Water use efficiency vulnerability to changes of vegetation and climate in the high mountain area of the northwest China

Xi Chen[1,2], Richao Huang[1,2]

[1]Institute of Surface-Earth System Science, School of Earth System Science, Tianjin University, Weijin Road 92, Tianjin 300072, P.R. China

[2]Tianjin Key Laboratory of Earth Critical Zone Science and Sustainable Development in Bohai Rim, Tianjin University, Weijin Road 92, Tianjin 300072, P.R. China

Abstract: In the high mountain areas, particularly in the northwest China, climate warming and vegetation dynamic (e.g., net primary production) and hydrological components markedly change with the topography, especially altitude. The spatiotemporal vulnerability of vegetation-hydrological patterns to climate change in the high mountain areas is poorly understood. In this study, the net primary production (*NPP*), actual evapotranspiration (*E*), and water use efficiency (*WUE=NPP/E*) are simulated and predicted by a modified Lund–Potsdam–Jena (LPJ) model in the upstream of Shiyang River basin of the eastern Qilian Mountains, China. Results show that the increase of *NPP* was greater than that of *E* in the entire region during 1979-2014 due to the fertilization effect of increasing atmospheric CO_2, which leads to an increase of *WUE*. The *NPP*, *E*, and *WUE* increased below altitude of 3000 m attributed to increase of precipitation, but decreased above altitude of 3000 m due to declines of temperature. The predicted results indicate that mean annual CO_2 would increase by 22.3 and 37.7%, rise of temperature would be 2.1 and 3.1℃, and precipitation would increase by 2.1 and 4.3% in the future periods of 2021−2040 and 2041−2060, respectively. In such climate, *NPP* would increase by 18.4~43.1%, *E* would increase by 5.7~9.3%, and *WUE* would increase by 12.1~31.2%. As a consequence, streamflow would increase by 5.5% during 2021−2040 but decrease by 5.0% during 2041−2060. Meanwhile, the increased *NPP*, *E* and *WUE* become larger towards high altitude in the warming and elevated CO_2 climate. As a main water resource contributed to the downstream oasis, the change of WUE and streamflow would significantly affect water allocation strategies in the area.