Ecosystem Services 25 (2017) 213–226

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

Incentive-compatible payments for watershed services along the Eastern Route of China's South-North Water Transfer Project

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ARTICLE INFO

Article history:
Received 23 December 2016
Received in revised form 1 April 2017
Accepted 15 April 2017

Keywords:
South-North Water Transfer Project
Eastern route
Payments for watershed services
Evolutionary game
Numerical simulation

ABSTRACT

In transboundary rivers, upstream and downstream users have different interests, which affect their willingness to pay to protect the river's ecological services. This is true of the Eastern Route of China's South-North Water Transfer Project (SNWTP), with the added complication that the State Council Office (of SNWT Construction Committee) supervises upstream and downstream users. This paper analyses the strategies of upstream users, downstream users and the State Council Office, to explore an incentive-compatible system of payments for watershed services through a tripartite evolutionary game model. The results demonstrate that: First, whether lower Yangtze governments can obtain payments for reduced access to water depends on State Council Office's supervision costs. Second, upstream and downstream users' initial willingness to participate may determine the ultimate evolutionary stable strategy. Third, State Council Office could ensure that payment system works, by increasing punishment for users that are initially unwilling to pay for watershed services. Fourth, high opportunity costs and high payments to upstream governments reduce the upstream and downstream users' incentives to participate. All these factors need to be considered in designing payment systems for watershed services to establish an incentive-compatible scheme and realize appropriate water governance in SNWTP.

1. Introduction

Increasing demand for irrigation, domestic and industrial water have produced a huge growth in the number of large-scale water infrastructure projects. Many of these projects involve water transfer from basins of surplus supply to those in deficit, and are not only in developed countries (Davies et al., 1992; Meador, 1992) but also in developing countries (Griffin et al., 1989). Developed countries adopt water transfers to improve water use efficiency in all sectors of the economy, while developing countries use water transfers to meet untrammeled water demand (Ghassemi and White, 2007). After investing approximately $20 billion and resettling more than 300,000 people (Ministry of Water Resources, 2002), China's SNWTP has become the largest and most expensive inter-basin water transfer megaproject in the world (Pohlner, 2016). Its middle and eastern routes are now operational (Fig. 1). The combined transfer capacity has reached 18.4 billion m^3, and will reach 27.82 billion m^3 according to long-term plans (Ministry of Water Resources, 2002). The SNWTP aims to change the uneven spatial distribution of water resources in China by bringing water from the Yangtze River to North China.

In 2013, the first phase of the Eastern Route was completed. Unlike building new trunk canals in the Middle Route, the Eastern Route expands the scale of Yangtze River Water Transfer Project in Jiangsu Province and extends it north. The Eastern Route makes full use of the Beijing-Hangzhou Grand Canal and the existing rivers in the Huai and Hai River Basins, and connects the downstream regions of four major river basins – the Yangtze River, Huai River, Yellow River and Hai River basins. However, pollutants in the four basins have a serious impact on the quality of transferred water (Ministry of Environmental Protection, 2001). The Eastern Route passes through two of the most developed areas in China – the Yangtze River Delta and the Bohai Rim. With the vigorous development of manufacturing industry, water pollution has become particularly prominent in these regions. Large amounts of untreated industrial wastewater are directly discharged to the lakes and rivers along the Eastern Route, and non-point source pollution caused by agricultural production causes a huge threat to these rivers and lakes (Zhang, 2009). For example, Jiangsu, one of the provinces

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http://dx.doi.org/10.1016/j.ecoser.2017.04.006
2212-0416/

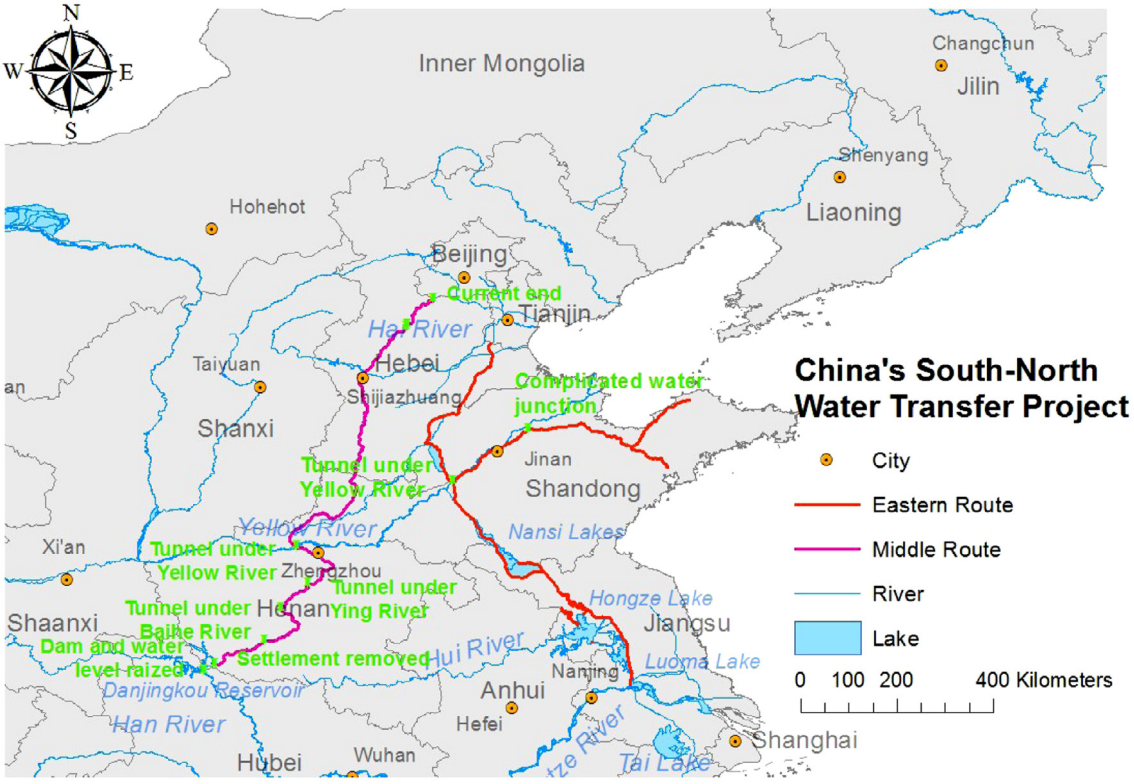

Fig. 1. The Eastern and Middle Routes of China's South-North Water Transfer Project Source: Author's work.

along the Eastern Route, contributed about nine per cent of China's total wastewater discharge in 2013 (Yang et al., 2015).

Systems of payments for watershed services provide financial incentives for dealing with water pollution in watersheds, and have become an important tool of environmental governance (Bennett et al., 2014). In 2013, there were at least 345 such payment systems in the world (Bennett and Carroll, 2014), significantly more than the 127 projects in 2008 (Stanton et al., 2010). Payments for watershed services allow government agencies to pay landowners in an upstream region for their watershed services in order to reduce water pollution in a downstream region (Webb and Martin, 2016). China is the largest investor in such payment systems in the world: the government invested $11.5 billion in 2013, accounting for 94% of global investment in payments for watershed services (Bennett and Carroll, 2014). China's payment systems are generally concerned with ecological services and pollution related to watersheds; they have been widely used to protect water quality by encouraging cooperation between the governments in upstream and downstream regions (Zhang and Bennett, 2011). Since the 1990s, some systems of payment for watershed services have been implemented in the Yangtze River, Yellow River and Huai River basins; however, the systems did not have appropriate legal authority (Wang et al., 2016). A scheme similar to payments for watershed services is called 'ecological compensation' or 'eco-compensation' (生态补偿) in China (Dong and Wang, 2011; Pohlner, 2016); it combines payments for watershed services with the "polluter pays" principle to balance the costs and benefits between upstream and downstream regions (Dai, 2014). The eco-compensation scheme is intended not only to compensate for the right that is foregone in order to maintain a certain watershed service, but also to charge for ecosystem loss (Zhang et al., 2010). Therefore, eco-compensation for SNWTP in China is defined in both narrow and broad terms. The narrow definition, which is comparable with payments for watershed services, refers to incentives for water quality protection; the broad definition includes not only incentives but also water pollution charges (Dai, 2014). In 2014, the newly revised environmental protection law proposed to establish and improve China's eco-compensation policy (National People's Congress, 2014). Since there is a series of laws and regulations for water pollution charges in China, this paper focuses more specifically on the narrow definition of eco-compensation, i.e. payments for watershed services.

Water governance requires policy design and implementation in a complex system (Huang and Xia, 2001). The significant characteristic of water governance in the Eastern Route is that the pollutants flow across administrative boundaries, from Jiangsu Province (upstream) to Shandong Province, Hebei Province and the municipality of Tianjin (downstream). As a result, cooperation between local upstream and downstream governments is necessary to address transboundary environmental issues. However, the uneven distribution of the costs and benefits between upstream and downstream regions may lead to the failure of water governance (Wang et al., 2016). To maximize the ecological and environmental benefits of the Eastern Route, the costs and benefits of water governance need to be balanced among different watershed regions. Thus, the distribution of costs and benefits of payment systems for watershed services along the Eastern Route naturally forms a game relationship among the stakeholders along the Route.

The system of payments for watershed services along the Eastern Route involves several game players, including local upstream and downstream governments, regions of the lower Yangtze River and the central government. However, the current literature generally emphasizes upstream and downstream sectors (such as Li et al. (2014) and Wei et al. (2010)), while the interests the lower Yangtze River are ignored (Pohlner, 2016). From the perspective of understanding cooperation in water governance, game theory provides some clues beyond the answers that traditional water