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研究課題名(和文) 効率性と公平性に着目した水資源管理政策に関する計量的研究

研究課題名(英文) An Integrated Econometric Assessment of Water Resources Management: Efficiency & Equity

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研究成果の概要(和文)：中国西北部に位置する黒河流域を事例に、効率性と公正性の両面から水資源管理の政策影響を評価し、その統合的フレームワークについて検討した。統計データおよび家計調査のデータに基づいて計量分析を行った結果、昨今の改革がより効率的な水利用に貢献したが、それが水利用システム全体のレジリアンスの低下とのトレードオフで実現できたことが検証された。また、地域住民の水需要は、価格の変化に非弾力的であることを明らかにした。

研究成果の概要(英文)：This research aims to propose an integrated framework to assess policy options of water resources management in terms of two pillars: economic efficiency and social equity. Combining the analytical results based on both statistical data of water consumption of each environmental/socioeconomic sector and household survey data in Zhangye City, northwestern China, we found that, recent policy changes including the adoption of economic/market-oriented instruments did contribute to a more efficient water use, however, this has been achieved with a trade-off of decreasing levels of system resilience. In addition, local residents' water demand appeared to be inelastic to the changes of water price.

研究分野：開発経済学

キーワード：Econometric analysis Environmental policy China

1 . 研究開始当初の背景

Improving water resources management is the key in solving severe water crisis in the world as well as is an issue of complexity due to its relevancy to food security, poverty reduction, economic development, climate change, environmental conservation and so on. The literature to date has mostly focused on the water balance study within a river basin. In recent years, along with the prevalence of concepts including virtual water and water footprint, substantial studies shift to the quantitative measurement of water flows across the borders of river basins and/or nations.

The biggest challenge facing the literature is how to assess economic perspective of various policy options in water resources management. In economic literature, Input-Output analysis has been applied to address this challenge. Input-Output analysis is a useful technique to explore the relationships between economic activities and water consumption. It emphasizes on water accounting and realization of future economic growth depending on more productive inter-sectoral/inter-regional water re-allocation. However, the literature applying Input-Output analysis bears two shortcomings. First, Input-Output analysis only captures the operations of production economy. It addresses overall allocation efficiency of water supply based on economic gains; however, the efficiency consideration towards higher value use neglects the issue of social equity. Second, Input-Output analysis is useful in measuring the impacts of macro-economic structural changes; however, it cannot capture the institutional changes at the micro-economic level, for instance, the introduction of Water Users' Association to promote public participation in water management.

2 . 研究の目的

This research aimed to propose an integrated framework to assess policy options of water resources management in terms of two pillars: economic efficiency and social equity. Based on both statistical data of water consumption of each environmental/socioeconomic sector and household survey data, this research used China as a case study to examine impacts of different scenarios of policy changes and identify desirable policy mix.

3 . 研究の方法

We adopted three main methodologies in this research project:

- 1) ENA (Ecological Network Analysis) approach adopted to investigate the

sustainability of the water use system, and consequently further the understanding of the impacts of recent water policy changes taking into account the integrity and organization of the system.

- 2) Semi-structured questionnaire survey targeting farm managers (1/1,000 rural population) in Zhangye City of northwestern China to identify major water users' behavior;
- 3) MBDC (multi-bounded discrete choice) model adopted to analyze household survey data and consequently explore farmers' acceptability of different levels of water price for irrigation facility improvement;

4 . 研究成果

Combining the analytical results based on both statistical data of water consumption of each environmental/socioeconomic sector and household survey data in Zhangye City, northwestern China, we found that, recent policy changes including the adoption of economic/market-oriented instruments did contribute to a more efficient water use; however, this has been achieved with a trade-off of decreasing levels of system resilience. In addition, local residents' water demand appeared to be inelastic to the changes of water price.

- 1) To measure complex relationship among various hydrological components using ENA approach, we built an 8 compartment steady-state network model to represent the flows of water within the water use system. The environmental compartments such as precipitation of water in the form of rain, river body from the upper reaches, groundwater body in the locality distribute water to four socioeconomic compartments including agricultural usage, landscape usage, industrial usage, and households (domestic usage). Finally the outflow compartment represents the input of water to the lower reaches. The system was then described by three network flow matrices for model calibration.

We found that, the trend of system efficiency is positive between 2000 and 2009, while the trend of redundancy is negative during the same period. The lower levels of resilience is presumably due to the increases in efficiency and decreases in redundancy and can be interpreted as increasing brittleness of the system. We concluded that water saving policies in the region might be successful in terms of efficiency improvement; however, this success came with a trade-off of decreasing levels of system resiliency. In addition, the decrease of groundwater recharge from

irrigation seems to be the main reason for the decrease of resiliency in the system. In one word, system resilience was sacrificed to achieve a more efficient water use.

- 2) We conducted a household survey and received 648 responses in total. The data were processed using MBDC model to explore the willingness to pay of farmers regarding irrigation water, as well as the social-economic factors which might influence farmers' willingness to pay. We found that, farmers' willingness to pay regarding irrigation water in Zhangye city is not significantly different from the current price level. In addition, social-economic factors including household income, gender, nonfarm activities can barely explain the changes of water use amount. We concluded that water charge might reach a low level of equilibrium at this moment, especially compared to other production costs of farmers such as fertilizer expenditures, so farmers' water demand is inelastic to price changes of water.

5. 主な発表論文等

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〔その他〕
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