Simulating hydrological consequences of the 2022 severe drought in the Yangtze River Basin, China

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Abstract: Severe drought events can cause water stress, severe economic loss and an extraordinary increase in wildfires (Yoon et al., 2015). In the summer of 2022, the Yangtze River basin experienced a severe drought, which had a major impact on water, food, socio-economy, and livelihood security. An accurate simulation of the hydrological consequences of the severe drought is crucial to mitigate its impact.

This study used observed daily streamflow data to analyze the evolution of severe drought processes and quantify the extent of drought. A distributed hydrological model framework wflow_hbv was used to simulate the hydrological processes in the Yangtze River Basin in 2022. Latin hypercube sampling was used to estimate the parameters of the wflow_hbv model. The initial results show that:

- Compared to the same period in the previous three years, 127 of 143 hydrological stations in the Yangtze River basin observed a decreased streamflow from June to October 2022. Forty-one hydrological stations observed decreased streamflow of more than 500m³/s (13% to 70% decrease) while the streamflow at the Datong gauge decreased by 16,252m³/s (37%).
- The megadrought started in July and continued until October 2022. As a result, lots of catchments within the Yangtze River Basin have not fully recovered by the end of April 2023.
- Based on best 10 groups of the Latin Hypercube samplings (1%), the wflow_hbv model achieved good simulation results at both upstream and downstream of the Three Gorges Dam. In 2019-2022, the model obtained daily NSE ranging from 0.79 to 0.81, KGE ranging from 0.86 to 0.89, and model bias ranging from -0.78% to 2.22% at the upstream gauge Cuntan and NSE ranging from 0.75 to 0.77, KGE ranging from 0.78 to 0.84, and model bias ranging from -1.99% to 0.69% at the downstream gauge Yichang. These results demonstrate that it is feasible to use this model conducting simulations and predictions under the megadrought in the Yangtze River Basin.

This study has made preliminary progress in the study of surface hydrological processes in the Yangtze River basin during the 2022 severe drought. However, more studies are needed to refine and improve the results to achieve a comprehensive understanding of hydrologic processes under those conditions. In the future, we plan to modify the human water consumption module of wflow_hbv to achieve better simulation results in anthropogenically influenced areas to accurately simulate the hydrological processes in the whole Yangtze River basin.

REFERENCES

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