



Hydrological processes responding to climate warming in a snow-dominated river basin of the Altay Mountains region, Xinjiang, China

Y.P. Shen (1), G.Y. Wang (1), H.C. Su (2) and Q.Z. Gao (1)

(1) Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences, Lanzhou 730000, China, (2) Xinjiang Hydrological and Water Resource Bureau, Ürümqi 830000, China (shenyp@lzb.ac.cn / Fax & Phone: +86-931-4967248)

Abstract: Kelan River is a branch of the Ertix River, originated from the Altay Mountains in Xinjiang, China. The Kelan River basin upstream located in the southern slope of the Altay Mountains, and rises in small glacial erosion lakes at an elevation of more than 2500 m and forms a part of the Ertix River system. The total area of the study basin is about 1655km² and elevation varies from about 988 to 3480 m asl. Almost 95% of the basin area is covered with snow during winters. The westerly weather disturbances deposit nearly all the precipitation in the form of snow during the winter months in the upper part and middle part of the basin. That annual flow of the basin is about 382 mm, in which about 45% contribution derived is from the melting of snow. The mean annual rainfall in the basin is about 620 mm. The distribution of rainfall indicates that mostly rainfall is concentrated in the upper and middle parts of the basin. Increasing precipitation changes with elevation as the formulate $P(\text{mm})=0.28H(\text{m})-8.3$.

Recent global climate analysis has indicated that the climate change is likely to change streamflow volume, as well as the temporal distribution throughout the year over Asian region, imposing significant stress on the water resources in the region. An examination of the possible effects of climate change in the design and management of water resources systems was suggested. The Kelan River system is expected to be much vulnerable to climate change because of substantial contribution from snow. During

winter, a large extent of mountainous area of Altay river basins is covered by snow. The response of hydrological system in this region could alter significantly due to climate change. It is understood that the global warming and its impact on the hydrological cycle and the nature of hydrological events would pose an additional threat to the Altay region. Possible impacts of climatic changes on various aspects of hydrological cycle are not much studied.

Kelan River is a typical snow-dominated watershed, have more area at higher elevation and accumulate snow during the winter, the peak flow occurs during the late spring or early summer as the snow melts. Streamflow varies strongly throughout the year as a result of seasonal cycles of precipitation, snowpack, temperature, and groundwater. Changes in the temperature and precipitation will affect the timing and volume of streamflow. River fed by high elevation sources, is considered snow melt-dominate, the watershed experiences low flow in winter, peak flow during the spring and early summer as snowpack melts, and low flows during the late summer. The streamflow of the Kelan River consists of contributions from melting of snow and ice, and rainfall-induced runoff.

Snow cover in mountain regions provides critical water supplies, serving human with freshwater for domestic, agricultural and industrial uses. As climate warming, hydrology process of Kelan River undergone great changes, and demonstrated in the largest month runoff in June moved up to May, the streamflow of the largest runoff month have also an increase of about 15%, April-June runoff as the snowmelt season from flow of 60 percent to nearly 70 percent of the annual runoff. For the long-term change trend, the temperature rose mainly in the winter, winter precipitation has also increased significantly, and the downward trend in summer rainfall; hydrological process is manifested in May runoff showed an increasing trend, and June runoff for the downward trend; summer runoff to reduce and spring runoff increasing markedly. Warming and the increase in winter and spring snow covers, leading to increased melting snow from causing floods and the largest flood peak flow increased, destructive intensify. Climate and hydrological process caused by the change have changed in the urban water supply along the river and make an impact on agricultural and livestock production.

Key words: climate change; streamflow responding; snowmelt; Kelan River; Altay Mountains