

Integrated Water Resources Management for Conserving Holy Pushkar Lake, Ajmer District, Rajasthan, India

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ABSTRACT

The whole gamut of conservation of lakes is to be understood holistically on scientific basis integrating surface water-groundwater resource management. The Nag & Savitri Pahari landscape in Pushkar valley is drained by Ghori Nadi, Savitri and Gomukh nallah. Lake is having dimensions of 1,11,500 m² and depth of 6.70 m (storage capacity 0.75 mcm). Semi arid to arid climatic area receives average annual rainfall of 445 mm. Delhi Super Group of rocks consists of quartzite and schist intruded by Post Delhi rocks. Quaternary formation comprises of fluvial, aeolian and lacustrine deposits. Annual groundwater recharge in Pisangan block (as on 31.03.2004) is 54mcm and gross draft is 96.64mcm (stage of development 178%). Decline in groundwater level from 4m in 1966 to over 25m indicate that earlier groundwater was catering water to the lake, while it is getting dried up now due to reversal of hydraulic gradient i.e. from lake (surface water) to groundwater owing to their rapid decline in the surrounding areas. Central Ground Water Authority constituted under Environment (Protection) Act, 1986 has declared Pushkar valley as "Notified Area" for regulating groundwater abstraction by construction of any new wells/tube wells. However, enforcement of regulatory measures is a difficult management option. Gravity of seriousness therefore calls for implementing alternate remedial measures including large scale artificial recharge to groundwater to bring back it up for ensuring its perennial flow in to the lake as was naturally happening earlier. Need of the hour is to introduce Public-Private-Community Participation for managing water resources in a sustainable manner. Government's policy planning is to be seriously reviewed to develop integrated approach of surface water-ground water management to save holy Pushkar lake.

INTRODUCTION

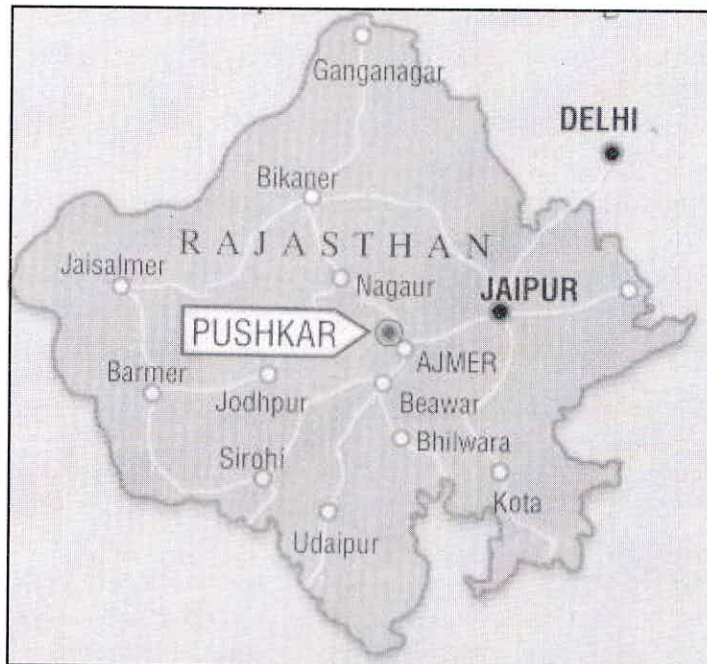
Freshwater lakes of semi-arid regions in the vicinity of Aravalli hills and saline lakes in arid zones of Rajasthan are having diversified genesis, issues and management strategies thereof. Pushkar is well known for lake of Tirth Raj Status, having only Brahma Mindir, place of tourist attraction for International & National tourists and also for a big cattle fair. The freshwater Pushkar lake is getting dried up due to reversal of hydraulic gradient from centripetal to centrifugal (from lake to groundwater) owing to rapid decline in groundwater levels in the surrounding areas of the lake due to its over exploitation for irrigation; in addition to construction of enroute embankments & tendency of local people

for encroachment in the catchment's area. Keeping in view the situation of ground water over exploitation, Central Ground Water Authority constituted under Environment (Protection) Act, 1986 has declared Pushkar valley as "Notified Area" banning/regulating construction of any new well or tube well (CGWB, 2001). However, regulatory measures are difficult to enforce in Indian scenario. Therefore, there is need for implementing urgent alternative effective solutions of the problem including large scale artificial recharge to groundwater for bringing groundwater levels up and thereby ensuring its perennial flow in to the Pushkar lake as was naturally happening earlier.

GENERAL INFORMATION

LOCATION

Pushkar, the "Pilgrim City" is located about 11 kms from Ajmer in Rajasthan State, India. The town is surrounded by hills from three sides with temples of Savitri and Papmochni Mata at their summits. The Nag Pahar on the south forms a pictorial back drop view of the Sarovar. The main town is situated around the beautiful Pushkar Sarovar. Besides the pavitra Sarovar, the Pushkar town has number of famous temples and ashram. It is believed that a bath in the Sarovar provides "Moksha". The drainage area of the Pushkar valley is about 21.66 sq. km occupying about 1.74% part of Pisangan block of district Ajmer. Population of Pushkar town is about 15,000 persons.



Location of Pushkar lake

GEOMORPHOLOGY AND DRAINAGE SYSTEM

Landscapes of hills & valleys in the area have been formed due to differential erosion of isoclinal folds and steeply dipping rocks of Delhi Super Group (Karanth, 1965). The denudation landforms of valleys were formed by erosion of less resistant schistose rocks while the resistant quartzite left out as hills rising to height of about 720 metres above mean sea level (msl). The important hills are Nag Pahari and Savitri Pahari. The elevation of plain surface is about 465m amsl. Sand dunes cover a large part of the valley. Ghori Nadi, Savitri and Gomukh nallah drain the area. However, natural drainage has been obstructed by aeolian activities i.e. accumulation of shifting sands in its course and also has been disturbed because of agricultural activities and encroachments in the catchment's areas.

SURFACE LAKE WATER

Area of Pushkar lake is about 1,11,500 sq.m having average of 6.70 m. Storage capacity of the lake with full reservoir level is thus 0.75 million cubic metres (mcm). The Sarowar is fed by surface run-off from various drainages of this valley. Sarowar water is fresh and potable so far as chemical constituents are concerned. However, it is quite dirty because of human activities. During rainy season Pushkar Sarovar is being fed by three streamlets having approximate catchments areas as follows (CGWB, 2001):

Table 1 : Catchment Area of Streamlets for Pushkar Sarovar

S. No.	Name of streamlet	Length (km.)	Catchment area (km ²)
1	Savitri feeder	2.7	3.0
2	Nag Pahar feeder	6.9	7.3
3	Pushkar feeder	7.8	11.5
	Total	17.4	21.8

HYDROMETEOROLOGY

The area witness semi-arid to arid type of climatic conditions. It is extremely cold during winter and hot during summer. The average annual rainfall in the area is 445 mm with standard deviation as 226 mm. The normal annual rainfall (1901-70) is 409 mm with average 20 rainy days.

HYDROGEOLOGY

In the Pushkar valley area, Delhi Super Group of rocks (Ajabgarh Group) consisting of quartzite, calc silicate rocks and mica schist are intruded by Post Delhi Intrusive namely Phulad Ophiolite Suite and Sendra Ambaji Granite (CGWB, 1996). Quaternary formation

occupying the valley portion comprises of fluvial, aeolian and lacustrine deposits. The alluvium is composed of gravel, pebble, coarse sand and clay. The lacustrine deposits consisting of silt, sand and mud are found in Pushkar lake. The aeolian sand generally overlies fluvial deposits and comprises of sand having light yellow brown to reddish brown colour. Quaternary sediments in the area vary in thickness from 38 to 52m.

Table 2 : Hydrogeology of the study area

Super Group	Group	Lithology
Quaternary		Alluvium, aeolian sand
Post Delhi intrusives	Sandra Ambaji granite	Granite, granite & gneiss
	Phulad ophiolite suite	Ultramafic rocks
Delhi Super Group	Ajabgarh Group	Quartzite with mica schist Calc-silicate rock Amphibolites

Ground water in the Pushkar valley area occurs in alluvium as well as underlying hard rocks with saturated thickness varying from 18 to 30m owing to undulating topography. Yield of tube wells vary from 10m³/hr. to 25 m³/hr. There is significant long-term decline in water level of the tune of 0.60 m/year. Ground water movement is westerly i.e. towards Saraswati river. Ground water is potable & fresh and all the chemical constituents are within permissible limits. Ground water estimates of Pisangan block (as on 31.03.2004) infer recharge of the tune of 54mcm and gross draft of 96.64mcm with the level of ground water development as 178% (CGWB, 2005). Over exploitation of the resources has caused decline in groundwater level in the valley from 4m in 1966 to over 25m, which suggests that earlier the ground water was catering water in to the Pushkar lake. Thus, declining water level has resulted in reversal of water flow i.e. presently the lake is not fed by the groundwater but seepages from lake contribute to ground water resources.

PRESENT WATER SUPPLY SCHEMES (CGWB, 2001)

Groundwater is being exploited in the valley from Pushkar town for water supply and partly for augmentation of lake water. Earlier groundwater was exploited from Leela Sewri (2.5 kms east of Pushkar) for water supply to Ajmer, Ganera (2 kms west of Pushkar) for water supply to Ajmer and Budha Pushkar (4 kms northeast of Pushkar) for water supply to Ajmer Railways (4500 m³/day). In addition to these, there are more than 500 dug cum bore wells constructed in the area by private owners for irrigation purposes. About 1260 m³/day of water is utilized for city water supply to Pushkar, about 900 m³/day for augmentation of water in lake. Thus, excess exploitation of groundwater in the valley is not only for catering domestic water supply to Pushkar town and augmenting water in

the lake but also a significant volume is abstracted since long for water supply to Ajmer city in addition to heavy withdrawal by private structures for irrigation purposes, the combined impact of which is resulting in rapid decline in groundwater levels and water availability in Pushkar lake. It has been reported that ground water exploitation for domestic water supply to Ajmer has been discontinued owing to availability of Bisalpur dam water in the recent past.

ISSUES OF CONCERN

Pushkar is a holy Lake and place of only Brahma Mandir in the World. The place is on the global tourist map. Conservation of such a holy place and tourist interest is responsibility and duty of water resource professionals. Natural feeder drainage systems of Pushkar lake have been disturbed due to natural as well as anthropogenic activities including accumulation of shifting sands, agricultural activities, construction of surface rainwater harvesting structures; cumulative impact of which has reduced run off water in to the lake. Indiscriminate groundwater exploitation has caused decline in groundwater levels and as such subsurface water is no longer feeding the lake. All these factors put together have caused depletion of water in this prestigious lake. Isolated efforts have been made to conserve it keeping in view construction of surface water harvesting structures without giving attention to groundwater regime behaviour. Surface water & groundwater are two sides of a coin. Human intervention to natural process i.e. over exploitation of groundwater has inversed flow direction of water i.e. from lake to adjoining areas making the lake dry.

MANAGEMENT STRATEGIES- REMEDIAL MEASURES

There is solution for every problem. Problems in Pushkar Sarovar are associated with water scarcity and availability of which depends on rainwater run off from surface drainage as well as groundwater inflow. Management options should therefore essentially include removal of all sorts of obstructions in feeding channels/streams and augmentation of groundwater resources for rise in water levels in the valley. The main remedial measures may include:

- Sand migration especially through wind gaps in Aravalli hill range is a phenomenon witnessed in arid zones of Rajasthan. Shifting sand in the Nalla courses feeding Pushkar lake is to be checked by intensive afforestation as well as effective check over cropping in the catchment areas.
- Impact of all surface water embankments like anicuts/gabian structures needs to get studied & analyzed. These may be preferably converted in to groundwater recharge structures by constructing injection wells.
- Cropping may be a need for agriculture products and livelihood in any area. However, cropping in feeding channels should be discouraged/ banned. This not only consumes rainwater but also create, hindrance in water flow in to the lake. Utilization of groundwater for agriculture purposes should also be restricted

in the Pushkar valley and its adjoining areas, may be made mandatory in order to save sizeable volume of water. This will bring groundwater levels up and thereby flow towards Pushkar tank in due course of time.

- Effective & Efficient enforcement of suggested management strategies in the area notified by Central Ground Water Authority under Environment Protection Act, 1986, Section 3(3) for control and regulation of groundwater resource development including registration of drilling agencies, existing ground water abstraction structures, seeking prior permission for further construction of ground water abstraction structures etc.
- Evaporation losses are high in the arid State of Rajasthan. High evaporation losses may be tried to get reduced by chemical treatment in the Pushkar lake as well with the precautions of harm to the biodiversity.
- Intensive Awareness Programmes need to be arranged for educating the local people at grass root level for judicious use of surface & groundwater assets for domestic as well as irrigation purposes for enhancing over all availability of water resources in the valley area.
- The most effective tool appears to be large scale recharge to groundwater in the area. This will ensure raise in groundwater levels and thereby its flow in to the Holy Sarovar. The suitable techniques of artificial recharge may include roof top rainwater harvesting, gabian structures with injection wells etc. Construction of subsurface barrier at the out flow location of lake may be studied & implemented.

CONCLUSION

Pushkar is a holy Lake and place of only Brahma Mandir in the World. Lacs of religious persons & tourist visit the lake but get disappointed after looking at smaller water body and also avoid to even touch lake water because of its dirtiness. Despite several efforts since long, input of water in to the Pushkar Lake is diminishing and being contaminated. Water is being pumped from tube wells for artificially filling the lake disheartening the pilgrims. Efforts till date is partially success due to enforcement of surface water oriented solutions forgetting its integration with declining ground water level scenario (in and around lake area) which is indeed root cause of the problem. Thus, isolated efforts so far made to conserve the lake included construction of surface water harvesting structures alone without giving due attention to ground water regime. Surface water and groundwater are two sides of coin. In contrast to earlier days, over exploitation of ground water has inversed flow direction of water i.e. from lake to adjoining agriculture areas making the lake dry. Human intervention to natural process is having severe consequences.

Solution of issue needs to be re-looked and re-examined keeping in view groundwater system behaviour in the region. Enforcement of regulatory measures is a difficult task before administration and water managers. Rainwater harvesting for large

scale artificial recharge to ground water has not so far tried which indeed is dire need and solution to the most of water related problems in the area. The whole gamut of situation is to be understood holistically on scientific basis integrating surface water-groundwater resource management. Inferences of scientific studies suggest need for paradigm shift in Government's policy planning so as to save wetlands especially fresh water holy lakes like Pushkar on priority basis.

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