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REACHING THE UNREACHED: CHALLENGES FOR THE 21ST CENTURY

Water harvesting in coastal areas

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EXPERIENCES FROM ARID and semi-arid areas in the field of coastal aquifer management where water harvesting and artificial recharge strategies are adopted, are rare and scarcity of data is a commonly encountered problem. However an increased awareness of its potential applicability is taking place and is increasingly being recommended (Rushton and Phadtare, 1989; Goldenberg and Melloul, 1994; Khair et al, 1994). Therefore, there is today a growing need for acquiring knowledge about systems capable of making use of ephemeral runoff waters and river base flows. These systems should require low inputs once established and no sources of energy for their functioning. They should also present the possibilities to be applied at village levels and implemented and managed by local peoples (Raju, 1992). The paper introduces the case of Moti Rayan village in southern Kachchh district in the state of Gujarat, India.

Kachchh district

The study area is located in the district of Kachchh in the northwestern state of Gujarat, India (Figure 1).

Gujarat is a state of dwindling water resources which faces acute water shortage every year. Most of its water resources are concentrated in South and Central Gujarat whereas the drought-prone areas are in Kachchh in the northwest and in the Saurashtra peninsula in the west. Kachchh is the largest district in India with considerable ecological variety and a unique topography where more than half of its area is covered by the saline marshy flats of the Great and Little Rann of Kachchh. The backbone of the district is the elevated zone known as the Bhuj Ridge where most of the rivers originate from. Broadly speaking, the rivers flow mainly northward or southward starting from the ranges in the central areas which serve as watersheds. The rivers are non perennial. The runoff is high and the flow is totally drained away within hours after rainfall.

Kachchh is an agrarian district. The population of 1,26 million inhabitants is to 90 per cent depending on agriculture and they are mainly settled in the central and coastal parts of the district (GIAP, 1989). The climate of Kachchh is semi-arid to arid with frequent occurrence of droughts. The district receives rain only through the southwest monsoon which occurs between the last week of June to the second week of September. The mean annual rainfall of Kachchh district is 336mm. However the rainfall is extremely uneven and ill distributed, both in time and space, since the district is located at the periphery of the main current of the southwest monsoon.

Experimental site

Background

The village of Moti Rayan is situated at 22°45' north latitude and 69°59' east longitude in the Mandvi taluka. The village is located at 6 km from the Arabian Sea, on the bank of one of the major south flowing rivers in Kachchh, the Rukmavati river originating from the central parts of the district. Moti Rayan is typical for southern Kachchh.

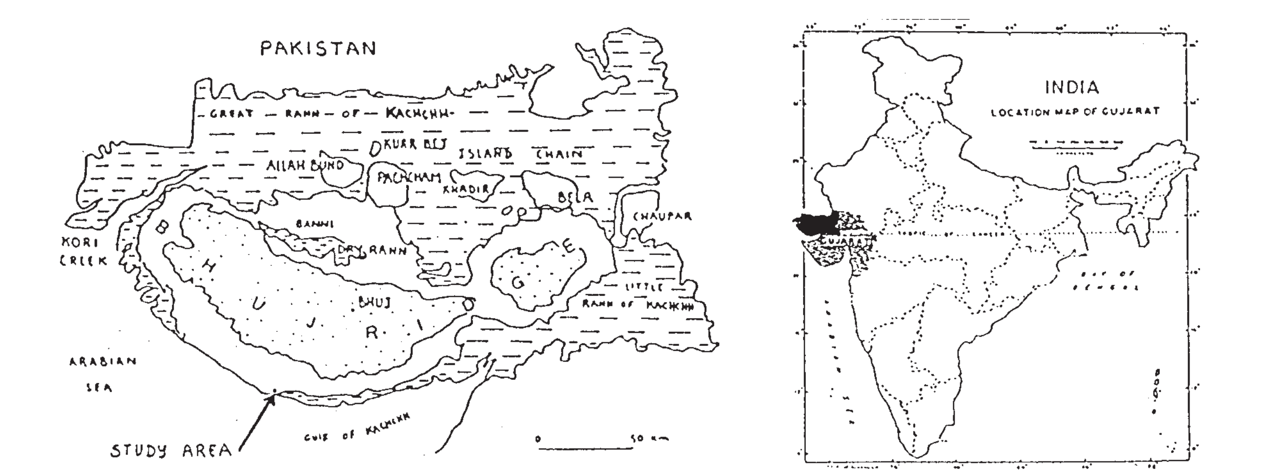

Figure 1. Kachchh district

It has an area of 743 ha and a population of 2533 comprising 472 households. The cattle population is about 1250 including cows, buffaloes, goats, sheep and camels. The people are depending on agriculture and the major crops grown are pearlmillet, castor, groundnut, wheat, sorghum, sesame and sunflower. Among the fruits, date palms, coconut, pomma granate, jujube, chicko and papayas are common. The area receives on average 435mm of rain annually.

There are two drainage streams passing through the village and leading to the Rukmavati river. Besides that, there are about half a dozen water courses carved by erosive activity within the village. These water courses are non perennial and remain dry most of the year. During the rainy season they get filled up very fast and carry large quantities of water for a few hours or days after each important shower. That water is drained directly to the Rukmavati river and further to the Arabian sea. As a result of intensive exploitation of the groundwater, water availability has been reduced and saline water have intruded into the aquifers. The TDS value of the water has increased drastically over the last decades and have now attained values varying between 1010mg/l and 4350mg/l.

After seeing severe recurring droughts in the mid-eighties and ever increasing problems of groundwater depletion and salt water contamination, the Vivekanand Research and Training Institute (VRTI) installed since 1978 near the old harbour town of Mandvi and the farmers of the nearby village of Moti Rayan, decided to start a common water management plan for the area that would include rainwater harvesting and artificial groundwater recharge. A precondition was that the structures should be as simple as possible and be constructed with material locally available only. Another priority was that the structures should be easy to maintain. It was also agreed from the start to actively solicit the participation and the involvement of the water resources users as direct actors and build the project upon their own skills and knowledge of their local environment. This approach would reinforce local village organization, involve villagers in technology generation and employ village facilitators for appraisal, planning, implementation and monitoring. VRTI would act as a support organization playing a catalytic role of facilitation and networking.

Together, VRTI and the farmers of Moti Rayan designed and started in 1989 a pilot project plan where the idea was to harvest the large amounts of flood waters drained by the streams and rivulets in the village after each monsoon showers. It was also decided that where possible, recharge and store water as much as possible in the underlying aquifers. A proposal was submitted to the Council of Advancement for People's Action and Rural Technology in New Delhi (CAPART) which approved to finance 75 per cent of the project. The farmers provided the 25 per cent balance. The strategies that were designed and implemented in the village were based on existing concepts and techniques but modified and redesigned to suit the local conditions. This resulted by the end of 1989 in a combination of check-dams, recharging tube wells and a percolation tank. By June 1990 two more percolation dams and a subsurface dyke were constructed. Their concepts were innovated and designed within this project (Figure 2).

Several structures were constructed in Kachchh the following years after that farmers from different villages had seen the results in Moti Rayan after the monsoon of 1989. Since then, the collaboration between farmers in the coastal villages of Kachchh and VRTI have expanded continuously and is today taking place all along the coastal belt from West to East. Over 170 water harvesting and recharging structures have been constructed. So far the structures have performed very well all along the coastal line. TDS and water level data have been collected regularly before and after recharge every year and in every village where structures have been constructed.

Construction design

Three percolation tanks were created upstream in the rivers (Figure 2). Among these, one had already been constructed by the farmers long time ago and it was now deepened and expanded. The farmers and VRTI did not only wish to recharge large amounts of water through infiltration from the percolation tanks. They also wanted the recharging process to be quick and capable of improv

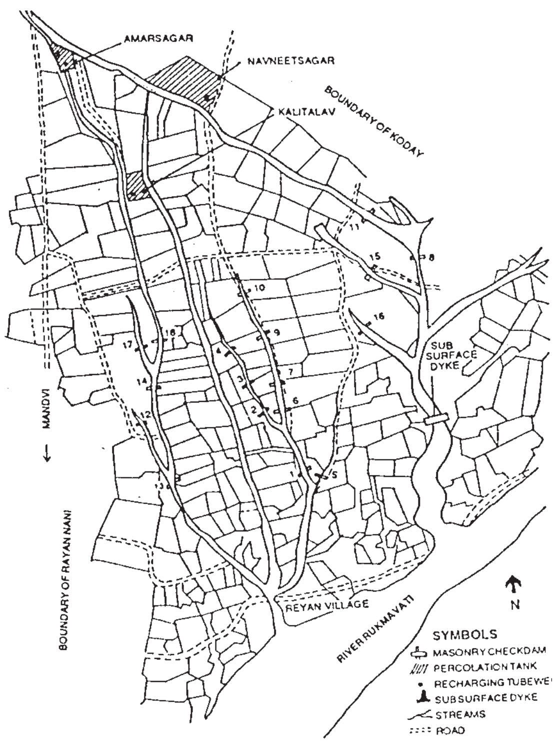

Figure 2. Location map of the water harvesting and recharging structures in Moti Rayan

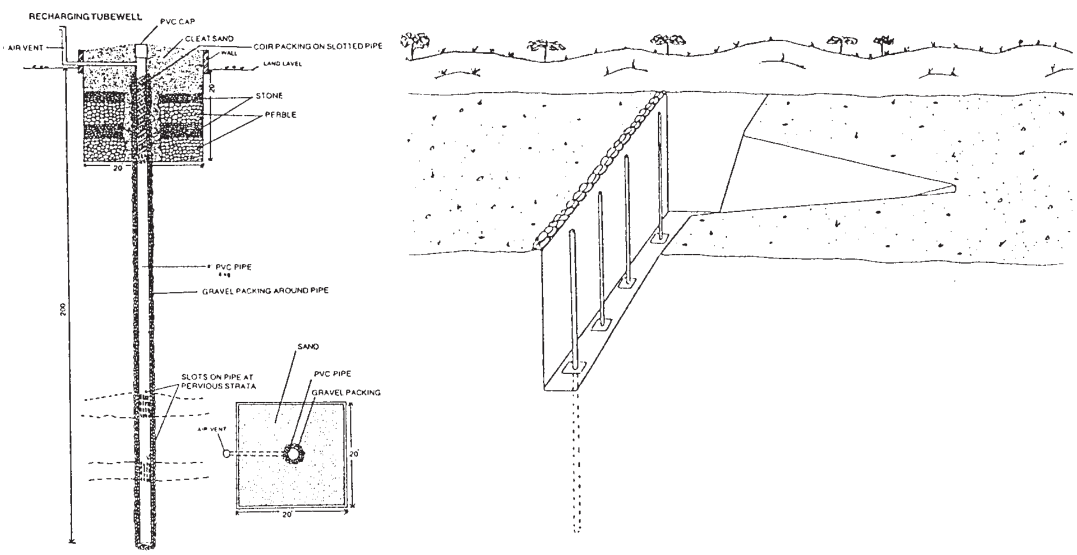

Figure 3. Recharging tube well and subsurface dyke

ing the water quality of the groundwater. However, it was feared that the construction of a conventional percolation tank, where water after accumulation in the tank is left to infiltrate through the bottom, would lead to a slow recharging process. Indeed the various geological layers with low permeability present under the village would slow down the percolating processes. In that case, the impounded water would increase the TDS level. Thereby, the purpose to recharge and store in the aquifers fresh rainwater, thus improving their quality, would not be fulfilled. Also, because of the important depth to the water table the percolating water would take long time before finally reaching it.

Therefore, it was decided to provide every percolation tank with a recharging tube well in its lowest part. By doing so, a quick recharge of rainwater to the aquifers is achieved and the quality of the recharged water is not altered. Another important goal that is achieved through this method is that the tanks can be replenished by flood water more often than in conventional percolation tanks as the recharging tube wells contribute to empty the tanks quickly thus making the these ready to store new amounts of water if a new important shower would occur within a short lapse of time. The percolation tanks are provided with waste weirs so that the excess water can flow towards the Rukmavati river. On its way, the water is intercepted by a series of small check-dams (figure 2).

The flood water to be recharged into the depleted aquifers must be of good quality and free from suspended solids. A very common problem encountered with conventional recharging wells is clogging due to silt and sediment present in the recharged water. To avoid this the recharging tube wells upper section were provided with a filtering system designed at VRTI and based on a sequence of fine sand, gravels, pebbles, and coconut coir (Figure 3).

In the streamway with the largest width and which carries important masses of flood water after monsoon showers, a ”subsurface dyke” was constructed in 1990 partly based on the principle of groundwater dams (Figure 3). Here the entire width of 71m was excavated down to 15m. The downstream wall of the excavated portion was made impervious with a silpaulin sheet in order to arrest the important base flow occurring under the river bed and observed by the farmers for months after each monsoon season. Since the water table is located at important depth, the entire section of the dyke was provided with four recharging wells extended from about 60cm under the river bed down to almost 60m. The entire excavated dyke was then filled with fine pervious sand taken from the Rukmavati river bed. A check-dam built with sand bags and with a height of about 2m was provided on the river bed, with the function to arrest the flood water so that it can be allowed to infiltrate into the sand filled dyke and finally through the recharging wells. Overflowing water is going to the Rukmavati river (Figure 3).

Results and discussion

The storage capacity created in 1989 was 44 715m³. The construction of two more percolation tanks and one subsurface dyke created a total maximal storage capacity of 127 020m³. So far the structures have performed well and in normal and good years the different structures get totally filled up and emptied up to three times.

All the wells in the village are monitored regularly between May and December. The results suggest that the structures can have large benefits on salinity levels in the area particularly during years of good rainfall. But even if the rainfall is quite low, the recharge can also have substantial effects on groundwater quality. As an example, in 1992, 765mm of rain fell down over the area. The structures recharged 224476m³ of floodwater. The TDS values in the 84 wells of the village decreased in average by 633mg/l and the water levels increased by 0,5m in average during 5 months. In 1990 only 185mm fell over the area during a spell of five days. The amounts recharged was estimated to 203 967m³. The TDS values decreased in average by 272mg/l. In 1993, only a total of 31mm of rain came and no water was intercepted and recharged by the structures. On average the TDS values in the village wells increased by 240mg/l between May and December.

So far the water harvesting project in Moti Rayan has given encouraging results and the recharging tube wells and the subsurface dyke have technically proven to be effective recharge structures. The data obtained suggest that if the district receives good rainfall there can be significant temporal improvements in groundwater quality. However, the discharge rate in the area is still more important than the recharge. All along the coastal area of Kachchh the farmers are pumping on average 12 hours a day at the rate of 300 LPM and during 180 days per year. The problem is aggravated by the fact that electricity is not charged on the actual consumption but on the horse power amounts of the submersible pumps. The decline in groundwater levels is therefore still very important. Today groundwater levels have reached 40m in Moti Rayan and the recharge activities have not resulted in substantial increases in groundwater levels.

The results obtained in Kachchh shows that the issue of water use and access is the most important to handle with the farmers and concerned authorities because the effects of over exploitation and saline water ingress which have occurred due to heavy irrigation cannot be overcome solely by water harvesting and artificial recharge. Encouraging though, is that awareness of the problems is increasing among the resource users. The villagers have appointed a committee to take care of the structures and maintenance is done regularly by the farmers. Also, for the last decade, major changes in the cropping pattern have taken place towards more salt tolerant and less water requiring crops. Farmers have also been investing more and more in horticulture and drip irrigation systems.

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