

EGU2020-3208

<https://doi.org/10.5194/egusphere-egu2020-3208>

EGU General Assembly 2020

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Non-negligible regional differences in the driving forces of crop-related water footprint and virtual water flows: a case study for the Beijing-Tianjin-Hebei region

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Water scarcity is a significant risk for meeting increasing food demand around the world. The importance of identifying the driving forces behind water consumption in agriculture and relative virtual water (VW) flows has been widely reported in order to provide practical advice for sustainable agricultural water resource management. However, the regional differences in the driving forces behind either water consumption or VW flows were largely ignored. To fill the crucial gap, taking nine major crops grown in the Beijing-Tianjin-Hebei (BTH) region in China over 2000-2013 as the study case, we investigate the regional differences in socio-economic driving forces on both the estimated water footprint (WF) in crop production and relative inter-city VW flows for each crop per year. Results show that although there is little change in total WFs in crop production (~43.3 billion m³/y on annual average), the WF per unit mass of crop decreased and the crop structure in the total WFs changed greatly. The BTH region was a VW importer with net VW import of 11.7 billion m³/y by 2013. The per capita GDP was the main positive driver of both total WFs of crop production and relative VW flows. Whereas the economic productivity and consumption ability were inhibiting factors for the WFs and VW flows, respectively. The levels of total crop WFs in agricultural cities were more sensitive to the effects of the main driving factors. The intensity of driving factors behind the inter-regional crop-related VW flows was shown to be directly related to the regional role as an importer or exporter. The current analysis suggests to develop characteristic agriculture considering the local role and regional differences in terms of water consumption and relative inter-regional VW flows, aiming for a balance between water sustainability, food security and economic developments.