

EGU2020-3366

<https://doi.org/10.5194/egusphere-egu2020-3366>

EGU General Assembly 2020

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Agricultural infrastructure: the forgotten key driving force on crop-related water footprints and virtual water flows in developing countries: a case for China

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Agricultural infrastructure plays important roles in boosting food production and trade system in developing countries, while as being a 'grey solutions', generates increasingly risks on the environmental sustainability. There is little information on impacts of agricultural infrastructure developments on water consumption and flows, (i.e. water footprint and virtual water flows) related to crop production, consumption and trade especially in developing countries with high water risk. Here we, taking mainland China over 2000-2017 as the study case, identified and evaluated the strengths and spatial heterogeneities in main socio-economic driving factors of provincial water footprints and inter-provincial virtual water flows related to three staple crops (rice, wheat and maize). For the first time, we consider irrigation (II), electricity (EI) and road infrastructures (RI) in the driving factor analysis through the extended STIRPAT (stochastic impacts by regression on population, affluence and technology) model. Results show that the II, EI and RI in China were expanded by 33.8 times, 4.5 times and 2.4 times, respectively by year 2017 compared to 2000. Although the II was the most critical driver to effectively reduce the per unit water footprint, especially the blue water footprint in crop production (i.e., increasing water efficiency), the developments of II led to the bigger total water consumption. Such phenomenon was observed in Jing-Jin region, North Coast and Northwest China with water resource shortage. The EI and RI had increasing effects on provincial virtual water export, and the corresponding driving strengths varied across spaces. Obviously, the visible effects from the agricultural infrastructures on regional water consumption, water productivity and virtual water patterns cannot be neglected.