Sustainable Management of Groundwater in the Drylands of Pakistan

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ABSTRACT
Water is symbol of life on this planet. Although ¾ of the world approx is covered with water but human being is exposed to severe scarcity of fresh water. As a result, water has become a precious commodity. All over the world, expanding economic pressures are degrading water resources, while confronting people with increasing cultural assimilation, debilitating poverty and political disempowerment. Now there is a growing concern in the world for the need to identify sustainable alternatives to use water resources to meet the needs of the society. Pakistan is also facing serious shortage in both surface and groundwater resources like other developing countries. However, groundwater is depleting at an alarming rate, especially in drylands of Pakistan. Therefore, there is an urgent and emergent need to save these areas to ensure availability of water to the neglected societies of Pakistan.

INTRODUCTION

The objective of this study is to estimate annual water surplus, water deficiency and sustainable water harvesting techniques for rehabilitation of agricultural land to meet the needs of the society. It is well known that the amount of precipitation in Pakistan is not only inadequate but is also highly variable from year to year. Its distribution in time and over the area is such as to render most parts of the country dry during most of the year when water is most needed by the plants.

Pakistan is an extra-tropical country lying just north of the tropic of Cancer. During summer the region is under the influence of monsoon winds, but as it lies along the extreme western margin of the subcontinent and the Asian monsoon region; most of it receives very scanty precipitation during summer the small amount of precipitation that comes to the ground is not very effective.

During winter the country is under the influence of westerlies and they like the monsoons reach here after covering long distances from the Mediterranean Sea and Persian Gulf. Resultantly they lose much of their moisture before reaching Pakistan and the amount of precipitation in winter is also very small.

POTENTIAL EVAPOTRANSPIRATION

Aridity signifies a deficiency of moisture and is created when the meteoric supply of water is unable to meet the requirements of evaporation from the soil and transpiration from the plants.

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Moreover aridity and greater continentality enhance the rate of evaporation and resultantly potential evapotranspiration is very great.
The isopleths of potential evapotranspiration follows approximately the course of isotherms. Resultantly they run parallel to the Kirthar and the Suleman ranges near their foothills, but in the open plains they assume an almost east-west direction characteristic of isotherms.

The southeastern part of Pakistan, which is part of the Thar Desert of the subcontinent, experiences the greatest normal annual potential evapotranspiration. Here the maximum is experienced around Hyderabad and it amounts to 160 cm per annum. This region of maximum potential evapotranspiration extends in an oval shape with east-west extension in Hyderabad division. The highest values of potential evapotranspiration are result partly of the great influence of the Thar Desert in summer and partly of the marine influence of the Arabian Sea, which keeps the temperature higher in winter. Broadly speaking there are only two regions of greatest potential evapotranspiration with their centres over Hyderabad and Turbat and both extend northward; the former into the upper Indus Basin and eastward into the Thar desert; the latter into Hamun-i-Mashkhel depression across the central Makran range and further into the Seistan desert of Afghanistan. The former is the largest and the driest region of the subcontinent with a normal annual potential evapotranspiration of 130 cm. It has northward extension into Sibi re-entrant and three outliers Bannu, Kohat and Peshawar (Khan 1966).

Potential evapotranspiration or water need increases southwestward with gradual decrease in precipitation and therefore with deterioration of the conditions of aridity till the high mountains on the west are reached.

The regions with lowest potential evapotranspiration are the northern mountain ranges and their continuation towards southwest in the Koh-i-Safed, Waziristan Hills, Toba Kakar range and the central Brouhi range. Here potential evapotranspiration is low because of greater elevation of the mountain ranges and hence of low temperature efficiency is experienced.

Another region of low potential evapotranspiration is the Murree Hills. This narrow strip of land with potential evapotranspiration as low as 60 cm extends in north south direction along the western bank of the Jhelum.

In the marine type of climate along the Arabian Sea potential evapotranspiration increases with increase in distance from the sea until the marine type of climate comes to an end. To the north of this, gradual decrease in potential evapotranspiration is experienced again.

March of potential evapotranspiration follows a uniform pattern all over the country. Potential evapotranspiration is highest in the months of June and July and then it decreases gradually till the lowest, which is experienced in January is reached. It ranges from 19 cm for each of the two summer months of June and July to 3 or 4 cm for January in the marine type of climate along the Arabian Sea. During winter potential evapotranspiration is very small and forms about 17 percent to 19 percent of the normal annual potential evapotranspiration in the continental parts of the country.

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It is a matter of concern for the environmentalists that Pakistan's precious land resources are subjected to severe land degradation and desertification. Controlling the water lost by evaporative process is one of the most cost-effective methods of maintaining adequate water supplies and should be an integral part of any open top water storage facility. It is necessary to promote participatory management of natural resources to meet the needs of rural population and for conservation of vital land and water resources through innovative or indigenous technologies.

SALINE WATER IRRIGATION IN CHOLISTAN

Although the groundwater is saline but it can be used for saline agriculture to grow salt tolerant trees, vegetables, crops and fodder grasses in non-saline-non-sodic coarse textured soils with minimum adverse effects due to rapid leaching of salts beyond the root zone and flushing of salts from root zone by rains. Furthermore, dense saline-sodic soils can also be used for growing such palatable grasses, which are very salt tolerant and capable of surviving in soils having poor properties. The sandy and loamy soil that is about 1 million hectares can be brought under agriculture by using underground saline water and harvested rainwater (Ahmad 1999).

Experiments showed that under certain conditions plant could not only survive but also even vast area of land could be irrigated with water of such high concentration. The soil is either sandy gravel or dune sand. Moderately saline irrigation water stimulates vegetation, assists the benevolent bacteria of the soil and improves yield and quality. Further, use of brackish water reduces soil evaporation, transpiration of plants and increases resistance to drought (Abdullah *et al* 1990; Ahmad 2002).

WATER RESOURCES OF BALOCHISTAN

Balochistan is the largest province of Pakistan as far as area is concerned and smallest in terms of population. The climatic conditions are harsh, ranging from hyper-arid to dry, with erratic rainfall in the range of 100-400 mm per annum. More than 92% of the area consists of arid grazing land and desert. The situation can be realized by the fact that groundwater has been depleting at rate of two meters approximately per annum. As a result many *karezes* and several old dug wells have slowly dried up.

Karez irrigation in Balochistan

Karez technology is sufficiently sophisticated in which groundwater is brought to the surface by a tunnel (Khan and Nawaz 1995). No mechanical pump or lift is used. Gravity alone brings the water from the underground source. *Karezes* in Balochistan are of various types: 1) Alluvial fan or piedmont *karez*, 2) Infiltration gallery *karez*, 3) Rain-fed *karez*, 4) Spring *karez*. Most of the *karezes* of Balochistan are alluvial fan type. The alluvial fans develop at the foothills where the motherwells are bored to tap the underlying aquifer.

Rehabilitation of the *karezes*

Rehabilitation of many *karezes* is possible. The first step to augment the flow is to clean the *karezes* thoroughly. In case cleaning does not restore the flow, boring of the motherwell can be undertaken with the hope that the aquifer, which may be present at some depth may be punctured and the water in the motherwell may rise up by artesian effect. The dead *karezes* may also undergo through the same operation, if the water in the motherwell is present. If the motherwell is dry, the boring should precede the cleaning. If the motherwell is not rejuvenated, the *karez* should be taken as dead and no cleaning is required.

It is a common practice to tap two or three motherwells falling in a row within the tunnel at its upper part. Attempts should be made to locate some artesian wells in the middle part of the tunnel also. If this succeeds, it will increase the depleted flow of the *karez*.

Lining of the *karez* is difficult and expensive. But the open channel from the day-light point upto the outlet can be easily lined. This will arrest seepage of water and make more water available for irrigation.

Water in the *karezes* flows non-stop. Therefore a considerable quantity of water goes waste when irrigation is not required. To conserve the water it is suggested than an artificial lake may be developed at the day-point where the surplus water can be stored. The suggestions made for the rehabilitation of the *karezes* will only be helpful if the water users are interested in maintaining the *karez*.

More work is needed to determine the vicissitudes of water deficiency in the arid zone of Pakistan. This will not only give us as insight into the problem of planning for the purposes of reclamation and demobilization of the desert but it may also help in the refinement of the method itself.

CONCLUSION

Local availability of natural resources is declining and increasing demands are being made on the remaining resources, the cumulative impacts on environmental and social system are being severe. In order to monitor this accelerated desertification problem, it is necessary to promote the systematic and successive studies by applying improved rainwater conservation techniques and to develop sustainable groundwater management through participatory cooperation and advocacy for rehabilitation of agricultural land in the drylands of Pakistan.

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