive impact by checking erosion, improving land cover, and improved groundwater recharge, there are many unintended impacts that have affected its sustainability adversely (see Box 1). A critical analysis of the results achieved so far reveal that in the context of sustainability, there is an urgent need to:

- plan watersheds on the basis of ridge to valley, without taking a dogmatic position
- plan runoff-suppression / water harvesting measures based on water-balance and geo-morphological studies for the whole catchment
- regulate groundwater extraction
- shift to integrated planning, adopting a basin-wide approach, and
- socially regulate water, to bring sustainability to the programme.

Children play on a check dam

Box 1. KAWAD

The Karnataka Watershed Development Project (KAWAD) was located in the northern districts of Karnataka State, India. This is an area characterized by limited water resources for which there is increasing competition. In addition to piloting different institutional approaches to watershed development, KAWAD aimed to improve the livelihoods of the inhabitants of three selected watersheds (total area of around 45 000 ha).

A large number of water harvesting structures, such as village tanks and other smaller structures, existed in the KAWAD watersheds before the project started. The KAWAD project design, which took no account of existing water harvesting structures, was based on the assumption that large volumes of water were being lost as runoff from the project watersheds and, hence, there was considerable scope for using water harvesting to augment the water resources available to farmers and other users. Discussions with villagers at the start of the project revealed that many tanks had not filled to capacity for several years and others were not overflowing with the regularity of previous times.

These discussions prompted some searching questions, including: why should KAWAD promote and fund additional water harvesting structures, when, in the view of villagers, the existing structures (i.e. the tanks) were catching all the runoff in all but the wettest years? Accordingly, the KAWAD Executive Director ran a series of studies to identify the causes of reduced tank inflows and the potential effects of increased water harvesting.

Methodology. River-flow data and information on runoff were collected from a wide range of sources. These were analysed to provide information on the variability of runoff at a range of spatial and temporal scales. The impacts of intensive water harvesting were investigated using field data from the project watersheds and standard analytical procedures. The main findings of this analysis were then cross-checked against the perceptions and knowledge of villagers and NGO staff living in the KAWAD watersheds.

Results. Data from river gauging stations operated by the Central Water Commission indicated that the scope for augmenting water resources using water harvesting was very limited. Before KAWAD started its work, the long-term annual average runoff as a percentage of annual rainfall was around 6 and 2 per cent for the Doddahalla and Chinnahagari rivers, respectively. These data, taken in conjunction with village-level observations of infrequent spilling of tanks, indicated that surface-water resources were close to being fully committed at the macro-watershed scale, and that creating additional storage was more likely to change the overall pattern of availability and access than to augment the total volume of runoff harvested. Using the International Water Management Institute nomenclature, the KAWAD watersheds were effectively in the 'closed' classification in all but the highest rainfall years.

Notwithstanding this finding, KAWAD funded a large number of water harvesting structures on the basis that large numbers of small water-harvesting structures would lead to a more equitable access to water than traditional tanks.

Sustainable use of groundwater resources? In the KAWAD watersheds, groundwater is the main source of water for domestic and agricultural purposes. There was a dramatic increase in groundwater extraction for irrigation in the KAWAD watersheds in the 10–15 years preceding the implementation of the project. Prior to KAWAD's inception, demand for groundwater was in excess of annual recharge and, as a result, groundwater levels were falling, shallow wells were failing and competitive well-deepening was taking place. Indications are that the large number of additional water harvesting structures funded by the KAWAD project improved groundwater recharge but, in most cases, at the cost of reduced inflow to tanks. Of greater concern, increased water harvesting did not lead to sustainable groundwater usage, as demand continued to outstrip supply. This was partly a result of increased irrigation water use and partly a result of below-average rainfall during the last three years the project was being implemented. Throughout the duration of the project, competitive well deepening continued and many farmers faced severe hardship as a result of failed investments in borewell construction.

Have the new water harvesting structures improved groundwater recharge? In some locations, the number and total storage of new water-harvesting structures has been such that all the runoff from small and medium runoff events has been harvested. In volumetric terms, this resulted in harvesting of approximately 10–20 per cent of annual rainfall that would otherwise have flowed into tanks. The percentage of harvested water going to groundwater recharge is difficult to estimate given that it depends on many site-specific factors that are highly variable. These include catchment area, infiltration rates behind the structures, presence of deep-rooting vegetation in and around the structures and hydrogeological conditions. Modelling studies indicated that, on average, water-harvesting structures in the KAWAD watersheds are filling approximately twice every year. Notwithstanding issues of efficiency of recharge from individual structures, this represents a significant localized enhancement in groundwater recharge and, not surprisingly, farmers with wells near to structures reported improvements in well yield.

What was the impact on tank inflows? Although government water harvesting programmes are usually considered to be entirely benign, it is clear they can have a big impact on the viability and utility of traditional tank systems, especially in low rainfall years. The changed pattern of water use has resulted in trade-offs and distinct winners and losers. From the irrigation perspective, changes have benefited poor and marginal farmers as well as richer farmers. However, if the non-irrigation uses of the tank are considered, it becomes obvious that 'irrigation' benefits have come at a social and economic cost. In the last 20 years the utility of tanks for activities such as washing, bathing, watering livestock, pisciculture and various cultural activities has declined. In extreme cases, tanks are no longer perennial sources of recharge for village wells supplying drinking water. The quantity of water surplusing from tanks has also been reduced and, hence, less water is available to downstream users.

What was the environmental impact? KAWAD interventions have led to an increase in vegetative cover on arable and non-arable lands. On the less positive side, there are indications that the changing patterns of land and water use and unsustainable levels of groundwater extraction may be leading to a reduction in biodiversity as a result of the drying-up of tanks, reduced flow in ephemeral streams and desiccation of seepage zones. There is also a risk that, in some areas, agricultural intensification may have led to a deterioration in groundwater quality. This would be in addition to the rise in fluoride levels in wells in some villages of Upparahalla, as a result of falling groundwater levels.

Source: 'Water Harvesting Briefing note', KAWAD, June 2005, Write-Arm, Bangalore.

Conclusions and recommendations

In the past, to overcome water shortages, small, medium and large structures were built to direct water for irrigation, flood control and other purposes. However, the extent of such interventions was relatively small. Over the past two decades, however, the number of small-scale watershed management interventions has increased exponentially, paid for by generous government funding. In addition, groundwater has been considered unlimited and the property of the overlying land owner; pumping was therefore uncontrolled, and indeed was supported by a power subsidy. For several decades the economy has flourished on this basis. These two interventions have been considered benign and the authorities felt that there was no need for scientific analyses to evaluate their impacts. The reality is that the gap between demand and supply in the water sector has been aggravated, leading to disputes between the various users.

The time has come when there is no other alternative but to apply the integrated watershed philosophy on the ground and not just on paper. This requires integrating all the line departments and other stakeholders and using a common information base to depict the availability of water resources in the drainage systems on the one hand and the present and future demands of all the stakeholders on the other. Any new intervention should be validated with respect to this base to see whether the system could bear any further stress. This will allow for continuous water resource audit and a provide a decision base to manage the resource in a sustainable manner. A sample water resource audit procedure was successfully demonstrated during KAWAD in Karnataka and APRLP in Andhra Pradesh (Box 1).

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From our water correspondent

Global climate change: a rural perspective from Nigeria
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The rains suddenly appeared from nowhere on 24 and 25 January 2006. The mark of a heavy rain is that within a short time of falling, the dry village drains are suddenly full of water. None of the elders in the village can remember the last time rains fell so heavily and so late in January. The heavy rains are usually over by October or November, with a few desperate drops following on in the early days of December.

This is normally the *harmattan* season, and you can leave your harvested crop in the field till the end of January, so that it will be fully dried. This ensures it is well preserved, as the moisture content will not support moulds and weevils. Unfortunately some of us still had not brought the guinea corn home from the farms before the rains struck. The dry season also usually allows better use of available space for drying and storage of animal feeds outside – grain and legume husks being stored for the hunger months.

Reactions to this rain have been varied. Some think God must be annoyed about our sins in this little village; others think Americans are causing problems by going to the moon and thereby confusing the rain clouds. We certainly made no preparation for this eventuality; we had no early warning that the rain clouds were coming at this time of year. We hear that the national television does broadcast weather news, but no one here heard a mention of this coming. Even if people had heard, they probably would not have believed it because such rains at this time of year, in our little corner, are unheard of.

The weather this last year has certainly been strange: first the hunger months lasted longer than usual because the rains did not come as expected, and then when they finally arrived it was torrential, as we had never seen before. It was so heavy, the banks of the small gentle village stream overran and flooded homes, leading to loss of lives and collapsed mud buildings. And now, these two days of heavy rain from out of nowhere have devastated farm crops and livestock feeds. The most comforting opinion about these strange climate reversals is that it must be an act of God. With this pronouncement by the village elders, the matter is put to rest and people try to salvage what they can and get on with life as best as they can.

But as the Health and Water Development officer for Fantsuam Foundation, the matter has to remain alive until we find ways of mitigating these natural disasters. Weather forecasts are still largely unheard of here in BayanLoco, Kafanchan. Those in the cities who listen to weather forecasts advise against setting much score by them. At any rate the rural dweller, who probably needs these forecasts more than anyone else, has no television to watch; although she or he may have access to a radio, radio programme producers do not consider forecasts to be important enough to broadcast. Geographic Information Systems are supposed to be accurate enough now to give some advance warning, and there is some GIS information that we understand can be obtained for free. When we eventually have access to GIS information for weather forecast, raising public awareness about their usefulness and dependability will be a strategic objective.

Time is not on our side, however; we have to come up with some strategies fast if we are to avoid a repeat of the recent disasters. Fortunately, the memory of these disasters is still fresh in people's minds, so now will be the ideal time for innovative solutions which the people can buy into, and implement, because our lives will depend on these.

For the last year, it has been a pleasure to share with *Waterlines* readers my thoughts, plans, activities and fears in promoting access to safe water in rural Nigeria. It is no coincidence that each article reports on a new issue or problem faced by rural communities; life here seems to roll from one challenge into another. As *Waterlines* correspondent, I hope I have been able to bring some readers a different perspective of water in the daily lives of our people.

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