CHAPTER VII

SUMMERY AND CONCLUSION

The Subansiri is the largest north bank tributary of the mighty Brahmaputra. It originates from the Tibetan part of the Himalaya at an elevation of almost 5000 m and traverses 468 km up to its mouth at Subansirimukh with a drainage area of 35,771 sq. km. The river Alaknanda, the main tributary of the Ganga, originates from the Satopanth and Bhagirath Kharak glaciers at an elevation of approximately 3680 m and has a drainage area of 10936.35 sq. km. It traverses 190 km up to the confluence with Bhagirathi at Devprayag. The Subansiri contributes about 10 % of the total discharge of the river Brahmaputra at Pandu (Assam), while the Alaknanda contributes 3.76% of the total discharge at its confluence with Ganga near Devprayag.

The geoenvironmental setting of the western Himalaya shows many contrasting features in various aspects like altitudinal variation, slope steepness, rock composition, soil profile and tectonic events compared to the eastern Himalayas. The main structural discontinuity running through the Uttarakhand is the Main Central Thrust (MCT) and the North Almora Thrust (NAT), while in the case of Subansiri basin two main tectonic features are seen, namely the Main central Thrust (MCT) and the Main Boundary Thrust (MBT). The MCT is a steep, north dipping thrust and it runs along the Himalayas. The MBT is the tectonic boundary between the Lesser Himalayas and sub-Himalayas. This fault lies about 9 km north of the Lower Subansiri dam site presently under construction. Between the Alaknanda fault and the NAT around Rudraprayag there are several E-W trending folds and faults of considerable extent. The Rudraprayag anticline follows almost the bed of Alaknanda River at Rudraprayag. The rock type of Rudraprayag is of metavolcanic activity in the western part, whereas Haryali Quartzite and Thalasser schistore grit are found in the adjoining parts of Alaknanda valley. The rock units are aligned as NE-SW trending zone with folded and local window structures in case of Subansiri basin. Sandy loam soils are seen at Joshimath. Towards the north of Chamoli quartzite, chinka formations are present. The rock structure of Subansiri basin is fine grained to pebbly, weathered, highly jointed to massive sandstone, medium to coarse grained, soft weathered to shared, massive to moderately jointed sandstone with stringers of carbonaceous material. Overall rock composition is poor. As result, erosion is more in this basin compared to the Alaknanda basin of western Himalayas. In case of moderate to steep slopes, the presence of shallow surface horizon of soil which is of medium to coarse texture is the result of very little tectonic effect in the region. Valley soils are well developed from colluvial material brought down from the up slopes. The Subansiri basin lies under seismically active zone V and therefore highly hazard prone compared to the Alaknanda river basin of western Himalayas which falls in the seismic zone both IV and V. Besides, in case of the Subansiri basin, the slopes are too steep compared to those of the Alaknanda basin.

On the basis of available hydrometeorological data it is observed that, there is a fair degree of correlation between the rainfall parameters and flow patterns in both the basins. From the rainfall investigation it is seen that the monsoon rainfall is more dominant in the eastern Himalayan region than in the western Himalayan region, while the temperature is comparatively high in the stations of the Alaknanda basin of western Himalaya. The comparison of flow patterns in the two rivers shows that relatively high flows characterize the Subansiri basin as against the Alaknanda basin of western Himalaya for the same season. The high flow in the Subansiri basin may be primarily due to the intense monsoon rainfall in the eastern part of the Himalayas, accentuated further by unique physiographic and ecological setting. Inadequacy of hydrometeorological data and extremely sparse coverage of existing observation networks are found to be the major constraints in the study of the two river basins located at two extremes of the broad Himalayan arc.

The Himalaya covers 18% of geographical area in India and accounts for 50% of country's forest cover and 40% of its endemic species (Chauhan, 2010). Both the Subansiri and Alaknanda basins of eastern and western Himalayas respectively are bestowed with rich biodiversity but there are some differences of ecological aspects in between them. It is observed that the number of wetlands and beels are more in the lower part of the Subansiri basin than in the Alaknanda basin. These beels are the habitats of a variety of aquatic flora and fauna. There is high endemism in the Subansiri Basin as it has 62 endemic species which accounts for 28% of the State's endemic flora.

The water quality parameters show a similar trend in case of the pH and electrical conductivity in both the basins of eastern and western Himalayas, but most of the other parameters show dissimilarities. The river water of the Subansiri is more turbid which carries high amount of total solid and also debris than the river Alaknanda. It may be due to the peculiar soil texture of the basin or high velocity of the water causing erosion. It is seen that the concentrations of PO_4^{---} and NO_3^- are low in case of the Subansiri but these are in elevated range in case of the river Alaknanda, probably due to more agricultural practices and anthropogenic activities (like constructional activities) in and around the basin area.

The characteristics of the morphometric parameters may be well understood from the use of remote sensing and GIS techniques. Morphometric study (case study 1) reveals the contrasting features in regard to their relief, slope and aspect conditions, and the physiography of the basins. Study 2 reflects the differences of linear aspects, areal aspects and relief aspects of both the two basins which further indicates the youthful and immature topography of the eastern Himalayan basins undergoing more erosion than the comparatively mature and stable development of the western Himalayan basin. The morphometric parameters also indicate the comparatively more hazard prone areas in the representative catchments of the Subansiri river.

From the LULC study, it is observed that the vegetation cover and barren land declines while there is a positive change in agriculture and built-up land in both the basins. The reason for the decline of the forest cover may be due to the increasing agricultural practices, population pressure and the construction activities in the basins. A negative change of water/snow/glacier is seen in case of the Subansiri basin of eastern Himalaya. But there is positive change of Water/Snow/Glacier in the Alaknanda basin of western Himalaya which may be due to the seasonal variation or may be due to glacial lake outburst flood (GLOF).

From the socioeconomic and demographic study, it is observed that the Subansiri basin is sparsely populated especially in the higher altitude that falls in the state Arunachal Pradesh while a quite opposite scenario is revealed in the Alaknanda basin of western Himalaya. Scattered and sparse pattern of habitation in the state as observed in the case of Arunachal Pradesh is not conducive for rapid economic development. In terms of per capita State Domestic Product and other development indices such as power, road length etc., Arunachal Pradesh ranks below the national average. The poverty level is much higher than the national average. The low per capita income, lower growth rate of income and higher poverty ratio is a cause of concern. Vast natural resources, particularly enormous hydropower potential, oil and natural gas, forest resources, and tourism potential offer a strong advantage to transform this strategically located State into one of the richest States of the country (Draft, Annual Plan 2010-11, Arunachal Pradesh). Both the Alaknanda and the Subansiri basins of the western and eastern Himalayas have hilly and complex terrain, still it is seen that the habitation is more in the Alaknanda basin even in the higher altitudes and the region is comparatively developed in many aspects such as literacy and its related facilities, transport and communication, health services and agricultural production etc. than the Subansiri basin of the eastern Himalaya. From the above analysis, it is pertinent to mention that the big dams on Alaknanda river are much smaller in size in comparison to the mega dams being proposed or under construction on the Subansiri river. Besides these, the Alaknanda basin of western Himalaya is comparatively much better placed and attractive in regard to tourism industry (especially ecotourism) than the Subansiri basin of eastern Himalaya.

The analysis of climate change impact on the hydrology of high altitude glacierized catchments in the Himalayas is complex due to the high variability in climate, lack of data, large uncertainties in climate change projections and uncertainty about the response of glaciers (Immerzeel et al., 2012). As the Alaknanda basin of western Himalaya is comparatively more developed so the region is comparatively more impacted by anthropogenic activities such as construction of roads, buildings and dams which will further contribute to the process of increasing pollution and global warming due to climate change.

It is seen from the above discussion that the geoenvironmental characteristics of the river Alaknanda in western Himalayas differ from those of the river Subansiri in eastern Himalayas. The geology of Subansiri basin is relatively more fragile and seismically more active compared to the Alaknanda basin. Thus the eastern Himalayan region represented by the Subansiri basin is comparatively more sensitive and hazard prone than the western Himalayan region of India represented by the Alaknanda basin.