

THESIS

**QUANTIFICATION OF INTRACTION BETWEEN RIVER RAVI
AND THE LAHORE AQUIFER**



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ABSTRACT

Water is the pre-requisite for life and development. This is the reason that from early age of civilization, most of the population initially settled along the rivers and streams but always with the fear of high floods in river and quantum movement of water interchange from the river to the adjoining aquifer resulting high water table conditions. Every use of water by the population generates waste water. Natural streams are always considered as an easy way to dispose-off many kinds of waste water effluent. Sewage water is discharged into the river at some places. If there is high flow conditions in river, these effluents of waste water are diluted and river remains as a fresh water body. However if there be the low flow conditions in river then river becomes as a waste water channel without any chance of waste water dilution. Thus, it's very important to determine the quality and quantity interchanging from river to adjoining flow domain.

The pollution of river Ravi from disposal of sewerage waste effluent is significantly affecting the hydrodynamics and quality of Lahore aquifer. This is very serious situation for those households located adjacent to Ravi River and which pump out ground water for daily consumption. This research was undertaken to quantify the interaction of Ravi River to the Lahore aquifer. It is desirable and more meaningful to stop the Lahore aquifer deterioration from drinking as well as irrigation point of view.

This study was conducted near River Ravi at Lahore. The site is situated close to the new Shahdara Bridge and is downstream of Shad-bagh waste disposal. Flow was evaluated at two transacts line-A and line-B spaced 1000 m apart. Ground elevation was determined along the transact lines by elevations survey. Eleven piezometers were

installed along the transact lines (6 along Line-A and 5 along Line-B). A staff gauge was erected near to B-05 in the river to measure river stage and water levels. Hydraulic conductivity was measured at piezometers by augur hole method.

Data was collected periodically in terms of river water level, ground water level at all 11 piezometers and water quality (i.e. EC) of river water and ground water of all piezometres. The study and field data collection continued for 206 days (14th November, 2007 to 08th June, 2008). Data was collected on daily basis for 60 days and on thrice a weak for next 60 days and on once a week for rest of 86 days.

To see the phreatic surface profile from river to the aquifer, river stage data and hydraulic-heads in all piezometers were drawn spatially and temporarily. The plume of electrical conductivity, traversing from river to the flow domain was also studied both spatially and temporarily. MOD-FLOW, ground water model was developed for the selected flow domain of 1000×1000 m where each cell of model contained 10×10 m area. Model parameters like initial hydraulic heads, bore hole and observations, field measurements of hydraulic conductivities, storage coefficient and effective porosities were assigned initially and adjusted during model calibration. Model was simulated for one year and final accepted results were obtained. Using the water balance of simulated model, the quantum movement of flow and salts interchanging from river to the aquifer was quantified.

The phreatic surface profile for River Ravi is towards Lahore city area. It represents that River Ravi behaved as infiltrating stream throughout the year. The EC of the river varies from $300 \mu\text{s/cm}$ to $500 \mu\text{s/cm}$ while EC of the monitoring wells fluctuates between $900 \mu\text{s/cm}$ to $1200 \mu\text{s/cm}$ during the low flow season. The EC data of monitoring

wells do not follow any expected pattern. The plume's movement into neighboring aquifer could not be traced in both high and low flow seasons due to vast fluctuations in water quality of monitoring wells. Quantity of water interchanged from River Ravi to adjoining aquifer is $0.041 \text{ m}^3/\text{sec}/\text{km}$ river length which equals $1.845 \text{ m}^3/\text{sec}$ for 45 km length of River Ravi facing Lahore. The annual quantity of salt load interchanged from River Ravi to Lahore aquifer is $2.37 \text{ kg}/\text{sec}/\text{km}$ for upper 20 km length which equals 1.5 Million Tons/year /Lahore aquifer. The total salt load inflow to Lahore aquifer is estimated as 5.2 MillionTons/ year.

High salt contents of River Ravi are causing deterioration of upper zone of Lahore aquifer. It is recommended that there should be a lined disposal channel at river edge to carry the city waste disposal effluent from all disposal stations and discharge into river downstream of southern end of city beyond Thokar Niaz Baig. Thus the disposal water will not get mixed with river water especially in low flow days. It will be more meaningful to stop the Lahore aquifer deterioration. It is recommended to elaborate this study for a longer time period (2-3 years) and for full river reaches to account for complete low as well as high flow seasons. Complete survey of quality interchanging for river to Lahore aquifer should also be conducted. It is also recommended to elaborate monitoring well EC variations in contrast to river water EC at the study site.