



Isotopic characterisation of different sources in a river basin for its better management: a case study from India

B. Kumar(1), S. P. Rai(1), K.M. Kulkarni(2), P. Aggarwal(2), M. S. Rao(1), K.D. Sharma(1), Manfred Groening(2), T. Vitvar(2), and S. K. Verma(1)

(1) National Institute of Hydrology, Roorkee, India, (2) Isotope Hydrology Section, IAEA, Vienna, Austria (bk@nih.ernet.in / Fax: +91 1332-272123 / Phone: +91 1332-276414)

Introduction: India has a number of large rivers like Ganga, Godavari, Brahmaputra, Narmada and many others. The river Yamuna, a tributary of the River Ganga is infact also a large river of Northern India and drains a large area (366223 Km²). The River Yamuna rises at Yamunotri glacier in Tehri-Garhwal district of U.P. at an elevation of 6330 m (Lat. 31⁰N, Long. 78⁰E). The river forms the common boundary between Haryana and U. P. States for 320 Km, flows through the Union territory of Delhi for 40 km and the balance 970 km through the U. P. State and finally joins the River Ganga at its Right bank in Allahabad city. The Hindon river joins the Yamuna at its left bank at Dankaur. The Tons, the largest Himalayan tributary of the Yamuna joins it below Kalsi. The Giri, another mountainous tributary rises near Simla and joins the Yamuna near Paonta. During its course, some other tributaries also join at its left bank namely, Karon, Sanger and Rind rivers. The Chambal, Sindh, Betwa, Dhasan and Ken join the river at its right bank. All the right bank tributaries have their origin in the Vindhayas. Its total length from the source to its outfall into Ganga is 1376 km.

The Hindon river is an important tributary of river Yamuna. This river is sandwiched between two major rivers of Northern Fertile Plains of India, the Ganga on the left and the Yamuna on the right. It originates from upper Shiwaliks (Lower Himalayas). It lies between the latitude 28° 4' to 35° 5' N and longitude 77° 8' to 77 4'E. This river is purely rainfed. The Hindon river basin is a part of Indo-Gangetic plain. A total area of about 7083 sq. km constitutes the river basin. This river has a total run of about 400 km. The width of Hindon river ranges from a minimum of 20 m to a maximum of

about 160 m. The Chambal river is the most important tributary of the Yamuna river. It is 960 km long and rises at an elevation of 854 m in the Vindhyan range near Mhow in the Indore district of Madhya Pradesh. It flows through Madhya Pradesh, Rajasthan, and Uttar Pradesh, and it joins the Yamuna river near the city Etawah.

Core : The Yamuna river is perennial in nature as it receives all the three types of water inputs i. e., snowmelt runoff, rainfall runoff and groundwater. However, the three components vary in space and time. Therefore, the understanding of different components of water input to the River Yamuna may reveal its behavior at different locations that may be of great use to manage the groundwater as well as the river in a better way. Keeping this in view, a study of isotopic characterization of selected large Indian rivers has been initiated under a coordinated research project sponsored by the IAEA, Vienna.

Water samples are being collected once in a month since January 2004 from the Yamuna river at seven sites namely, Tajewala, Delhi (one before the city and other after the city), Agra, Etawah, Orayia and Allahabad. Water sampling is also being done from two tributaries i.e., Hindon and Chambal rivers before their confluence with the Yamuna River. The groundwater samples are also being collected from all the sites to understand the interaction of river at different locations. The water samples were analysed for oxygen-18, deuterium at the IAEA, Vienna, Austria while environmental tritium and physico-chemical parameters at the National Institute of Hydrology, Roorkee, India.

Conclusions: The river gets maximum contribution of snowmelt during the month of May and June. But the main source to this river is precipitation that it receives during the month of July to September. The stable isotopic analysis reveals that the Yamuna river has different isotopic characteristics than the Indian precipitation indicating the contribution of different sources. The depleted O-18 and D values than the precipitation indicates the snowmelt contribution in the river in the upper reaches. The change in isotopic contribution at different locations clearly indicates the contribution of groundwater as well as the effect of different tributaries that join it. The river has the different isotopic signatures than other Indian rivers like the Ganga etc and accordingly, the groundwater in the Yamuna river basin has different isotopic signatures. The variations of isotopic and chemical characteristics with distance and altitude have been studied and the contribution of relative water inputs at different locations have been estimated. It has been found that the isotopic signatures of groundwater and tributaries are almost similar to the river Yamuna at lower reaches confirming that the groundwater contribution is substantial from the river in the lower part of the basin.

The isotope data of groundwater reveals that the river influences groundwater regime

about 1 Km along the both sides in areas near Delhi city. But it has more influence in the trans Yamuna region. However, the contribution to groundwater increases with the distance and the tributaries also have pronounced effect on groundwater recharge. The details of various isotopic characteristics of the Yamuna river, groundwater, precipitation, snowmelt and surface water and groundwater interaction along with the relative contributions in the river basin are described in this paper.