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Watershed hydrological impacts of climate variability and land use change by using an eco-hydrological approach combined with differential elasticity-based analysis

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It is important for adaptive water resource management under the changing environment to understand how and to what extent the land use change and climate variability affects streamflow. As a case study, we used a simple conceptual ecohydrological approach (Tomer et al., 2009) combined with the differential elasticity-based analysis (Zhang et al., 2001) to identify the dominant cause for the change in streamflow and quantify the respective impacts of land use change and climate variability of the Chaohe watershed in northern China. Chaohe watershed is the main subwatershed of the Miyun reservoir which supplies most of the drinking water for Beijing. Since 1978, Chaohe watershed has experienced various degrees of land use change within the "Three-North Protection Forest" program which tries to implement protective forest in the North, the Northwest, and the Northeast of China to improve the ecological situation of these regions. Comparing three successive analysis periods i.e. 1980 to 1989, 1990 to 1999, and 2000 to 2008 with the reference period of 1963 to 1979 respectively, we found that the change in annual streamflow during 1980 to 1989 was equally explained by the land use change and climate variability. However, the change in annual streamflow during the period of 1990 to1999 was mainly attributed to the land use change, and the change of 2000 to 2008 to climate variability, the contribution being 125% and 59% around, respectively. We have found that the land use change has actually dominated the advent of change in streamflow, whilst climate variability either reduce or augment the magnitude of change, dependent on whether the land use change and climate change has an opposite impacts on hydrological response. Moreover, it was found that the magnitude of land use-induced impact increased when the climate was wet for all land use change, suggesting the role of vegetation properties has in affecting the evolution of streamflow by varying the transpiration activity in response to climate variability. We concluded that it is critically important to integrate the interactions between vegetation and climate variation for assessing the impacts of changing environment in the framework of adaptive approach.

References:

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