Predictability and Diagnostics of Western Himalayan Satluj River Flow: Spring Seasonal Inflow into Bhakra Dam in India

Snowmelt dominated streamflow of the Western Himalayan rivers is an important water resource during the dry pre-monsoon months to meet the irrigation and hydropower needs in northern India. On the other hand, winter precipitation as the form of snow over Himalayas helps in maintaining the glaciers, which serve as a storehouse of freshwater throughout the year. With the help of the hydro-climatological data provided by the Bhakra Beas Management Board in India, I present the predictability and diagnostics of Satluj river basin hydro-climatology at the Indian side up to the upstream of Bhakra dam, which is a major source of water for irrigation and electricity generation (1325MW) for north India. Spring seasonal inflow anomalies to Bhakra dam are strongly correlated with large-scale precipitation and temperature in the preceding winter over the Western Himalayas and adjoining north and central Indian plains, suggesting a potentially usable predictability for reservoir managers. Winter precipitation in the Western Himalayas is mainly brought about by the mid-latitude jet stream leading to the formation of low-pressure synoptic systems known as Western Disturbances (WD). WDs originate over the North Atlantic Ocean or Mediterranean Sea, with secondaries developing over the Persian Gulf and Caspian Sea either directly or as a result of the arrival of low-pressure systems from southwest Arabia, and travel eastward over Iran, Afghanistan, Pakistan, and northwest India. Winter WDs (and therefore the average volume of winter precipitation over Western Himalayas) are also modulated by the large-scale interaction between ocean and atmosphere led by the variation of the SSTs of the Indian Ocean and Pacific. As a result, average spring inflow volume, which is a function of the average volume of precipitation in winter, was also found to be positively correlated with the SSTs over the western and equatorial Indian Ocean, and with below-normal sea-level pressures centered over the Azores, both during the preceding winter. Teleconnections of winter precipitation and spring Bhakra inflow with the El-Nino indices in winter are also noted, which provide some promise for improving the long lead prediction capability for inflows into this important multi-purpose reservoir that is operated at seasonal time scales for irrigation, flood control and hydropower production. They also provide potential directions for the statistical downscaling of precipitation, temperature and/or streamflow directly from large-scale climate model simulations of ocean temperature and atmospheric pressure fields.