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An estimate of human and natural contributions to changes in water resources in the upper reaches of the Minjiang River

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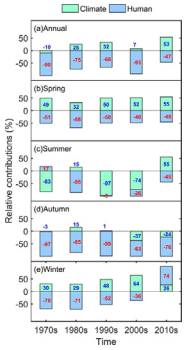
HIGHLIGHTS

- Water resources in the upper reaches of the Mingjiang River (UMR) basin decreased.
- Climate change had led to an increase in water resource availability in the UMR basin.
- Human activity had led to a decrease in water resource availability in the UMR basin.
- Multi-models can decrease the uncertainty of results.

GRAPHICAL ABSTRACT



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ABSTRACT

Climate change and human activities have changed the spatial-temporal distribution of water resources, especially in a fragile ecological area such as the upper reaches of the Minjiang River (UMR) basin, where they have had a more profound effect. The average of double-mass curve (DMC) and Distributed Time-Variant Gain Hydrological Model (DTVGM) are applied to distinguish between the impacts of climate change and human activities on water resources in this paper. Results indicated that water resources decreased over nearly 50 years in the UMR. At the annual scale, contributions of human activities and climate change to changes in discharge were −77% and 23%, respectively. In general, human activities decreased the availability of water resources, whereas climate change increased the availability of water resources. However, the impacts of human activities and climate change on water resources availability were distinctly different on annual versus seasonal scales, and they showed more inconsistency in summer and autumn. The main causes of decreasing water resources are reservoir regulation, and water use increases due to population growth. The results of this study can provide support for water resource management and sustainable development in the UMR basin.

1. Introduction

The hydrological cycle of watersheds in both spatial and temporal changes is a complex process that is widely influenced by climate change and human activities (Milliman et al., 2008; Zhang et al., 2011a; Song et al., 2013). The Intergovernmental Panel on Climate

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Change (IPCC) report indicated that climate change has led to changes in global precipitation patterns since the 20th century, which has changed the global hydrological process and directly affect the spatial and temporal distribution of global water sources; thus, it can cause changes in discharge (Milly et al., 2005; Huntington, 2006). Human activities, such as changes in land use/cover, dam construction, and urbanization, have an obvious impact on all aspects of the water cycle (Sterling et al., 2013), which can greatly change the spatiotemporal distribution of water resources. The contradiction between the supply and demand of global water resources is becoming more and more prominent, primarily due to human activities and climate change (e.g., rapid economic development, increasing population and frequent extreme weather problems) (Wang et al., 2013; Luo et al., 2015a), which directly results in the reduction of discharge and causes challenges for global river ecosystem. Hence, it is of great significance to quantitatively assess the impact of climate change and human activities on discharge variations, which will enhance our understanding of the water cycle at both regional and global scales, improve water resource planning and management, and help to mitigate extreme weather events.

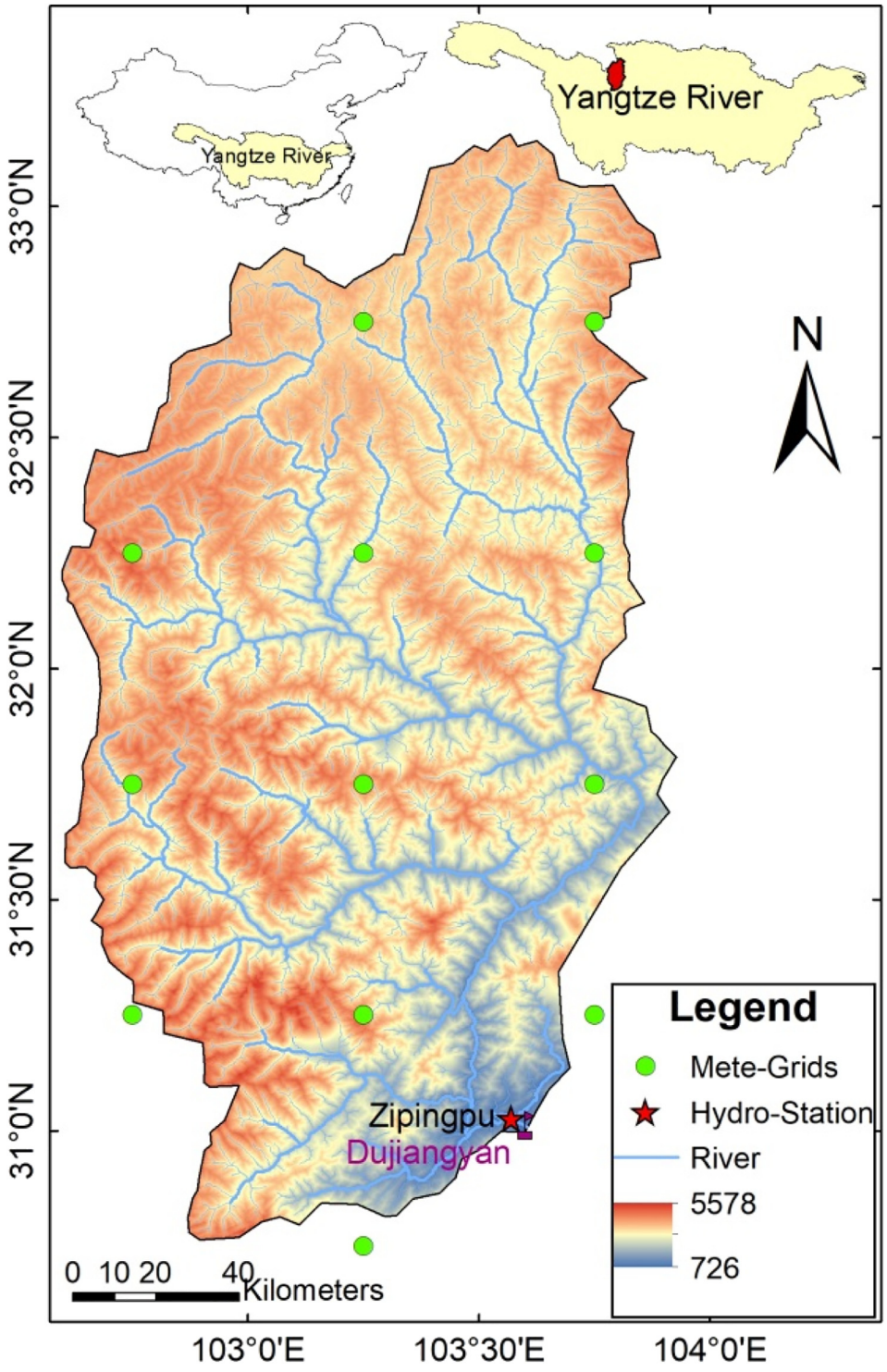

Fig. 1. Locations of the upper reaches of the Minjiang River Basin, meteorological grid points and hydrological station.