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Study of Lake Nainital-Groundwater Interaction Using Isotope Techniques

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ABSTRACT

The lake -groundwater interaction study for Lake Nainital, Kumaun Himalaya has been carried out using isotope mass balance method in conjunction with conventional water balance method. Based on the hydrological investigations carried out a conceptual model for the water balance of lake Nainital has been developed. All the components of the lake water balance, except the sub-surface ones, have been measured / estimated using standard methods.

To assess the subsurface outflow from the lake by conventional method, the hydraulic interconnection of the lake and downstream springs were investigated using environmental tracers. Analyses of hydro-chemical data indicate that Lake Nainital and the few downstream springs viz. Sariyatal and Balia ravine springs are hydraulically interconnected and that the other downstream springs such as those located to the west of the lake catchment, and in Kailakhan area are not connected to the lake. In order to complement the information obtained through the hydrochemistry, stable isotopic investigations were carried out. During winter, when the lake is well mixed, the Balia Ravine Springs showed an $\delta^{18}O$ value (-9.5%0) close to that of the Lake (-9.6%0), while most of the other springs showed a more depleted value (<-9.6) conforming the results obtained from the hydro-chemical analyses.

In order to assess the proportion of the lake water being tapped in the wells located in the northern bank of the lake, a two-component mixing model was employed using the stable isotope data. The results of the model indicate that the proportion of the lake water in the pumpage varies from 33% to 100% in different seasons.

By combining the discharge data on the spring that are interconnected to the lake and the proportion of the lake water in the pumpage, the total sub-surface outflow from the lake has been (56% of the total outflow). The sub-surface inflow has been estimated as the residual of the water balance equation, as all other components have been computed/ estimated using standard methods. The sub-surface inflow computed by the water balance method is around 49% of the total inflow to the lake. The sub-surface and outflow computed using stable isotope mass balance method are about 51% and 56%,

respectively, while that computed using chlorine mass balance method are about 55% and 59%, respectively.

The results show that the estimates of sub-surface inflow to the lake and outflow from the lake obtained through the isotopic and chemical balance compare very well with those obtained through conventional water balance method. The water retention time (t) of the lake computed using isotopic mass balance approach is about 1.93 years. chemical (chlorine) mass balance is about 1.77 years and conventional water balance is about 1.92 years. The results obtained by all the three methods do not vary significantly from each other (compared to the size of the lake) and compare very well within the error limits. The water retention time computed using isotopic mass balance approach is about 2% lower and that computed using chlorine mass balance results is about 10% lower than the water retention time computed using conventional water balance results. The value that reflects the true water retention time may be the one computed using the isotopic mass balance approach as it was arrived independent of the estimates of pumpage and outflow through springs. Further, isotope mass balance has the advantage over the chlorine mass balance as chlorine may be introduced into the lake and groundwater systems through anthropological activity.