Chapter – 3

RESEARCH & DEVELOPMENT

During the year 2008-09, research and development activities at the Institute were carried out under the five divisions at headquarters at Roorkee and four regional centres at Belgaum (Karnataka), Jammu (J&K), Kakinada (Andhra Pradesh), Sagar (Madhya Pradesh) and two Centre for Flood Management Studies (CFMS) at Guwahati (Assam), & Patna (Bihar).

The program of studies and research for the year 2008-09 of the Institute was deliberated at length in the Working Group meetings and then approved by the Technical Advisory Committee. The work programs of regional centres and CFMS were deliberated in their respective Regional Coordination Committee meetings as well as at Headquarters. Brief description of some of the important studies carried out during the year 2008-09 is given below.

A. NIH INTERNAL FUNDED PROJECTS (COMPLETED)

1. Hydrological Studies for Restoration of the Renuka Lake, Dist. Sirmaur, HP

The Renuka lake is a very important religious and tourist place in Himachal Pradesh. The lake is an abandoned tract of the river Giri. Apart from regular tourists, the lake witnesses the presence of many thousands of devotees from the Himachal Pradesh and adjoining States during its annual fair. With the part of worship in ancient temples located on the bank of Renuka lake and Parashuram Tal, the devotees offer flour balls/pallets in the lake for fish feeding, which also causes water pollution in the lake besides other catchment induced factors. In this study, quarterly water quality monitoring was carried out for relevant physico-chemical (Temperature, pH, EC, TDS, DO, BOD, COD, Ca, Mg, Na, K, Alkalinity, HCO_3, Cl, SO_4, NO_3, PO_4, F, Hardness), bacteriological (faecal coliform, total coliform) and trace elements (Fe, Mn, Cu, Ni, Pb, Cd, Zn). The lake water quality was assessed based on spatio-temporal and depth wise monitoring of lake for physical, chemical and bacteriological analysis. Eutrophication status was carried out on the basis of Trophic State Indices (Carlson, 1977) for observed phosphate concentration data. The isotopic composition of the lake was also studied. The depth wise thermal behaviour of the lake is monitored using thermometer. The following equation was used to study the water balance of the Renuka lake:

$$\Delta L = (RO+RF+GWI)-(DR+EV+GWO)$$

The net groundwater contribution (GWI-GWO) was estimated on rearranging the above water balance equation (in depth units) as given by (LaBaugh, 1986):

$$GWI - GWO = \Delta L + EV + DR - RF - RO$$

Where, ΔL is change in lake level, RO is surface runoff from the lake catchment, RF is rainfall over lake, GWI is groundwater inflow, DR is withdrawal from lake (including pumping and other outflow), EV is evaporation loss, GWI is groundwater outflow from the lake. The water balance components (RF, EV, ΔL) of the Renuka lake were monitored on daily basis in the field. The daily evaporation of the lake water was estimated by multiplying US Class-A pan data with a pan coefficient of 0.7. The water balance components are given in Table 1. The monthly variation of change in storage (Δ S mcm) v/s rainfall (mm) is plotted in Fig. 1.

The Renuka lake water was classified as per CPCB classification based on Total Coliform (mean: 20 MPN/100 ml), pH (Mean: 6.8) DO (mean:7.7 mg/l), BOD (mean: 2.1), Electrical conductivity (mean: 607 μmhos/cm). The free ammonia-N has been reported from 0.035 to 0.082 mg/l during stagnant and 0.072 to 0.094 mg/l during lake overturn period (Singh, 1987). Accordingly, the Renuka lake water was classified under "B" Type of water (Outdoor bathing). The major recommendations are given as below:

- Based upon the above classification of water, the Renuka lake water could be best suitable for the uses viz., (a) Outdoor bathing (organized), (b) Drinking water source with conventional treatment, (c) Propagation of wildlife and fisheries, (d) Irrigation, industrial cooling and controlled disposal.
- The eutrophication status and its trend was studied based on Carlson Trophic State Index. The study has shown a declining trend of eutrophication level (hyper eutrophic to eutrophic), mainly due to restoration measures and mass awareness initiated by the H.P. Government in the lake/catchment.
- The thermal behavior of the lake has shown that the lake remains stratified during summer and mixed during winter. The minimum DO in the order of 2.0 mg/l was observed during winter in bottom of the lake, is indicating anoxius condition. Appropriate measures are required to increase the DO during winter months to preserve healthy ecosystem of the lake.
- The water balance of the Renuka lake has shown that lake receives a major component of input water through Runoff (RO: 61.1%) from the catchment. The groundwater contribution (GWI-GWO: 29.2%) was the second highest component followed by direct precipitation falling over lake (RF: 10.7%).
- The lake catchment should be periodically treated to maintain the proper vegetation so that delayed sub-surface runoff contribution could be increased in the lake.

- Various anthropogenic activities in the lake/catchment (viz., grazing, felling of trees, fish feeding, dumping of wastes including residue of flesh feeding to zoo animals, fertilizer application, etc.) should be restricted. Mass awareness programs are also required to educate the local people/pilgrims for conservation of the lake.
- Integrated approach is required to apply in the catchment as well in the lake for controlling eutrophication of the lake.

Table 1: Water balance components of Renuka lake (H.P.)

Month	RF	RF	RO	EV	Δ S	DR	GWI-GWO
	mm	mcm	mcm	mcm	mcm	mcm	mcm
April	20	0.004	0.0006	0.023	-0.01	0	0.0092
May	2	0	0	0.029	-0.011	0	0.0178
Jun	122	0.022	0.1066	0.025	0.0216	0.094	0.0126
Jul	241	0.043	0.3203	0.023	0.0524	0.291	0.0036
Aug	390	0.069	0.4488	0.023	0.086	0.53	0.1211
Sep	102	0.018	0.0737	0.015	0.0154	0.196	0.1343
Oct	20	0.004	0.0006	0.013	-0.016	0.149	0.142
Nov	0	0	0	0.01	-0.016	0.027	0.0209
Dec	14	0.002	0.0028	0.005	-0.005	0	-0.0051
Jan., 08	26	0.005	0.00001	0.005	-0.002	0	-0.001
Feb	26	0.005	0.00001	0.006	-0.001	0	0.0004
March	0	0	0	0.01	-0.015	0	-0.0055
Total	963	0.17	0.9534	0.189	0.0993	1.286	0.450
% Contribution		10.7	60.1	12.7		86.5	29.2

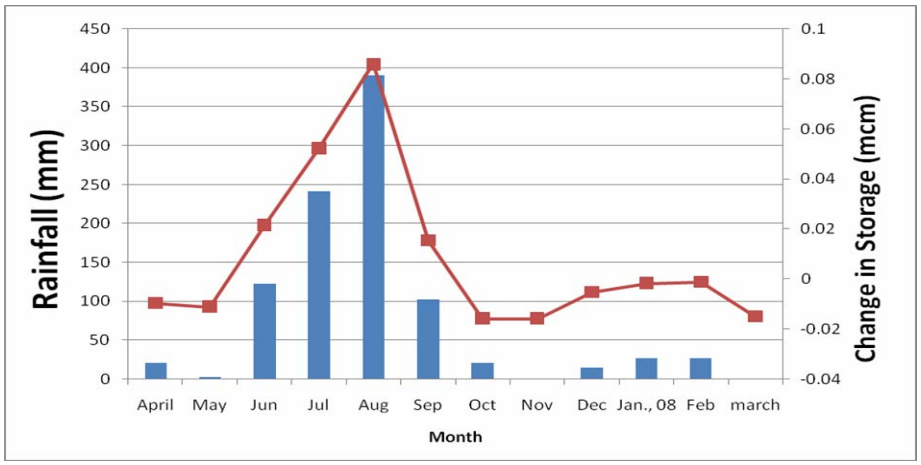

Fig. 1: Monthly variation of rainfall and change in storage volume of the Renuka lake