

A Quantitative Assessment of Watershed Resilience: A Case Study of the Heihe River basin in Northwestern China

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The Heihe River Basin has been through significant transformation and the sustainability of its water network has been significantly altered by mankind as a result of historical agricultural activity and the more recent water infrastructure investments. While there are many studies examining the sustainability of the Heihe River Basin, most studies focus on single issue criteria and do not have a holistic system-level perspective. As sustainability is a system-level trait a system-level analysis is warranted. The objective of this study is to investigate sustainability of the Heihe River Basin through the ecological network analysis (ENA). We established a framework of the ecological network analysis that can be used to examine sustainability of a river basin. We collected detailed data from the flow network, such as precipitation, river discharge, groundwater storage change in the Heihe River Basin from 2000 to 2010. We also estimated evapotranspiration from different land uses based on the heat balance at the surface using the daily mean air temperature, relative humidity, and wind speed. Compared to previous studies (Li et al., 2009; Li and Yang, 2011), our study successfully combined hydrological model into the existing method of the ecological network analysis. The system-level metrics of the basin were measured and through these metrics the evolution of the basin was examined. Specifically through the metrics of efficiency, resilience, redundancy, cycling, and robustness, the long term effects of agricultural development and the more recent effects of water infrastructure investment in the Heihe River Basin. The proposed ENA methodology is significant in terms of ability to examine sustainability from several different key concepts such as efficiency, resilience, redundancy, cycling, and robustness. This method can be incorporated into existing decision-making support system for integrated water resources management in the river basin. We highlight the importance of combining the proposed ENA methodology into a framework of multi-criteria decision analysis, so called MCDA.

Keywords: Ecological Network Analysis, Sustainability, Resilience, Efficiency, Robustness, Water Resource Management