

# The effect of permafrost degradation on hydrological process in basins with various permafrost coverage in Northwest China

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We use monthly discharge in cold season in four rivers with various permafrost coverage and without much human impact to identify the effect of permafrost degradation on flow regime and change over the past 50 years. The monthly discharge are used at for four hydrological stations in the basins during 1951-2006. The daily air temperature data is also available at four meteorological stations in each basins during 1951-2006. The four river basins, the Shulehe, Heihe, Shiyanghe, and upper Yellow Rivers in Northwest China, are located in Qilian Mountains and Middle Qinghai-Tibet Plateau of northwest China, and have 83%, 58%, 33% and 43% permafrost coverage, respectively. The drainage areas are between 800-12000 km<sup>2</sup>.

The air temperatures are significantly increased in the region during the past 50 years. The monthly discharge are increased in summer and fall months in Shulehe and Heihe basins, but decreased in Shiyanghe basins due to precipitation change during the study period. The discharge in winter months has increased in Shulehe and Heihe and decreased in Shiyanghe and upper Yellow River.

There is snow cover during winter season in the basins and no rain to supply to the river flow. The discharge is a hydrological recession process in winter months in the basins. The monthly recession coefficient (RC) of streamflow in winter reflect the ground water conditions. The RC has obvious increases in Shulehe and Heihe rivers with 80% and 58% permafrost coverage, but have not increased, even insignificant decreased in the Shiyanghe and upper Yellow Rivers with less permafrost coverage. There are good negative relationship between RC and annual total negative degree-day at meteorological stations in high permafrost coverage basins. The annual total negative degree-day as good index for permafrost conditions has obvious increased in the regions, and lead to permafrost degradation.

The ratio of monthly maximum discharge vs. monthly minimum discharge is defined as the index of hydrological regime. The ratio is mostly related to permafrost coverage in basins with

high permafrost coverage. The Ratio has decreased at the four river discharge during the past 50 years. The decrease may related to the permafrost degradation which may lead to less direct surface flow and more ground flow.

These results imply that permafrost degradation due to climate warming affect the hydrological process in winter season. The effect is obvious in high permafrost coverage, but is small in hydrological process in low permafrost basins. The permafrost usually is considered as impermeable layer. Degradation of permafrost and infiltration increase would lead to more surface water to ground water and enlarge the ground reservoir, leading to a slow discharge recession. This means the hydrological process is strongly affected by the permafrost degradation in river basin with high permafrost coverage, and is not so much affected in river basin with less permafrost coverage. The permafrost degradation will lead flat hydrological regime in basins with high permafrost coverage.

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