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# ISOTOPIC TECHNIQUES TO IDENTIFY THE RECHARGE MECHANISM AND SALINIZATION OF GROUNDWATER IN AN INTERFLUVIAL AREA OF INDUS BASIN, PAKISTAN.

**M. Azam Tasneem, M. Ishaq Sajjad, S.D.Hussain, Iqbal H. Khan, M. Ahmad and M.S.Zafar***
**Pakistan Institute of Nuclear Science and Technology, P.O. Nilore, Islamabad, Pakistan**
***Department of Physics, University of the Punjab, Lahore, Pakistan**

The study area, Rechna Doab, an important part of Indus Basin, comprising of about 28,500 sq. Km is enclosed by the river Chenab on the north-west and river Ravi on the south-east with the piedmonts near the Jammu and Kashmir boundary in the north-east. Rechna Doab is about 403 km long in a southwest direction and has a maximum width of about 113 km. The area is interfluvial and is southwesterly sloped. Controlled irrigation system was started in the area with the construction of four Head Works on the river Chenab. All the canals flowing through the study area have been taken out from the river Chenab. Four link canals are also flowing through the area. The area is badly hit by water logging and salinity. Isotopic techniques were applied to understand the recharge mechanism and to determine the source of groundwater salinity in the area. Groundwater samples were collected from 150 locations including hand pumps and tube wells on quarterly basis. Water samples from rivers/canals were collected on weekly basis. Location of sampling points is given in figure-1. Isotopic analyses for $^{18}O$, $^{2}H$, $^{3}H$ and chemical analyses were carried out in the laboratory while the electrical conductivity, pH and temperature were measured in the field. There are three possible input sources to the groundwater in the area. i) rivers, canals and their distributries; ii) rain and iii) irrigation water from canal system and tube wells.

The river Chenab at Marla H/works, has weighted averages of $\delta^{18}O$, $\delta D$ and deuterium excess 'd' as -10.04‰, -61.0‰ and 19‰ respectively with $^{3}H$ value of 30 TU. At Trimmu H/works, the weighted averages of $\delta^{18}O$, $\delta D$ and 'd' are -9.36‰, -59.4‰ and 15.5‰ respectively. The river Jhelum with the weighted averages of $\delta^{18}O$, $\delta D$ and 'd' as -7.95‰, -49.0‰ and 15‰ respectively contributions river Chenab at Khanki (downstream of Marala). The river Ravi was sampled at Balloki H/works and has weighted isotopic values of $\delta^{18}O$, $\delta D$ and 'd' as -8.30‰, -52.4‰ and 14‰ respectively.

Isotopic index of Upper Chenab Canal (UCC) is -9.63‰ and -62.8‰ for $\delta^{18}O$ and $\delta D$ respectively. Lower Chenab Canal (LCC) has four main branches e.g. Jhang Branch, Rakh branch and upper and lower Gugera branches. These irrigate about 2/3 area of the Doab starting from right of Qadirabad - Balloki link up to Trimmu-Sidhnai link canal. The canals flowing through out the year have similar isotopic variations. The range of $\delta^{18}O$ values is -11‰ to -5‰ with mean value of -8.6‰. The range of $\delta D$ variations is -79.8‰ to -21.3‰ with a mean value of -53.5‰. The isotopic index ($\delta^{18}O$) of rainfall at the piedmont area near Jammu and Kashmir boundary in the north-east of study area is estimated as -6.8‰ with d-excess of 9.3‰. The isotopic index ($\delta^{18}O$) of local rain is estimated as -5.3‰ with d-excess of 8.5‰.

$\delta^{18}O$-vs-$\delta D$ diagram of surface water/groundwater is given in figure-2 while spatial distribution of $\delta^{18}O$ of shallow and deep groundwater is given in figures-3. In general, the most heavier $\delta^{18}O$ values are found in the north-east of the study area, and become gradually more and more depleted towards the confluence area (south-west) with the most depleted (-10‰) just upstream of Trimmu H/works where the river Jhelum (with relatively higher $\delta^{18}O$ index) joins the river Chenab. Similarly, most depleted values of $\delta^{18}O$ are found along the length of river Chenab and become more and more heavier toward the river Ravi. The area in the north-east, up to Qadirabad-Balloki link canal, have isotopic contents ($\delta^{18}O$) very similar to that of rainfall ($\delta^{18}O$=-6.8‰) over the piedmont area on the north-eastern boundary of the study area. Here infiltration takes place along the boundary of the study area in the piedmont region. The upper silty layers in most of the region restrict the surface infiltration. This is further manifested by the fact that three canals (BRBD, UCC and Qadirabad-Balloki Link Canal) with mean $\delta^{18}O$ of -9.63‰ are flowing through this area for more than couple of decades, but there seems no influence of this isotopically depleted water on the groundwater regime. However, there is an exception too. A small area bounded by dotted line (below Marala H/works ) which has two groups: first one with $\delta^{18}O$ in the range of -5.9‰ to -5.0‰ (fig. 3), seems to be recharged by local rains. This area has about 3 m thick layer of silt at the top below which there exist a sandy zone. The recharge may be taking place by infiltration through some sandy region extending up to the surface. The other group (three wells) have $\delta^{18}O$ in the range of -8.4‰ to -7‰ showing mixing of canal water. The area near Trimmu H/works bounded by river Chenab and a dotted line has most depleted $\delta^{18}O$ values and is solely recharged by the river Chenab. The isotopic data in the rest of the study area show that the groundwater is a mixture of different input sources. However, the major contribution comes from the canal system. There is a wide range of variations in the stable isotopes of input sources. However, with some exception, no such variations have been observed in the groundwater indicating slow movement of groundwater in the area. The groundwater has tritium contents in the range of 0 to 57 TU. Tritium data also suggest (with the exception in certain areas), that groundwater movement is slow. The groundwater has generally low salt content along the rivers and canals and salinity increases towards the centre of the Doab. The stable isotopic composition is not changed with the increase in salinity of groundwater which suggests that the dissolution of salts from the sediments seems to be the dominant mechanism of groundwater salinization.

## REFERENCES

1. Ahmad, N., (1974). Groundwater Resources of Pakistan. Ripon printing press, Lahore.
2. Hussain, S.D., Sajjad, M.I., Akram, W., Ahmad, M., Rafique, M. and Tariq, J.A.,(1990). Surface water/Groundwater Relationship in Chaj Doab., Report No. PINSTECH/RIAD-122.

3. Khan, M.A., (1978) Hydrogeological Data, Rechna Doab. vol. I, publication No. 25, Project Planning Organization (NZ), WAPDA, Lahore.
4. Sajjad, M. I., Hussain. S. D., Waheed, R., Seiler, K. P., Stichler, W. and Tasneem, M. A., (1985). Study of Downward Movement of Soil Moisture in Unsaturated Zone, IAEA-TECDOC-357, 89-119.
5. Sajjad, M.I., Hussain, S.D., Tasneem, M.A., Ahmad, M., Akram, W. and Khan, I.H (1993). Isotopic Evidence of Source of Groundwater Salinity in the Indus Basin, Pakistan., Science of the Total Environment, 129: 311-318. Elsevier Science, B.V., Amsterdam.

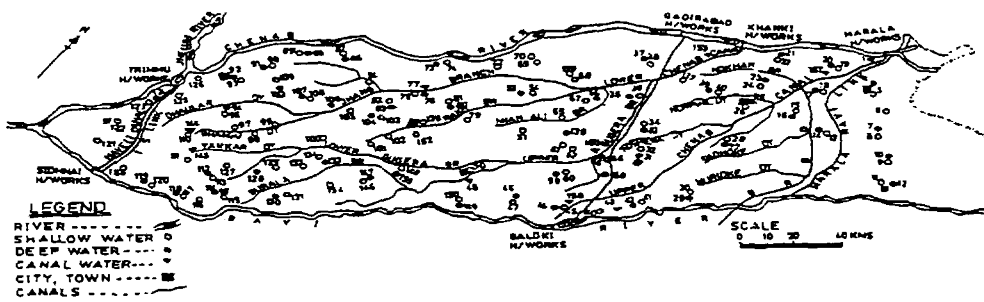


Figure-1. Location Map of Sampling stations in the project area.

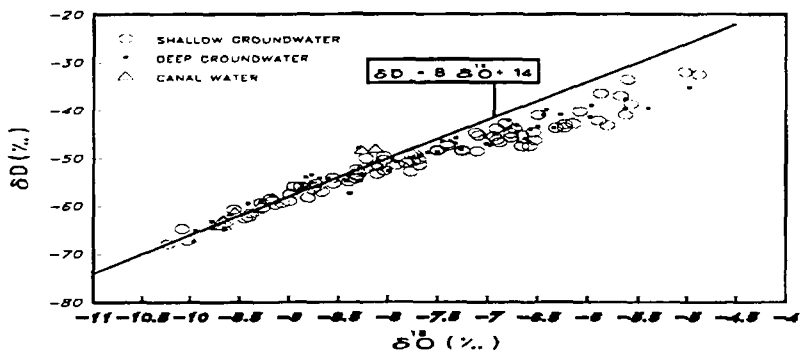


Figure- 2. $\delta^{18}O$ -vs- δD of Surface water/Groundwater in Rechna Doab (Mean Values)

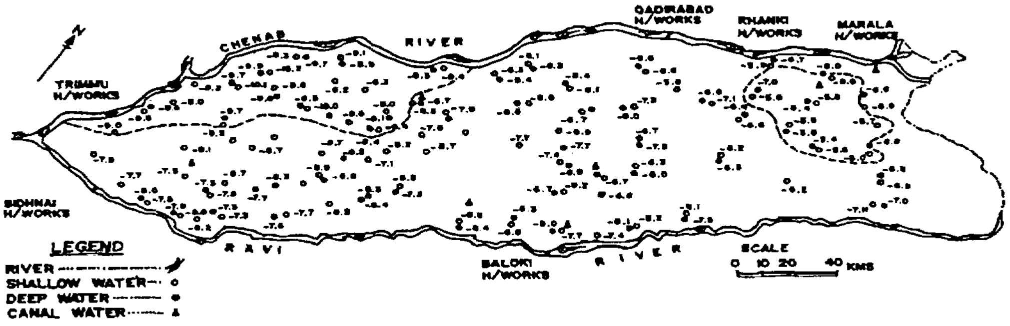


Figure-3. Spatial Distribution of $\delta^{18}O$ of Shallow and Deep Groundwater in Rechna Doab