Trans-Boundary Aquifers in the State of Punjab, India

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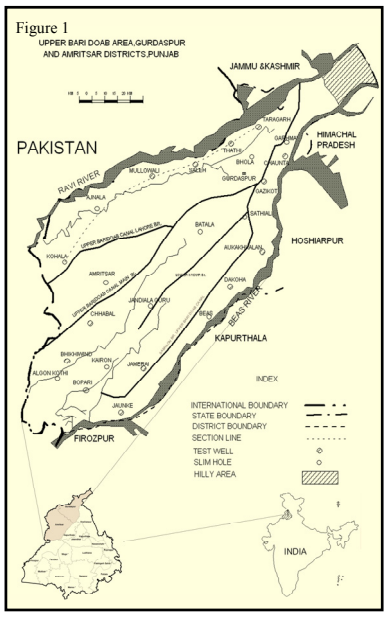
ABSTRACT

With growth of civilizations the insatiable demand for water resources has increased manifold. This huge stress on water resources due to increasing demands and declining water levels, growing vulnerability from floods and droughts, and eco-hydrological problems confront water resources management with challenges that need comprehensive strategies for providing water of adequate quantity and protecting mankind from adverse impacts. Sustainable solutions for trans-boundary water aquifer systems are therefore of high priority since nature does not draw its boundaries to coincide with the political boundaries. Punjab state is one of the most prosperous states of India with an agricultural based economy. The total water requirement of the state is 61.675 billion cubic meter (BCM). Against this, the water availability is only 17.54 BCM of surface water and 23.78 BCM of replenishable ground water resources. Punjab has a very long international boundary and the ground water aquifers are contiguous across the border too. Whereas the majority of the recharge areas lie in the hills of J&K and Punjab, the discharge areas extend to Pakistan too. It is thus felt that now is the time to study the trans-boundary aquifers of Punjab state in totality and on the basis of proper assessment of ground water contained down to a certain depth (say 1000 meters), decide the allocation of ground water usage by the neighbouring countries. The present paper outlines the above along with the hydrogeological set up of Punjab state with special emphasis on Upper Bari Doab area covering the districts of Amritsar, Gurdaspur and Taran Taran. Towards the end of the paper, a case study of trans-boundary aquifers across two states, Haryana and Uttar Pradesh, within India has also been detailed. The main aim of this was to study the effect of pumping of ground water through augmentation tubewells in Haryana on the Yamuna river flows and ground water resources of adjoining state of Uttar Pradesh. Similar situation may be present across global trans-boundary aquifers also. This study is a case in point to prove that study of trans-boundary aquifers is the need of the day.

Key words: *Eco-hydrological, Punjab, Haryana, Replenishable, Yamuna river flows*

1. INTRODUCTION

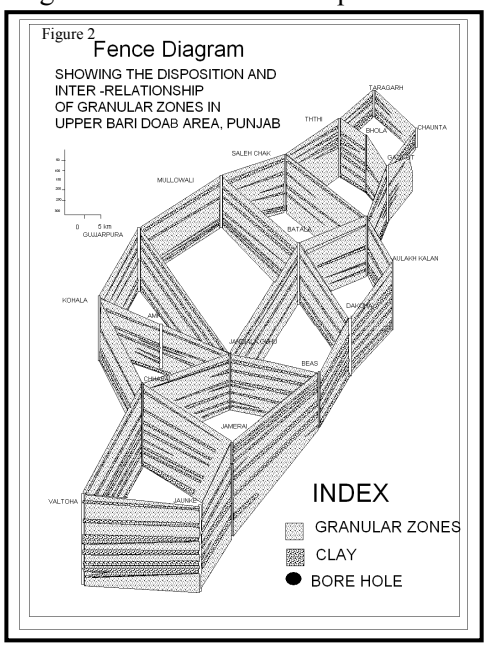
Ground water is a fugitive resource. Countries may legislate for water as a national asset, but the resource itself crosses political boundaries without a passport in the form of rivers, lakes and aquifers. Trans-boundary waters extend hydrological interdependence across national frontiers, linking users in different countries within a shared system. Managing that interdependence is one of the great human development challenges facing the international community.

Figure 1


The key features of trans-boundary aquifers include a natural subsurface path of ground water flow, intersected by a national or international boundary, such that water transfers from one side of the boundary to the other. In many cases, the aquifer might receive the majority of its recharge on one side, and the majority of discharge would occur in another side. In Punjab state of India, a majority of the area is irrigated by groundwater. The tubewells in the state have grown from 26 thousand in the year 1965-66 to 1.23 million in the year 2006-07 and the ground water withdrawal is

now 31.16 billion cubic meter (BCM) against total replenishable ground water resources of 23.78 BCM .

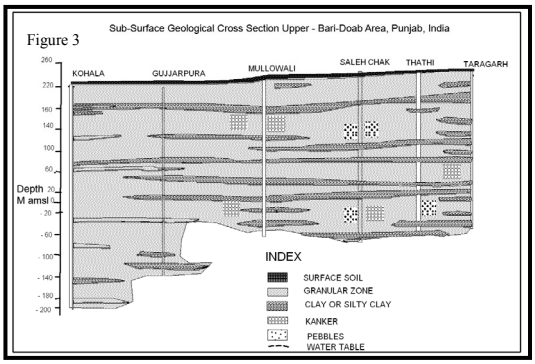
Punjab state is a vast tract of alluvial plain formed by mighty rivers, the Ravi, the Beas and the Satluj. The area discussed in this paper is locally called as "Upper Bari Doab" which is basically an inter-fluve area between the Beas and Ravi (Fig. 1). This area is underlain by aquifers that are laterally and vertically extensive containing good quality ground water. A lithological section drawn in a north-east: south-west direction parallel to the left bank of Ravi river, reveals the presence of 5 to 6 thick permeable granular zones down to a depth of 300-420 m below ground level. The first aquifer which forms the water table aquifer occurs up to 40-50m bgl and consists of sand with minor amount of gravel and *kankar*. The second and third aquifers consist mostly of sand, gravel and pebbles (Fig. 2 & 3).



A study of the disposition of the water table elevation of the phreatic aquifer reveals the existence of a water divide running in Northeast – Southwest direction. Whereas water table contours are closely spaced in the extreme North eastern part indicating that ground water movement is fast, in other parts these are widely spaced which show that ground water movement is slow. Both the rivers i.e. Ravi and Beas are effluent in nature. Ground water, in general, follows the surface topography and is flowing towards west and south-west towards the Ravi that forms the border with Pakistan. The major withdrawal of ground water in this area is through the phreatic aquifer that is being recharged locally through rainfall and other sources like canal seepage, return flow from applied irrigation etc. The 2nd and 3rd aquifers have by and large not been tapped so far and their recharge area lies in the Shivaliks in the north and north-east apart from localized vertical leakage from overlying aquifers.

2. DISCUSSIONS

In the context of Punjab state, sharing its international boundary with Pakistan falling in the Indus basin, it is important that the disposition and design of the trans-boundary aquifers be studied in detail so as to assess the quantities of water that are flowing across the border. Based on the available data discussed in the preceding paragraphs, it is opined that the slope of the water table is towards west and south-west, which follows land surface slopes. Thus apart from any natural flows that regularly take place due to the difference in the head, any pumping activity that is taking place in downstream direction may impact the upstream aquifers. The need is to assess and quantify the flows as well as study the chemical quality of the water flowing across. It is also important to assess the long-term behaviour of these flows in case of increased pumping due to water shortages all over the region.

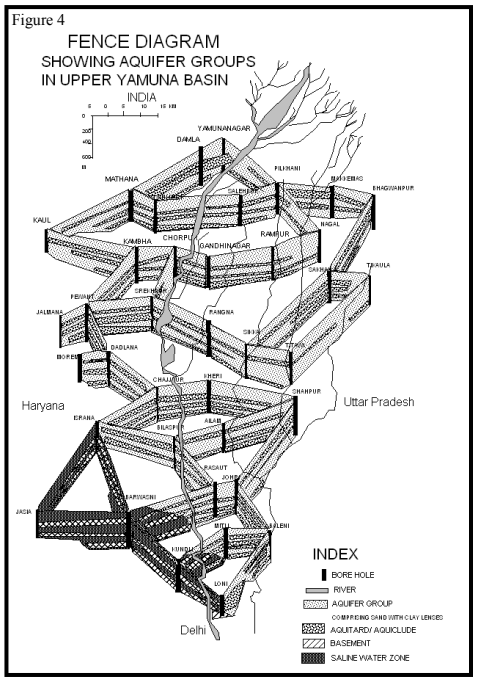


Central Ground Water Board has taken up study of trans-boundary aquifers within India where aquifers across the states of Haryana and Uttar Pradesh were studied during Upper Yamuna Project in the 1980s. A composite fence diagram (Fig. 4) across the state boundaries had also been prepared. The main aim of the project was to study the effect that pumping of ground water through augmentation tubewells located near the river Yamuna in Haryana might be having on the Yamuna river flows and

ground water resources of Uttar Pradesh. The project used a multidisciplinary approach and was successful in predicting that:

- Ground water draft through augmentation tubewells have local effects in declining the water table but it appears that the ground water gets recouped by ground water flow to a major extent. Present quantum of ground water draft is having little injurious effect on the unconfined aquifer.
- Further augmentation draft may be permitted in the area without affecting the river regeneration but that draft must be from deeper aquifers. The allocation of the augmentation draft must be further down the present augmentation canal project. Such a scheme, however, may create local depressions.
- Continuance of the augmentation draft in future may generate decline in water table adjacent to river in U.P. area as well without appreciably declining river regeneration.
- Any large-scale ground water development upstream of the present location of augmentation canal project may affect the river regeneration.

Figure 4



From the experience gained in the above case it can be surmised that technique, methodology and experience is already available to study the trans-boundary aquifers, whether national or international. It is anticipated that similar conditions do exist in the trans-boundary aquifers lying across various countries including India and Pakistan. It is recommended that such studies on trans-boundary aquifers be taken up across the borders where the aquifers are likely to be in continuity so as to obtain a holistic view of the ground water regime in the area. This will go a long way in planning and management of the ground water resources of countries that have common borders especially in view of the predictions that water resources are likely to become scarce with the impending climate change.

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