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Geographical Evolution of Agricultural Production in China and Its Effects on Water Stress, Economy, and the Environment: The Virtual Water Perspective

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Agricultural production is accompanied by a large amount of water consumption, nonpoint source pollution, and greenhouse gas emissions. However, the comprehensive and quantitative analysis of associated impacts on regional water, the environment, and the economy caused by variations in agricultural distribution is insufficient. This paper evaluates the evolution of grain production distribution and its effects on water resources, the economy, and the environment in China by using virtual water theory. The results show that the grain production area located in northern China is characterized by scarce water resources and a less developed economy. Due to the imbalance between grain supply and demand, virtual water embedded in grain will transfer among regions. These flows have formed a pattern where virtual water transfers from the water-scarce northern region to the water-rich southern region. Evolution of grain production distribution changes the spatial pattern of grain production and consumption, and it exacerbates water resource pressure, the gray water footprint, and greenhouse gas emissions in the area that exports grain virtual water. The gray water footprint and carbon emissions in the grain export area increased by 10.66% and 31.06% during the study period, respectively. Meanwhile, the distribution of regional grain production influences the allocation of water resources in agriculture and other industries. Due to the difference between the economic benefits created by industry and agriculture, grain virtual water flow will have effects on the regional economic development.