

Cooperation Fund for the Water Sector

Pilot Demonstration Activity Request Form

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Activity Title: Groundwater aquifer rejuvenation demonstration pilot project for Balochistan	
Proposer (Name, Div/Dept): Dr Abdul Majeed, Head Water Programme, IUCN Pakistan	
Request Date:	
Region: South Asia	Country: Pakistan
Activity Start Date: May 2005	Activity End Date: April 2006
Cost Estimate: \$49,850	
Implementing Organization Contact: IUCN Pakistan Water Programme Programme, Markar Cottage, Zarghoon Road, Quetta Email: bpo@qta.iucnp.org	
Consultant Identified? No	If so, Consultant(s) Contact:
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Short Description:

1. Background and Rationale:

The climate of Pakistan is predominantly desert or near desert with approximately half of the country receiving less than 250 mm average annual rainfall. Balochistan Province in the west of the country bordering with Afghanistan and Iran has a mean annual rainfall of less than 100 mm in southwest to just over 450 mm in the northeastern part of the Province. At the same time, daytime temperatures during summer can be as high as 40° Celsius even at higher elevations. In winters maximum temperatures range between sub-zero to just over 10. The relative humidity is generally low throughout the year. The high aridity index and low relative humidity causes the surface water bodies to evaporate rapidly. In the absence of perennial sources of water in most parts of the Province, groundwater is the only dependable source to meet the ever-increasing water demands in these areas. In particular the capital of Balochistan, Quetta town, and the surrounding valleys falling in the Pishin-Lora Basin, face extreme shortage of water, as the demand is far above the available supplies. It must be mentioned that Quetta valley has good soils, good climate, and with irrigation water, deciduous fruits of the highest quality are grown and as such the orchards are one of the main users of the water in Quetta valley. The demand for water to further expand orchard activity is extremely high.

In the past, groundwater was tapped through the traditional Karez system, a system of vertical shafts/wells in the alluvial fans at the foot of the mountains interconnected by a horizontal tunnel that would intercept the water table near the head of the alluvium, and provide a dependable source of water flowing under gravity to lower valley areas, where agriculture is mostly practiced. The advent of electricity in the province in the mid sixties, and its provision to the farmers on subsidized rates to promote agriculture heralded the exponential growth of tubewells with the result that the groundwater resources are currently under tremendous stress. Many areas/sub-basins show the rate of groundwater table decline from 1 to 3 meters per year.

Historically, the slopes of the mountains around Quetta Valley within the Pishin Lora Basin and the watersheds were covered with forests, and the natural recharge of the underground aquifer balanced well with the discharge from springs and Karezes. With passage of time, due to human interventions and pressures imposed by increased population, energy requirements, etc., not only did the forest cover disappear but the soil that covered the slopes was also washed down into the rivers/streams. As a result, the occasional rainstorms in this and similar vulnerable areas in Balochistan now cause flash

floods. The net result has been that the heavy withdrawal or abstraction of groundwater is no more matched by groundwater recharge. The problem is not unique to Quetta valley and is a common feature throughout Balochistan wherever electricity has reached the rural areas.

Justification: The efforts of the government to restore the groundwater in storage have been mostly directed towards finding engineering solutions (structural means), by building delay action recharge dams across some of the streams in the foot slopes of the mountains throughout upland areas of Balochistan. Up to now, over 160 such dams of varying heights (5 to 20 meters) and lengths have been built at a huge investment. The technique is based in the belief and hope that the deep percolation through the beds of the reservoirs created by these dams would aid in water for storage underground. While the Provincial Irrigation Department claims success, field observations show that the high content of fine clay in the river, brought in during runoff, gets deposited and rapidly seals the beds of the reservoirs created by the delay action dams (DAD) from where recharge is supposed to occur. Analysis of data indicates that the infiltration rates drop exponentially with each storm that brings in sediments. One significant feature is that most of these DADs were constructed without any method for release of the stored water to downstream areas. Consequently the dams now act as mere evaporation ponds with little to no recharge through the beds. A solution to this problem could be to either make the body of the dam leaky or provide enough outlets in the body to allow the stored water to get spread in the downstream riverbed, where small check structures can be built to allow recharge of cleaner water. Another solution could be to use siphon pipes to lift the water over the body of the dam and spread it on the downstream riverbed for recharge to take place.

However, as these dams are already completed, the earth embankments that form the body of the dams cannot be tampered with. Siphon pipes were installed by the Irrigation department to take out water from the reservoirs for releasing downstream but were found to be impractical as they were either stolen or tedious to prime and operate.

The present situation is that there are over 160 DADs, which are acting nothing more than large evaporation pans. This proposal would try and demonstrate appropriate methods to make the water stored in the DADs to be put in the shallow aquifers in the same areas. The larger need is to change the design and construction approach of the Irrigation Department to make any future dam perform as effective recharge structure.

Meanwhile, more boreholes continue to be drilled in the province and the water table continues to drop causing the traditional Karez systems to dry up and the tubewells to be deepened almost every couple of years. Currently water is being pumped from 500-900 feet below ground level in many places raising serious questions of water resources depletion and economic and technical sustainability of the resource. There is now urgent need for taking all possible remedial actions to control the situation aimed at not only legislative and institutional improvement but also through adopting improved technologies of recharging groundwater to balance groundwater abstraction to some level of sustainability. It is of utmost importance that the investment made in DADs does not go waste. To meet this end locally innovative technologies are proposed to be tried on pilot basis for demonstration purposes to show that these dams can still be made effective in achieving their objectives.

2. Objectives:

The immediate goal of the proposal is to demonstrate successful technologies for enabling the water stored at existing DADs to be put into shallow aquifers in these areas.

The following are the specific objectives of the Project.

1. Demonstrate appropriate and innovative technologies for making the existing Delay Action Dams effective in recharging aquifers.
2. Disseminate the tested technologies within Balochistan and elsewhere.
3. Ensure long term involvement of user/beneficiary communities in recharge

3. Scope of Work/Description of Activities:

The activities planned for each of the objectives outlined above are given in the following sections:

Objective 1: Demonstrate appropriate and innovative technology for making the existing Delay Action Dams effective in recharging aquifers

Both inverted well technology and siphon pipe techniques would be demonstrated under the project. This inverted well technology basically consists of drilling a large diameter borehole in the ground down to aquifer to provide direct path for water to infiltrate into the ground and thus recharge aquifer. The water can then flow under gravity or may be forcefully injected through reverse pumping. The basic requirements for an artificial recharge inverted well scheme are adequate source of water to recharge and the right hydro-geological environment to support such activity. Recharge wells are used where space is a premium or the aquifer to be recharged is deep and confined. In operation it is essentially the opposite of groundwater abstraction, a recharge mound forms rather than a cone of depression due to pumping of water downward.

Theoretically recharge is achievable at the same rate as abstraction. In practice this is not the case with suspended solids, entrained air is also a significant factor as well as bacterial growths and chemical encrustation on the screen of the well. It is reported that good recharge rates can be achieved through injection well, giving an average ranging from 1,235 to 5,725 m³/day, with a minimum of 200 m³/day and maximum of 51,000 m³/day. There is need to undertake such technique (cluster of wells) in the beds of existing delay action dams where water is stored at surface and where runoff occurs, which at present mostly evaporates without recharging the aquifer. It would therefore be very important to design a very good filter material on top of the well so that sand does not find its way into the borehole reducing its effectiveness.

The siphon pipes are simple and consist of providing inverted siphon pipes to allow flow of water over the body of the dam to be released and spread on the downstream riverbed for recharge to take place in the highly permeable riverbed. The recharge is further aided by constructing small loose stone check structures to form small basins where clean water gets collected.

As already pointed out, fortunately, there are numerous opportunities in Balochistan to demonstrate this technology due to the very large number of so called DADs with reservoirs meant for recharging aquifers. Water availability would not be a problem. Two pilot areas will be selected in Pishin Lora Basin – the most affected area with regard to severe groundwater depletion – where delay action dams have already been constructed but are currently ineffective in recharging aquifer due to siltation and consequent sealing of the beds of the reservoirs. The selection of the area would be carefully made to ensure that water-bearing strata are available on the downstream side of the dam and that there

are no tubewells in the vicinity and the water supply for irrigation/domestic requirements is dependent on Karezes and open wells.

Under the project the following activities will be undertaken:

1. Hydro-geological investigation of the area to locate suitable gravel strata would be undertaken in detail through resistivity surveys.
2. A Rapid Appraisal of the command area to locate Karezes and open wells.
3. Building working relationship with beneficiary community and raising its awareness about planned activities.
4. A cluster of inverted gravity wells will be drilled in the upstream bed of one DAD to allow direct flow of water into the aquifer. The wells will be scientifically designed and provided with appropriately designed filter material on top to eliminate chances of sediment flowing into the borehole. The system effectiveness will be monitored through the Karezes and open wells on the downstream side of the dam.
5. The second dam would be provided with siphon pipes to lift water from the reservoir after each storm and allow it to be discharged into the downstream infiltrating bed of the stream for recharge to take place. The lifted water would be much clearer and sediment free and is expected not to clog the downstream bed.
6. Interventions at both sites will be monitored through the existing network of Karezes and open well to see the effectiveness of the technologies in improving recharge. A small network of small diameter piezometers will also be installed and monitored.

Objective 2: Disseminate tested technologies within Balochistan and elsewhere

Field visits of Government of Balochistan (GoB) officials at the policy and implementing levels would be organized to show the successes achieved and that these techniques can be replicated elsewhere in the province. Wider dissemination of the technique results would be made throughout Pakistan and other parts of the globe. This is proposed to be achieved by the following activities:

1. Outreach workshops – one at each site – and meetings with local users/communities
2. Field visits of government and other high civil society organizations within Balochistan to demonstrate the effectiveness of the two technologies for future replication and adoption.
3. The results of the efforts will be put and updated whenever necessary on websites maintained by IUCNP under this knowledge management Programme.

Objective 3: Ensure long term involvement of user/beneficiary communities in recharge

The beneficiaries of the project are the communities living downstream of the dam, who earn their livelihood from small-scale horticulture activities; thus depending on access to sustainable and dependable source of water. In the absence of surface water sources they have come to exceedingly depend on groundwater as their primary source of irrigation water.

Through involving the community at all stages of project development and execution, dialogues, training, and education, the community in the project area would be reminded of their responsibility and the prime role they can play in ensuring the project operates and runs efficiently, which can ensure that their wells and Karezes run throughout the

year. A proper agreement will also be signed with the community to ensure their continued long-term involvement.

4. Implementation Schedule, Institutional Management Arrangements, and Proponent Qualifications:

a) Implementation Schedule: Following schedule will be followed:

May 2005	Selection of sites and resistivity surveys
June 2005	Inception report and work plan
June 2005	Dialogue and negotiations with communities
Jul-Aug 2005	Design of system/Purchase of materials
Sep-Dec 2005	Installation/construction of systems
Dec 2005-Apr 2006	Monitoring and outreach workshops/ field visits

b) Institutional Management Arrangements: IUCN Water Programme, Quetta and Water Savers Environmental Services (WSES), Quetta, an NGO working with communities on water development and management in Balochistan will jointly execute the project. The Project will, however, be managed by IUCNP through the IUCN Water Programme. The project will be executed by establishing strong linkages with stakeholders in the project area. These are identified to include the GoB line department of Irrigation and Power and the local user communities. For the success of the project it will be essential to establish working relationships with all the stakeholders not only at GoB level but also at implementation level with full cooperation of the local communities. The methodology for the same will be worked out.

WSES will be entrusted to do the entire resistivity surveys and come up with recommendations on proper site, as they are fully equipped to do the same. Both IUCN Water Programme and WSES will do installation/construction of the systems. However, short-term services of an international consultant will be needed to help plan and design the systems for recharge.

c) Proponent Qualifications:

Ph.D. (Water Resources Engineering)	USA
M.Sc (Water Management)	the Netherlands
B.E. (Civil Engineering)	Pakistan

5. Expected Results (outputs/outcomes/impacts):

- Increased recharge in shallow aquifer system resulting in:
 - Increased flow in Karezes
 - Increased water levels in open wells
- Increased understanding of recharge mechanism and technology among policy makers, planners and engineering community of GoB officials

The outcome/impact of the project as far as the first one is concerned would be visible within days, as there would be direct recharge to the aquifer system.

6. Measurable Performance Indicators:

Environmentally the project is going to be highly beneficial to the local environment, as the trend of the receding water table will be arrested making easier access to

water. The greater availability of water would make the area greener and economically better off.

Specifically the performance of the demonstration project (negative or positive) will be judged with the following indicators:

- Water level in open wells
- Discharge in Karezes

7. Stakeholders Participation:

The local community and GoB local Irrigation Department engineering officials will be closely involved in all stages of project implementation. Monitoring of the system will be made joint responsibility of local community and WSES, who will be trained for the purpose. IUCN Water Programme will continue to extend help in monitoring after project completion.

8. Scope for Replication/Use in Other DMCs:

Results from the study will be very relevant and applicable to other developing countries of the region as well as applicable worldwide where problems of similar nature exist.

9. Cost Estimates:

Activity	Budget	Total Budget
Resistivity surveys (Ten traverses)	400	4,000
Field surveys/scooping out (two)	1,500	3,000
Installation of inverted recharge wells/bores	LS	18,000
Provision of siphon pipes	LS	6,000
Raising awareness and capacity building of communities (two)	1,000	2,000
Karez and open well assessment pre-project (2 sites)	1,500	3,000
Outreach workshops and field visits (4)	750	3,000
Total activity budget		39,000
Consultancy (One)	5,000	5,000
IUCN Administration, reporting, printing cost		5,850
Grand Total		49,850