Report No. – CS/AR-6/98-99

Water balance of lake Nainital Kumaun Himalayas, U.P.

Bhishm Kumar

ABSTRACT

The water balance of lakes provide very useful information about the availability of water in lakes at any time. In order to utilize the lake water in a planned and systematic manner and to manage the required availability of water in the lake, the knowledge of different components of water balance of lake is essential. Nainital lake is the major water source, except for the water that is directly tapped from the springs, for drinking and domestic purposes to the people living in and around the lake basin. The lake is mainly fed by precipitation water during the rainy season and inflow from the number of perrennial springs such as Pardha Dhara and subsurface inflow. Unfortunately, the study of various parameters of water balance has not been carried out in detail in the past. The lack of knowledge on few input and output parameters such as subsurface inflow, use of lake water for domestic and industrial purposes. evaporation loss and leakage from lake including the outflow through sluices gates has created uncertainty in determining the availability of water in lake. Therefore, to understand the behaviour of different inputs and outputs, the water balance study of Lake Nainital has been carried out in detail by using both conventional and isotopic techniques. The methodology followed and results obtained are presented in this report.

The rainfall data collected from the three self recording raingauges installed under the project at ATI campus, Alma and Rattan cottage sites were used in addition to the PWD ordinary raingauge data by adopting Theissen Polygon Method to estimate the average areal rainfall in the lake basin. The direct precipitation over the lake surface accounts for about 16%of the total inflow to the lake during 1995. The volume of the lake has been computed using the bathymetric data obtained using sophisticated state-of-the-art equipments by Hashimi et al.(1993). The lake area in the shallower zones have been obtained from the PWD reports. The computed volume of the lake at its full level is 8.58 Mm3. Equations for estimating change in storage for different water levels in the shallower zones have been presented. Surface inflow to the lake has been estimated by two different techniques viz. the Lake Level Trend Analysis (LLTA) method and Soil Conservation Services - Curve Number (SCS-CN) method. The results from the two methods are comparable monsoon season. However, the inflow estimated by LLTA method is moderately higher than those estimated by SCS-CN

method. The difference can be attributed to the errors in arriving at true lake level trend values during monsoon as the trend is masked by the large subsurface inflow/outflow. The surface inflow to the lake as rainfall runoff accounts for about 30% of the total inflow to the lake. The inflow to the lake through the perennial drains that are sustained by spring discharges and domestic waste accounts for nearly 15%. The sub-surface inflow estimated as residual of the solved water balance equation is nearly 39% of the total inflow components.

The surface outflow from the lake has been computed using an empirical formula for submerged rectangular sluices. The surface outflow accounts for 41% of the total outflow from the lake during 1995. One of the outflow components of the lake viz. the pumping from the lake as well as from the open well and tube wells located a couple of meters from the lake shore, accounted for nearly 32 % of the total outflow. Stable isotope data were used to distinguish the differential contribution from the lake and groundwater to the water being pumped. It has been estimated that the percentage of lake water varies from 20% during summer season to 80% during monsoon season. The open surface evaporation from the lake has been estimated using the Modified-Penman equation. The evaporation accounts for nearly 12% of the total loss. The subsurface outflow has been estimated from the discharges interpolated from observed and historic discharges of the downstream springs located along the Balia ravine. The subsurface outflow as springs accounts for nearly 16% of the total outflow from the lake.

The water balance study indicates that the pumping pattern from the lake has a direct bearing on the water availability in the lake. This fact is clearly reflected in the relation between surface outflow and annual rainfall in the lake basin which shows a reduction in the annual surface outflow for a given amount of annual rainfall in the last 25 years. This reduction is mainly due to increased pumping. The reduction in the lake capacity due to sedimentation is very nominal. Further it has also been observed that the discharges of downstream springs located in the Balia ravine have declined drastically. The most probable reason for this reduction is the sedimentation that is taking place in the lake, because of which the subterranean pathways have been choked.