HYDROECOLOGICAL ANALYSIS OF AN AGRAIAN WATERSHED OF THE SIKKIM HIMALAYA

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The hydrological cycle is the most important ecological process determining the structural and functional dynamics in a watershed system. Sustainability and higher productivity of various land uses/land covers in watersheds are also dependent on the hydrological cycle. Information on the hydrological cycle in the Himalayan region is very important for considering management strategies at the watershed level. Different land uses are interdependent through hydrological linkages. The present investigation was undertaken to find out the different ecological processes linked with hydrology in a hilly watershed.

The Mamlay watershed is located in southern part of the Sikkim Himalaya. It has an elevation range from 300 to 2,650masl, with a total area of 3,014ha, covering 34 villages. The watershed has 45% of its area under agriculture, 26% under forest cover, and 29% is wasteland. The watershed area is typified by a folded structure and varied lithology, with older rocks occupying the upper structural levels. It bears the evidence of two persistent thrusts, namely the Sikkip and Tendong. A total of 113 tree species, 6 types of food grains, 8 types of pulses, 39 types of vegetables, 4 types of spices, 7 types of fruits, and 10 types of wild edible fruits have been recorded in the watershed, which indicates high biodiversity in such a small area.

A hydrological study was carried out in the watershed. The type drainage of the watershed is dendritic and the texture is fine on the higher elevation, gradually becoming coarse in the valley. The study was divided into estimation and experimentation on: (i) drainage, discharge, and sediment concentration; (ii) precipitation, overland flow, and soil loss; and (iii) precipitation-partitioning pathways. The drainage density of the watershed is very high, its total number of channels consisting of 80 of the first order,

18 of the second order, and 7 of the third order. The discharge in the rainy season was highest and the lowest was recorded in the summer. It ranged between 363 to 2,840l/sec at the outlet of the watershed. In the first order streams, the sediment load ranged from 0.4-5mg/l in summer, 57-84mg/l in winter, and 128-387mg/l during the rainy seasons.

The precipitation was recorded at six locations with all slope aspects of the watershed, covering lower, mid, and high, hills for the period of four years from 1991 to 1994. The average annual precipitation was 2,016mm in the high hills, 1,737mm in the mid hills, and 1,460mm in the lower hills. Overland flow was estimated to be highest (9.6%) in the cropped area and lowest in large cardamom-based agroforestry area (2.2%). Soil loss was highest (477kg/ha) in the cropped area and lowest in the dense, mixed natural forest. Nutrient loss in the eroded soil was also estimated in comparison to the parent soil.

Comparison of the soil loss in the total watershed area basin's natural forest, plantation forest, cardamom agroforestry area, mandarin agroforestry area, and cropped area showed that the loss was highest in the cropped area and the lowest in the mandarin agroforestry system. The total nitrogen loss from the watershed through soil erosion was 3,035kg/year; organic carbon, 15,438kg/year; and total phosphorus, 848kg/year.

Partitioning of the incident precipitation into various pathways in natural forest, plantation, and cardamom agroforestry areas in the temperate zone, and natural forest and mandarin agroforestry areas in the subtropical zone of the watershed was estimated. Floor interception was highest in the temperate natural forest while the lowest was recorded in the plantation forest. The biomass incorporation of precipitation was higher in forests than in agroforestry systems.

The comparison of overland flow, soil and nutrient loss, and precipitation-partitioning in various pathways in different land uses of the Mamlay watershed suggests that natural broad-leaved forests and agroforestry systems promote conservation of soil, water, and nutrients. Therefore, land use planning and development programmes should focus on these land uses in the hills.