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Impacts of land use/cover and climate changes on runoff in the upper reaches of Minjiang River watershed

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Quantifying the impacts of land use/cover change(LUCC)and climate change on hydrology at large watershed scale is of great significance to the land management and strategy formulation for sustainable development of watershed ecosystem. The upper reaches of the Minjiang river watershed is located between the Qinghai-Tibet Plateau and the Sichuan Basin. It is highly sensitive to climate and has distinct natural gradients such as altitude and vegetation. As an important water source of Sichuan Basin, the upper reaches of Minjiang river watershed plays a principal role in the urban development and agricultural irrigation, and its ecological protection, social and economic benefits even affect the entire Yangtze river basin.
In this study, we used the Soil and Water Assessment Tool (SWAT) to simulate the hydrological characters from 1985 to 2012, and the three satellite-based maps (1985, 2000, 2015) to show the main changes in the basin over the past 30 years. Then, the spatial distribution changes of 236 sub-basins were displayed in GIS-based images, and the main influencing factors were analyzed using CANOCO redundancy analysis. The simulation results were divided into three sub-periods (1985-1995, 1996-2003, 2004-2012), and five scenarios were also set up with 1985-1995 as the reference period for quantitative analysis of impact factors. The model showed a good performance with correlation coefficient (R2) of 0.83 and 0.77 and the Nash efficiency coefficient of 0.79 and 0.71 for calibration (1985-1999) and validation period (2000-2012), respectively. The result showed that in the period 1996-2003, the runoff was dominated by climate change, which led to a 67.61 mm decrease in the mean annual runoff, while LUCC resulted in a decrease of 12.61 mm. Similarly, annual runoff decreased by 58.53 mm due to climate change and 2.38 mm due to LUCC during the period 2004-2012. Moreover, the runoff changes mainly occurred in the southern part of Heishui, the northern and eastern parts of Lixian, most of Maoxian and the northern part of Dujiangyan. The changes of runoff during 1985-2000 ranged from 100 mm to 300 mm. Redundancy analysis exhibited the gradient effects of land use/cover and landscape indexes on rainfall, evaporation and flow on the watershed. Groundwater was affected by landscape fragmentation, and flow was highly correlated with landscape diversity and urban residents. Our study can provides scientific basis for watershed-scale rational land planning and water resource management in the watershed in the future.