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Analysis of the relationship between food production, water resources and power consumption in North China

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Abstract

North China is the major part in China's Huang-Huai-Hai grain production region, takes great responsibility to the collaborative development of Beijing, Tianjin and Hebei province. As the major driving factors of social and economic development, water resources and power play an important with the promotion and restriction between water and power consumption. In view of the shortage of water resources and severe overexploitation of groundwater in North China, the article selected the North China Plain, a concentration zone of the Huang-huai-Hai major grain production region, analyzed the relationship between grain production and the consumption of water and power through statistics data. The results show that the development of the irrigation agriculture greatly promoted the increasing of the grain production in the study area; and the groundwater is still dominant water resources in the farmland irrigation although there are the decreasing trend of the total water utilization amount and consumption structure of the increase of surface water consumption. And, the exponential relationships are obvious between groundwater consumption and the food output, as well as between groundwater consumption and power consumption in irrigation and drainage production process. The mutual relationship of the three has indicated that the exploitation of ground water within the region has greatly promoted food productivity and further increased power consumption. Therefore, it has been suggested to strictly restrain the exploitation of groundwater through power control under the premise of guaranteeing food safety by integrating the mutual relationship among food, water resources, and power consumption, which is not only conductive to improving the utilization efficiency of water resources and mitigating groundwater overexploitation, but also important for reducing regional power consumption.

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Keywords: food production; farmland irrigation; groundwater;power consumption;North China

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1. Introduction

North China is a major part of the China's Huang-Huai-Hai grain production area; takes great responsibility to the collaborative development of Beijing, Tianjin and Hebei province. However, due to the lack of harmony between regional water resources and the social-economic development, it has become a region with the most severe water resources shortage in China's watersheds; along with the practice of continuously compensating surface water shortage with groundwater exploitation, the groundwater depression created by the overexploitation of groundwater in the North China Plain has already resulted in social, economic, and ecological environment issues. According to the statistics, the rate of water resources development and utilization in North China has reached up to 105.2%, which has significantly exceeded the 40% internationally-accepted alarm rate level. The three major deep groundwater depressions have been emerged covering Ji-Zaozhuang-Hengshui, Cangzhou, and Nangong. According to the analysis of the Implementation Scheme of Groundwater fracturing exploitation in Hebei Province, the annual volume of groundwater overexploitation in Hebei province approximates 6.8 billion m^3, and the cumulative volume of its overexploitation exceeds 100 billion m^3. At current, the area of groundwater exploitation accounts for more than 90% of the total plain areas due to the continuous increase of agricultural irrigation water consumption.

Facing with the severe water resources situation, in order to reasonably use the limited water resources and guarantee the productivity in the Huang-Huai-Hai major grain production area, four national departments and commissions, as well as the provincial government of Hebei province successively has been carried out the "groundwater fracturing exploitation pilot scheme," "transformed administrative fees into taxes," and implemented other relevant pilot explorations with an aim at standardizing agricultural water consumption. During the process, it is essence to accurately measure agricultural water utilization. However, the accurate quantity technique has been lack in agricultural water utilization in the macro-scale for a long time due to the kinds of reasons with the regional variety, and the complex water allocation network in agricultural, as well as agricultural plant mode decided by every water user. At present, the estimated method of the groundwater exploitation amount has been progress from the groundwater level and statistical water balance estimation in the small zone to remote information utilization in the macro-scale which is mainly trend in future in macro-scale with the development of the remote technology [1,2], they supply good method to estimate the amount of the groundwater over exploitation. But they are difficulty in directly measuring the groundwater exploitation amount consumed by agricultural irrigation. Considering the power is directly driving force of the groundwater exploitation, there is an direct relationship between power consumption and the amount of groundwater exploitation, Therefore, the article analyzed the relationships between food production, water resources consumption, and power consumption during the grain production in North China plain by the historical statistic data in order to support for the precise control of ground water overexploitation. Meanwhile, it is also of great significance for the mitigating power shortage in North China.

2. Study Area

North China consists of Beijing, Tianjin, Hebei province, and partial areas of Shanxi province and part of Inner Mongolia. The agricultural production mainly concentrates in the Northern China plain, namely the Beijing-Tianjin-Hebei region. The North China plain lies in a temperate semi-humid continental climate zone with four distinctive seasons and sufficient sunlight, is a suitable planting area of winter wheat. Meanwhile, it is China's the political and cultural Centre of an economically-developed region. According to the statistics, in 2015, the population in the region had reached up to 110 million accounting for 8.0% of the national amount and exceeding the Philippines, which ranks 12th in the world. The GDP is approximately 6.9 trillion RMB yuan, accounting for 10.2% of the national value and exceeding Indonesia, which ranks 16th in the world. The food production reaches approximately 36.08 million tons, accounting for 5.8% of the national food output.

However, water resources conditions appear to lack optimism. According to statistics from the water resources bulletin [3], the total volume of water resources in Beijing, Tianjin, and Hebei province is of 25.8 billion m^3, while the water resources volume per capita is 233m^3 (according to the population in 2015), far less than the internationally-accepted per capita extreme shortage standard of 500m^3, approximating 11% of the national water resources volume per capita. Meanwhile, due to the influences of global climate change, water resources volume declined sharply (seen Fig. 1), which has worsened the situation of the water resources shortage. Furthermore, along with the synergetic

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