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Runoff Predictions in an Inland Lake Basin in Northeast Tibetan Plateau Based on Distributed Hydrological Modelling

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The water level of Qinghai Lake in Northeast Tibetan Plateau has dramatically kept significant rising for recent ten years, after a continuous decreasing for a century, which makes it become a hotspot in the research of hydrological responses of plateau lake to global warming. Improving runoff predictions in such a poorly gauged inland lake basin is critical for level change and water balance analysis of the lake, and forcasting and management of water resources in the region. However, it is challenging to simulate the runoff processes of such a large scale basin due to the complexity of land surfaces, influences of snow, glacier and frozen soils, and sparse observing networks. There is absolutely a need for taking full use of the ground-based observations, GIS and remote sensing data, and building a physically-based distributed hydrological model that does not quite rely on the observed data for parameter calibration. This study hence targets to estimate runoff inflow of the lake and identify the main factors affecting runoff changes based on distributed hydrological modelling.
The componentized Geomorphology-Based Hydrological Model was adopted, which is able to represent spatial variability such as topography, land cover and soil type, and in particular, implements very few empirical parameters. To reduce uncertainties of the modeling results from the forcing data, a satellite and rain gauge data-merging framework was employed for daily rainfall estimation. Vegetation parameters were improved. The maximum leaf area index for each grid simulation unit were estimated from the MODIS LAI product. The fraction of the vegetation coverage and crop coef[U+FB01]cient were estimated based on the MODIS NDVI, and dynamically updated during model simulation. Parameters' sensitivity was analyzed according to the conventional disturbing method, and three sensitive parameters were manually calibrated according to the observed discharge of the Buha River, the largest tributary of the lake, whereas soil parameters were not calibrated to avoid "over-parameterization". The observed discharges of the Buha and Yik'ulan River, the second largest tributary, were used to validate the model. The Nash-Sutcliffe efficiency (NSE), percent bias (PBIAS), and RMSE-observations standard deviation ratio (RSR) were used to evaluate the model performance.
The results showed the simulated accuracy of monthly discharge was improved. Sensitivities and uncertainties of the three vegetation parameters were highly reduced, and dependency of the model on high precision landuse data was lowered. For monthly streamflow simulation during 2004-2013, values of the NSE, PBIAS and RSR were 0.88, -4.96% and 0.34 for the Buha River, and 0.68, -29.06% and 0.56 for the Yik'ulan River. The Buha River contributed 49.2% of the lake's total inflow, the Yik'ulan River contributed 11.8%, and the rest ungauged rivers contributed 39.0%. The increase of precipitation was the essential reason for runoff increasing, whereas changes of air humidity, temperature, wind speed, sunshine duration, solar radiation and vegetation coverage had a small impact on runoff change.