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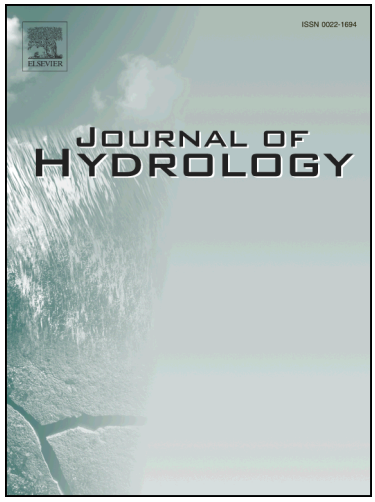

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Efficiency Evaluation with Feedback for Regional Water Use and Wastewater Treatment

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Abstract

Clean water is crucial for sustainable economic and social development; however, around the world low water use efficiency and increasing water pollution have become serious problems. To comprehensively evaluate water use and wastewater treatment, this paper integrated bi-level programming (BLP) and Data Envelopment Analysis (DEA) with a feedback variable to deal with poor output to rank DMUs using a super efficiency DEA. The proposed model was applied to a case study of 10 cities in the Minjiang River Basin to demonstrate the applicability and effectiveness, from which it was found that a water system can only be cost-efficient when both the water use and wastewater treatment subsystems are both cost-efficient. The comparison analysis demonstrated that the proposed model was more discriminating, and stable than traditional DEA models and was able to better improve total water system cost efficiencies than a BLP-DEA model.

Keywords: Bi-level programming, Data envelopment analysis, Cost efficiency, Water use, Wastewater treatment

1. Introduction

Water is essential for all social and economic activities (Pedro-Monzons et al., 2015; Hanasaki et al., 2013). Growing populations and rapid economic development have resulted in adverse environmental impacts, water scarcity, and serious water pollution (Han et al., 2016; Kummu et al., 2010). Further, in many cases, water is either wasted or water use efficiency is extremely low, all of which aggravates the possibility of a serious water crisis. Fortunately, it has been realized that total water system efficiency involves both water use and also wastewater treatment. Therefore, the evaluation of water use and wastewater treatment efficiencies has become an urgent research focus.

Over the past few decades, water use efficiency has gained increasing attention. Wen et al. (2014)

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