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Agricultural water allocation strategies along the oasis of Tarim River in Northwest China

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ABSTRACT

Efficient reallocation of existing water supply is gaining importance as demand grows and competitions among users intensify. In extremely arid regions, where deficit irrigation needs to be applied, management decisions on agricultural water allocation are often onerous tasks due to the confliction among water users. This paper presents a hydrological modeling approach to assist decision-makers and stakeholders to resolve potential water-sharing conflicts among water users. We combine the land use map with water distribution methods to solve the water allocation problems in a large basin scale. The model is tested and applied in three steps: (i) calibration and validation of water supply and demand along the Tarim River with a combined hydrological and groundwater model, (ii) developing climate change scenarios, (iii) optimizing agricultural water allocation for the entire Tarim River Basin for these scenarios and deriving of conclusions. The comprehensive management of farmland areas and water distribution strategies are investigated in the model scenarios. The results of these assessments provide opportunities for substantial improvement on water allocation and water right. The access of a user to use the water efficiently should be guaranteed, especially in the lower reaches of the river in the arid land. In practice, the hydrological model assists on decision-making for water resource management in a large river basin, and incentive to utilize water use in an efficient manner.

1. Introduction

A hydrological model for making water allocation strategies needs to consider both spatial and temporal variables, including land use, surface water routing, groundwater movements, water extractions, irrigation, and their interactions. On the other hand, an increasing number of model parameters often leads to high computational complexity, which enhance the difficulty on the analysis of simulation results and future scenarios.

Currently there are many catchment water allocation tools, such as CWAM, (Wang et al., 2008), REALM (George et al., 2011), MIWA (Dai and Li, 2013), CaWAT (Cai, 2014). These models often face difficulties in balancing model complexity and processing time in large basin modeling. A recent-developed software MIKE HYDRO provides a possible solution for managing water allocation problems in macro scale. MIKE HYDRO has the advantage of conjunctive simulation of spatial and temporal variables within low computational time, and thus beneficial for integrated water resources management (IWRM) in a large-basin project. IWRM has become a popular concept in recent years, but its track record in the application of more efficiently manage macro-scale water projects has been dismal (Biswas, 2008). In this paper, a case study is conducted on a typical dry land of central Asia, the Tarim River Basin.

Located on the fringe of Taklimakan Desert in Northwest China, the Tarim River Basin is one of the most arid region in the world. In the oasis along the Tarim River, water scarcity is crucial and typical in arid regions. Management decisions on agricultural water allocation are often onerous tasks due to the confliction among water users. It is difficult for hydrological models to provide practical and scientific solutions on IWRM. So far most studies about the Tarim River Basin focused on individual factors or driving forces of water scarcity, such as climate change (Chen et al., 2006), population increase (Zuo et al., 2015), agricultural development (Feike et al., 2015), excessive water exploitation and ecosystem degradation (Feng et al., 2001; Xu et al., 2008; Ye et al., 2014). There is a lack

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of studies addressing the management practice of water allocation strategies along the mainstream of the Tarim River at macro-spatial and temporal scales (Huang et al., 2012; Liu et al., 2013; Zhang et al., 2015; Thevs et al., 2015; Sun and Zhou, 2016).

One of the fundamentals of water allocation is that any form of abstraction, transfer, storage or other influences on natural stream has effects on the entire downstream river system (CAP-NET, 2008). The water authority must carry out a comprehensive management on the entire river basin. Xinjiang Tarim River Basin Management Bureau is such a management authority which is in charge of the water resources management in the entire Tarim River Basin. The bureau was established in 1990 and reports directly to the Xinjiang autonomous district government. Before that, water management decisions were made by counties and regiments along the river. The discussions with decision-makers in the bureau led to two questions which need to be solved urgently: (i) how much farmland area shall be irrigated each year, and (ii) how to distribute the water in the entire basin.

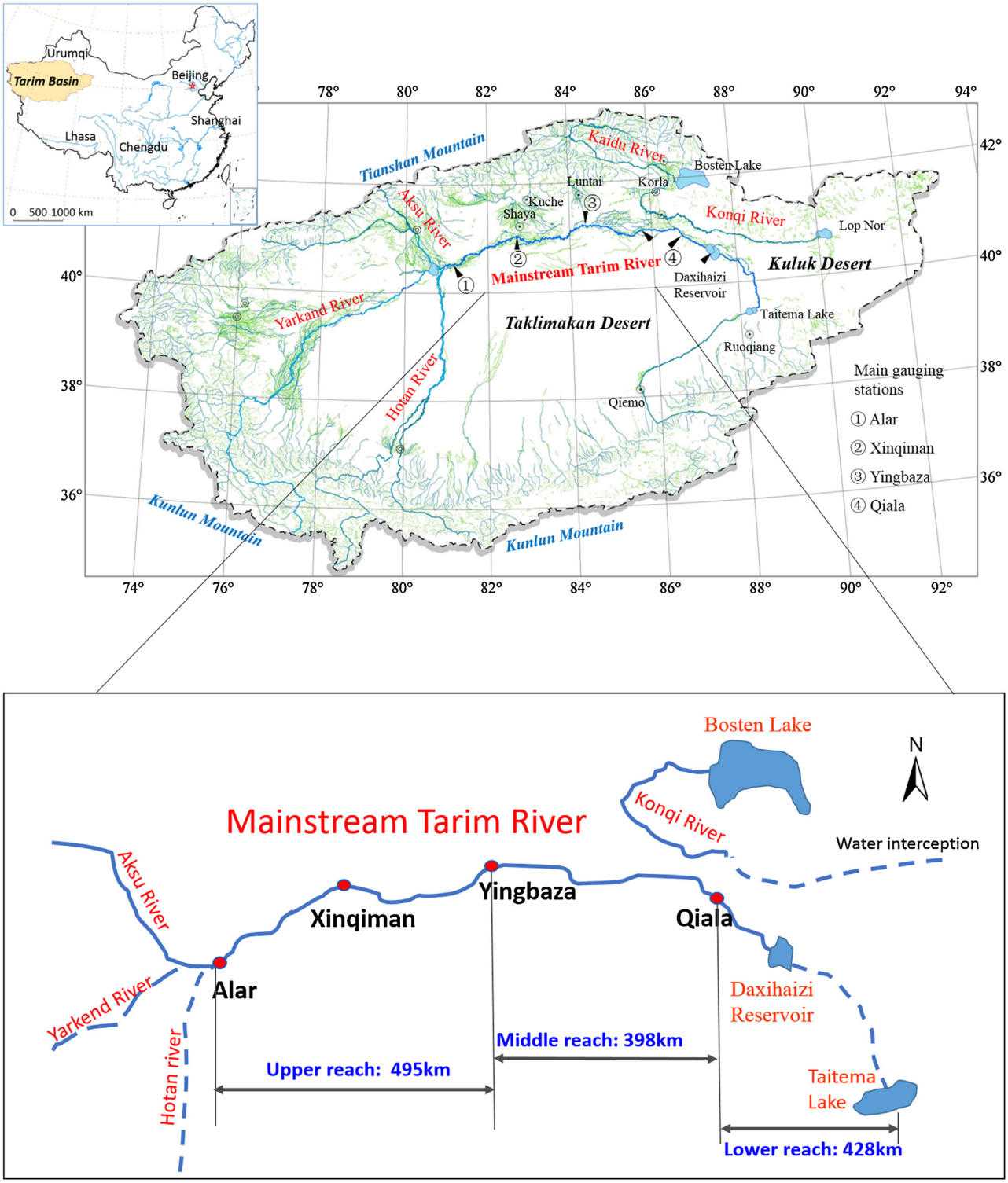

Fig. 1. Mainstream Tarim River and gauging stations.