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Scarce water footprint of energy production in China

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Abstract

Water shortage and uneven distribution posed significant challenge to sustainable energy production in China. We integrated extended mix multi-regional input-output model with water scarcity to analyze consumption water footprint and virtual water flows in inter-regional trade of energy production in China. The results show that electricity is the dominant sector of scarce water consumption per unit energy product in China. Remarkable regional difference is manifested for scarce water footprint per unit electricity production. Non-electrical energy production is recommended in north and northwest China due to both high water and scarce water consumptions. In the regions with lower scarce water consumptions, however, electrical industry is suggested to be developed, such as Guangdong, Zhejiang, Fujian and Hainan provinces.

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Keywords: Energy production; Multi-regional input-output

1. Introduction

The interdependence between water and energy, sometimes called water-energy nexus, is growing significant accompany with the increasing demand on both water and energy demand in China. Energy is necessary for water withdraws and treatment, while virtually almost each stage for the energy supply

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required large amount of water, e.g., drilling and fracturing in oil and gas exploration [1-2], cooling water for generating electricity in heat power plant [3].

Abbreviation

WF	water footprint
SWF	scarce water footprint
MRIO	multi-regional input-output
A	technological coefficients
fc	water footprint coefficient
fs	scrarce water footprint coefficient
I	identity matrix
X	total output
Y	final demand

Subscript

r	r-th region
s	s-th region
i	i-th sector
j	j-th sector

Since energy sector is the second largest water consumer in social economic system of China [4], it is crucial to quantify the total water consumption embodied in energy production for effective water resource management and policy making. Moreover, the same amount of water consumption for energy production in water rich region and water scarce region may have various environmental impacts on local water resource endowment. Thus, it is necessary to incorporate the local water scarcity level into the water resource accounting of energy production considering the spatial disparity of water resource distribution of China. There are several studies assessing water footprints for energy production in China, either focus on a particular region or specific treatment process [5-9]. In this study, regional difference of water shortage is introduced into water footprint accounting of energy production in China, representing the influence of degrees of water scarcity on energy production in local areas. In this way, regional virtual water flows characteristics of energy production can be addressed, and the spatial diversity environmental influence caused by the energy production can be revealed.

Extended mix model for scarce water consumption of energy production was thereby built in this paper. Scarce water consumption for eight energy products including coal, crude oil, natural gas, petroleum products, coke, electricity, heat, and gases were qualified to distinguish the spatial characteristics for scarce water footprint of China's energy production and identify the scarce water-related implications for energy policies of China.

2. Methodology