Study on the Potential and Path of Collaborative Governance of Energy and Water in China

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BACKGROUND

Energy and water are two important resources for human survival and economic development. With the rapid development of social economy, the social demand of these two resources is increasing rapidly. At present, China is facing the problems of energy and water security at the same time, and the management of energy and water resources is also facing severe challenges. More and more studies have proved that these two kinds of resources are closely related and interdependent. However, these two kinds of resources are managed in different departments in China, and the energy and water resources policies also independent of each other. Therefore, realizing the collaborative governance of energy and water is one of the effective ways to solve these two resource crises. There are significant differences in socio-economic development and industrial structure of different provinces of China, as well as in the industry characteristics of energy use and water use. The co-governance of energy and water needs to be studied in different province.There are few studies on coordinated energy and water governance from the provincial level.

METHODOLOGY

(1) Environmentally extended input-output model (EEIO)

$X=(I-A)^{(-1)}Y=LY$------X is the matrix of total output; A is the direct requirement coefficient matrix representing the ratios of sector inputs to sectoral outputs and element; Y is the final demand vector including rural and urban household consumption, government consumption, fixed capital formation, exports, and others; $L=(I-A)^{(-1)}$ is the Leontief inverse matrix.

The input-output model of environmental expansion (EEIO) can be obtained by introducing the intensity coefficient F into the input-output base model.

$S_i=f_{import(i)}/(x_i+f_{import(i)})$------$x_i$ and $f_{import(i)}$ are the total output and imports of sector i, respectively;

$A_d=(I-S')\times A$------S' is the diagonal matrix of S_i $(n\times1)$;

$Y_d=(I-S')\times Y$------A_d and Y_d are the adjusted values of the IO coefficient matrix and final demand matrix, respectively.

$E=F'(I-A_d)^{(-1)}Y_d$------in this study, F represents the energy intensity and water resource intensity per unit output of each industry.

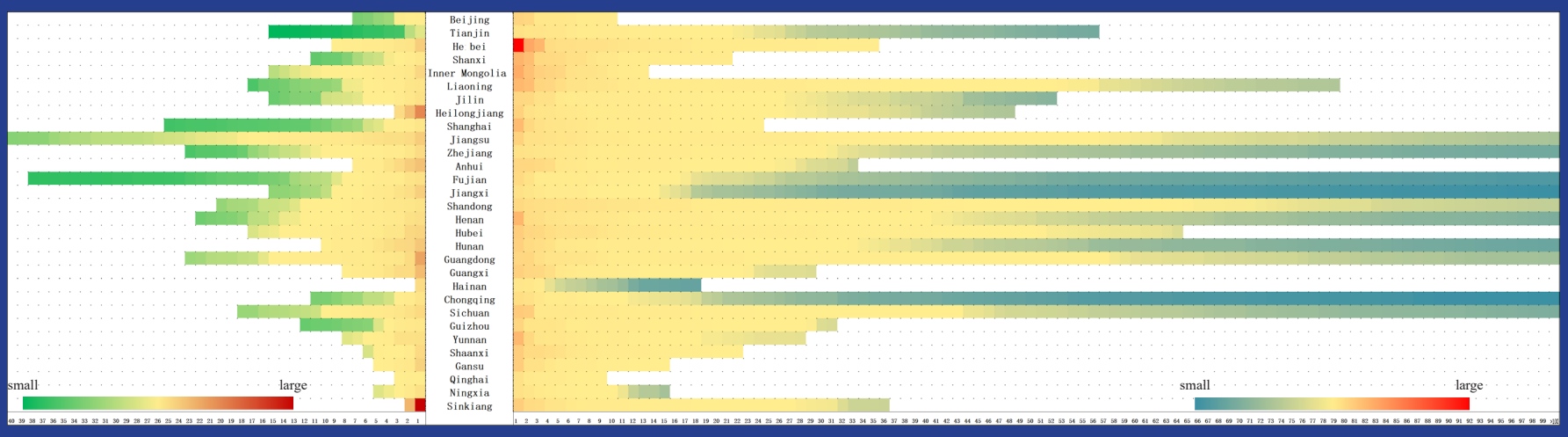
(2) Structure Path Analysis (SPA)

$L=(I-A)^{(-1)}=I+A+A^2+A^3+A^4+...+A^t$;

$E=F'\times(I-A_d)^{(-1)}Y_d=FIY_d+FA_dY_d+FA_d^2Y_d+FA_d^3Y_d+...+FA_d^tY_d$;

RESULT

(a)The concentration of energy and water in the supply chain varies greatly in different provinces, and water resources are more concentrated than energy.



The figure shows the number of paths for 50 percent of the total energy and water resources in each province. On the left is the path of the water supply chain, and on the right is the path of the energy supply chain. Different provinces have different concentrations of energy and water supply chains.

(b)Four provinces, Beijing, Tianjin, Henan and Fujian have shown the potential for better coordinated energy and water governance.

	Beijing	Tianjin	Henan	Fujian
Rural household consumption-Agriculture			√	√
Rural household consumption-Others			√	√
Rural household consumption-Food processing and tobaccos-Agriculture			√	√
Urban household consumption-Agriculture-Agriculture			√	
Urban household consumption-Agriculture		√	√	√
Urban household consumption-Electricity and hot water production and supply				√
Urban household consumption-Others	√	√	√	√
Urban household consumption-Food processing and tobaccos-Agriculture			√	√
Government consumption-Agriculture			√	√
Government consumption-Others	√	√	√	√
Fixed capital formation-Construction		√	√	√
Fixed capital formation-Construction-Nonmetal products			√	√
Fixed capital formation-Construction-Metal smelting and rolling products				√
Fixed capital formation-Construction-Transport and storage				√
Fixed capital formation-Others	√	√	√	√
Exports-Agriculture				√
Exports-Chemical industry				√
Exports-Others	√			√
Exports-Food processing and tobaccos				√
Exports-Clothing, leather, fur, etc.				√
Outflow from other provinces-Food processing and tobaccos			√	
Outflow from other provinces-Paper making, printing, stationery, etc.				√
Outflow from other provinces-Wholesale and retailing and hotel and restaurant	√	√		
Outflow from other provinces-Transport and storage		√		
Outflow from other provinces-Others	√	√	√	
Outflow from other provinces-Food processing and tobaccos-Food processing and tobaccos-Agriculture			√	
Outflow from other provinces-Food processing and tobaccos-Agriculture		√	√	√
Outflow from other provinces-Clothing, leather, fur, etc.				√

The graph on the left shows the number of co-governance paths among the top 50 percent of the total energy and water resources in all provinces, respectively, and the proportion of energy and water in the total. Beijing、Tianjin、Henan and Fujian have shown the potential for better coordinated energy and water governance. Through collaborative management, more than 10% of energy and 30% of water can be managed simultaneously.The graph on the right shows co-governance paths for the four provinces.

(c)There are some common paths that can contribute to the collaborative management of energy and water.

"Urban household consumption-Others" 、" Government consumption-Others" and "Fixed capital formation-Others" are the common paths for collaborative management of energy and water for the four provinces.

CONCLUSIONS

This paper studies the potential and potential path of energy and water collaborative management in 30 provinces of China by means of environmentally extended input-output model and structural path analysis, result shows from the perspective of supply chainwater resources are more concentrated than energy, and different provinces have different concentrations of energy and water supply chains.Beijing、Tianjin、Henan and Fujian have shown the potential for better coordinated energy and water governance. Through collaborative management, more than 10% of energy and 30% of water can be managed simultaneously. They have three common paths for collaborative management of energy and water, which are "Urban household consumption-Others" 、" Government consumption-Others" and "Fixed capital formation-Others" .