Hard Rock Hydrosystems (Proceedings of Rabat Symposium S2, May 1997).
IAHS Publ. no. 241, 1997

Artificial recharge of groundwater in hard rocks with special reference to India

B. B. S. SINGHAL
Department of Earth Sciences, University of Roorkee, Roorkee 247667, India

Abstract The common method of artificial recharge in hard rock terrains is by percolation tanks. At a few places subsurface dams are also constructed.

INTRODUCTION

Hard rocks are characterized by fracture system in which the groundwater flow may be either of discrete character or in cases where the fractures are interconnected an equivalent porous medium can be assumed.

The hard rocks pose special problems for artificial recharge due to the limited extent of aquifer horizons, heterogeneity and low hydraulic conductivity. The fracture system may have good storativity. To obtain additional storage volumes, artificial openings can also be created by blasting or by making underground cavities.

In order to achieve maximum recharge in the hard rock aquifers, various water and soil conservation measures like contour bunding, contour trenching, gully plugs, check dams etc. are practiced. Percolation tanks and subsurface dams are the two commonly used methods in the hard rock terrains of India.

PERCOLATION TANKS

Recharge by percolation (infiltration) tanks is an ancient practice of water conservation in the hard rock formations of central and south India. Thousands of such tanks are constructed every year, especially in drought prone areas to augment the groundwater recharge from river beds by building low earth dams across the ephemeral streams. Experience has shown that they are very effective for checking surface run-off and conserving water for artificial recharge. Rate of infiltration and area of influence of these tanks would depend on local hydrogeological conditions, topography and storage characteristics of the tank.

Infiltration from percolation tanks can be determined by

(a) water balance method,
(b) water level fluctuation in the adjacent wells and the specific yield of the formation in the zone of water level fluctuation and
(c) isotope technique.

Silting of tanks is a common problems which should be taken care of by adopting suitable preventive measures.

Studies in some river basins in crystalline rocks in Tamil Nadu indicated the rate of percolation from 0.05 to 1.5 m day^{-1}. The data indicate that the rate of percolation are high immediately after the inflow of water in the tank but decrease with time.

The rate of infiltration decreases to 0.01 to 0.03 m day^{-1} during the non-monsoon period (Raju, 1985). Annual evaporation losses are about 5% and the percolation is 85% of the total storage in the tank. In case of non-perennial tanks, the recharge rates are comparatively higher. This is due to the removal of silt during dry season which is used as manure.

Percolation tanks are used on a large scale for groundwater recharge in Deccan basalt aquifer in central Maharashtra having semiarid conditions with occasional recurrence of droughts. Average percolation rate is estimated to be between 0.04 and 0.06 m day^{-1} in the Sina River basin (Pardasaradhi, 1989).

Studies in Maharashtra shows that the capacity of each percolation tank ranges from 0.14 to 0.28 million m^3. The cost of each percolation tank in 1992 ranged from 1.5 to 3.0 million Rupees (equivalent to US $50 000 to $100 000). The recharge was estimated ranging from 30 to 60% depending on bed rock, and rainfall etc. (Maggirwar, 1992). An additional area of 0.02 to 0.16 km^2 is brought under irrigation due to additional availability of groundwater.

SUBSURFACE DAMS

The purpose of a subsurface dam is to check the outflow of groundwater from a sub-basin thereby raising the groundwater storage on the upstream side. A subsurface dam across a valley will therefore form groundwater sanctuaries from where water can be withdrawn during drought.

The subsurface dams are feasible in narrow and gently sloping valleys where the bed rock occurs at shallow depths overlain by valley fill deposit of 4-8 m thickness. A subsurface dam consists of an impervious wall with a jack well built of impervious material like clay, bricks and concrete. Tar felt, resin, polythene sheets and bitumen are also used. The structure usually extends to a depth of 1 m below the land surface.

Groundwater dams were constructed in ancient time also. There are examples of such structures from Islands of Sardinia in Roman times and from Tunisia. In recent years, this method of water conservation has gained popularity in India, southern and eastern Africa, Brazil and Japan. In India such dams were constructed in the southern state of Kerala where water is used for irrigating paddy. The benefit-cost ratio of one such dam was estimated to be 1.06 (Sinha & Sharma, 1990).

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