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Response of streamflow to climate variability and land use/cover changes in a watershed in Northern China

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Water shortages and related environment degradation in north china are major issues. As streamflow from the headwater region steadily decrease and water resources become overcommitted, serious water and environmental problems have resulted. These include drying-up of rivers, decline in groundwater levels, degradation of lakes and wetlands, and water pollution. Thus, problems of water shortage and related environment issues in Northern China have become the most significant limiting factors affecting sustainable development in this important region of China. A number of programs, such as the Natural Forest Protection Program, the Sloping Lands Conversion Program and Water Source Protection Project for Beijing, have been carried out in this area so that large scales of land use and land cover have been changed. It is important to understand the relationships between climate factors and land use/cover change for developing a sustainable basin management plan.

To assess the impacts of climate variability and land use/cover change on annual streamflow the watershed of the Chaohe watershed has been tested. Chaohe watershed is the main subcatchment of the Miyun reservoir which supplies most of the drinking water for Beijing. The trend of the time series of climate variables in terms of precipitation and potential evapotranspiration (PET) and annual streamflow of Chaohe (1961-2009) watershed were examined by using the non-parametric Mann-Kendall-Sneyers test. To quantify the impacts of land use change and climate variability on mean annual streamflow a conceptual ecohydrological approach (Tomer, 2009) on the basis of precipitation and PET was used. It was found that the annual precipitation decreased by 0.44mm/year but insignificantly ($p=0.575$) from 1961 to 2009, whilst the annual PET increased significantly ($p<0.001$) by 2.04mm/year for the same period. The annual streamflow significantly ($p<0.001$) decreased by 0.81mm/year from 1961 to 2009, and an abrupt change occurred in 1999. Compared to the period of 1961 to 1998, the average annual streamflow has decreased by 43 mm in the period of 1999-2009. Main reason for this behavior was attributed to the land use change with a contribution of 54.6%, while the rest was explained by climate variability.

Reference:
Tomer, M.D., Schilling, K.E. 2009. A simple approach to distinguish land-use and climate-change effects on watershed hydrology. Journal of Hydrology 376: 24–33.