Quantifying the Uncertainty of the Future Hydrological Impacts of Climate Change: an Advanced Hierarchical Sensitivity Analysis in a Humid Subtropical Basin, China

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Abstract

The comparison and quantification of different uncertainties of future climate change involved in the modeling of a hydrological system are highly important for both hydrological modelers and policy-makers. However, few studies have accurately estimated the relative importance of different sources of uncertainty involved in climate change predictions. In this study, an advanced hierarchical uncertainty analysis framework incorporated with a variance-based global sensitivity analysis, was developed to quantify different sources of uncertainty in hydrological projections under climate change. The uncertainties considered in this research are from greenhouse gas emission scenarios (GGES), global climate models (GCMs), hydrological models (Xinanjiang and variable infiltration capacity (VIC) models) and hydrological parameters, and this new methodology was implemented in a humid subtropical basin in southern China. The results indicated that the GCMs and hydrological parameters (GGESs) are the main (least) contributor of uncertainty in the discharge projections at the interannual scale. At the intra-annual scale, GCMs contribute the largest uncertainty of the discharge predictions during summer season, whereas the uncertainty due to GGESs, hydrological model and parameters is generally larger in winter. It was also found that although there is a strong temporal and spatial variability of general sources of uncertainty, this heterogeneity does not affect the importance of uncertainty sources. This study provides a better understanding of the uncertainty sources in hydrological predictions in the context of climate change. And the uncertainty analysis framework used is mathematically rigorous and can be applied to a wide range of climate and hydrological models with different uncertainty sources.

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