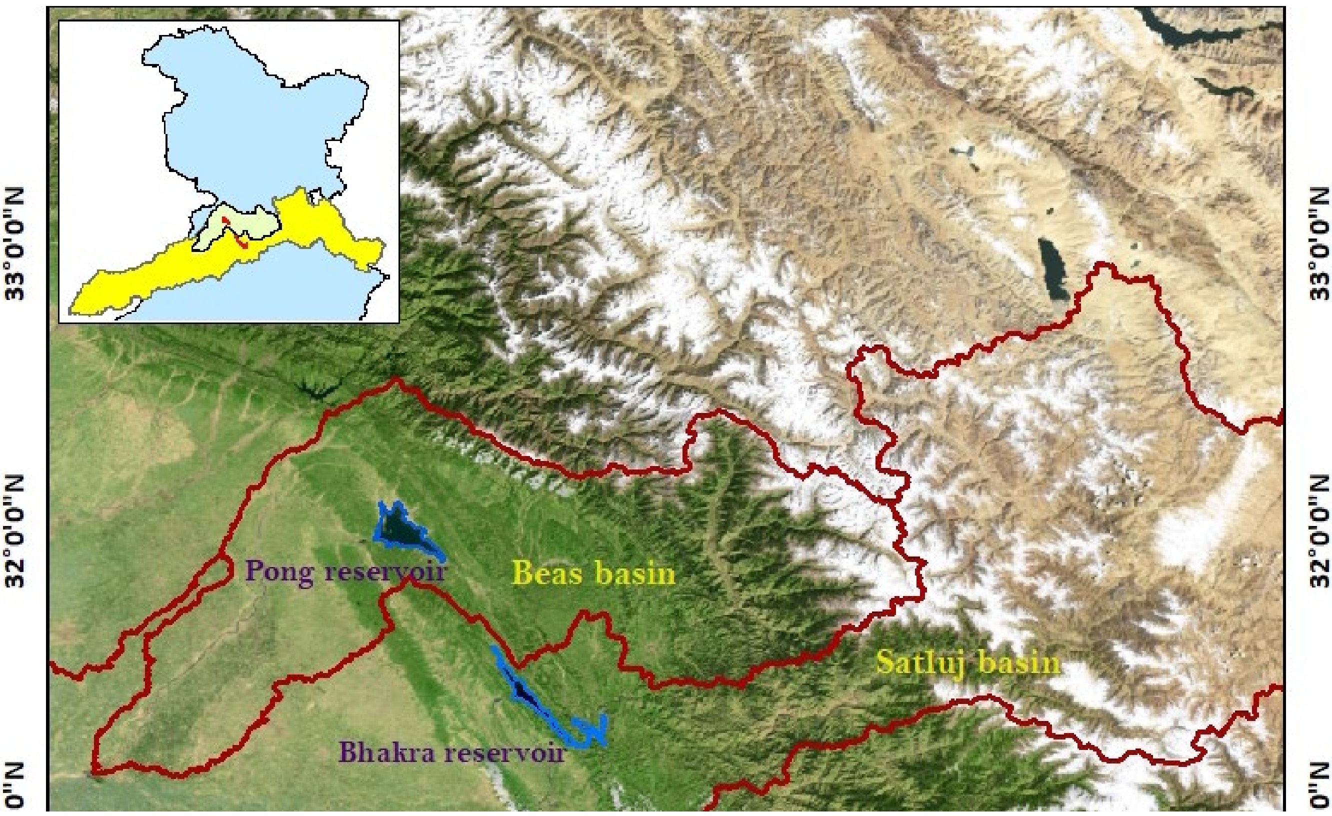
UNTANGLING THE WATER-FOOD-ENERGY-ENVIRONMENT NEXUS FOR GLOBAL CHANGE ADAPTATION IN A COMPLEX HIMALAYAN WATER RESOURCE SYSTEM

Water from Himalayan rivers is used in domestic, agriculture, energy and industrial sectors. The river flow is sustained by rainfall, groundwater, snow and glacier melt. The contribution of each component varies from basin to basin, making the region hydrologically complex. In the Himalaya, glaciers are thinning, losing mass, and retreating due to climate change. These changes in the cryosphere will influence the water availability. The water stress will also be affected by increasing water demand. In this era of rapid modernisation, water demands can grow and diversify; making water resources management increasingly complex.

In the present study, Water Evaluation and Planning (WEAP) model was used to integrate climate and socio-economic changes in Satluj and Beas basins. This approach combines diverse hydrological drivers such as rainfall, seasonal snowpack and glaciers with major sectors such as irrigation, energy and infrastructure. In the first step, seasonal changes in precipitation and temperature based on the 25th, 50th and 75th percentiles of a 42 CMIP5 GCM ensemble for RCP4.5 were used to quantify the effect of climate change on mean annual runoff at Bhakra and Pong reservoirs. All these scenarios indicate increase in total annual water availability by 2050 compared to baseline period of 1978 to 2007. Early melting of snow increases runoff in April, whereas higher temperature and rapid melting of glaciers increase flows in summer. The decrease in



Basin Map.

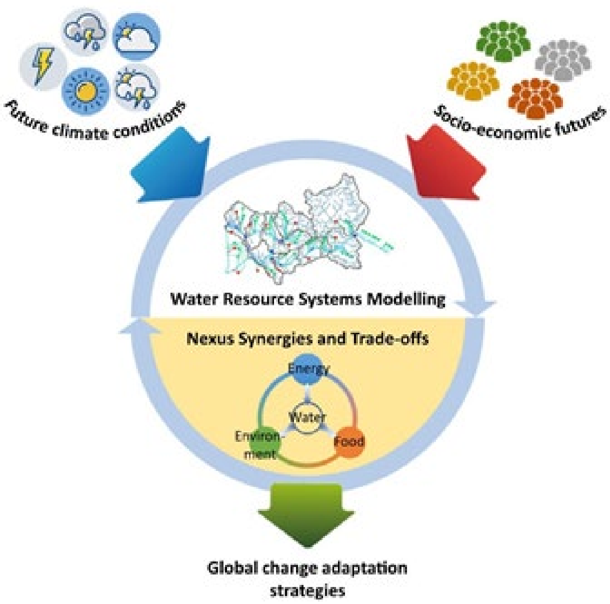
winter precipitation and enhanced glacier melt results in a negative mass balance of the glaciers. For the two scenarios that generated greatest and lowest runoff in the basins, total volume of glaciers was observed to decrease by 63-65% in Beas basin and 61-65% in Satluj Basin.

In the next stage, these two extreme climate change scenarios were incorporated in the socio-economic pathways (SSP). The indicators of each water, food, energy and environment components were analysed within 3 SSP scenarios. In the study area, the energy component is represented by the hydropower production; the food component refers to productivity of irrigated crops; the environment is represented by the maintenance of the flow regime downstream of reservoir relative to upstream flows; and the water component includes drinking water and flood abatement. SSP1 which focuses on total sustainability and high environmental awareness, SSP2 is middle of the road and SSP5 supports conventional development. In all SSP scenarios, population, consumption rate, irrigated land and hydropower demand increase. In the case of SSP2, growth of hydropower demand, drinking water and population are high.

The nexus analysis highlights the impact of both climate and socio-economic change together on each component. The results show that future socio-economic changes will have a much stronger impact on sustainable development than climate change. Hydropower generation and environmental protection represent the major sectors providing opportunities and limitations for adaptation. This approach is relevant as it considers the changes in both source and demand of various sectors.

Reference:

A.Momblanch, L. Papadimitriou, Sanjay. K. Jain, Anil Kulkarni, Chandra S.P.Ojha ,A.J. Adeloye, and I. P. Holman, Untangling the water-food-energy-environment nexus for global change adaptation in a complex Himalayan water resource system, Science of the Total Environment, doi.org/10.1016/j.scitotenv.2018.11.045



An illustration shwoing the approach of nexus analysis incorporating climate and socio-econmoic changes.