Blue and Green Virtual Water Flows within China

Authors: Pia Rothe, Dr. Anne Biewald, Dr. Susanne Rolinski, Dr. Hermann Lotze-Campen, Prof. Harald von Witzke

Introduction

The specific population pattern in China and the technical development in the agricultural sector lead to the paradox situation, that food crops and therefore huge amounts of virtual water are transported from the water scarce northern regions of the country to the water endowed south. The term “virtual water” denotes the amount of water that is used to produce a certain yield of a crop. The water used in the production process can be distinguished into blue (surface water) and green (soil water) virtual water, with different economic values.

This study examined the questions:

i. In which direction and at what quantity is virtual water traded within China?
ii. How big is the blue virtual water share?
iii. How do virtual water exporting regions in China correspond to regions of water and land scarcity?

Data and Methodology

The quantification of virtual water flows follows three main steps:

i. Identification of food surplus and deficit for eight sub-regions in China
ii. Distribution of food surplus volumes from the surplus regions to deficit regions
iii. Transformation of commodity trade flows into virtual water flows

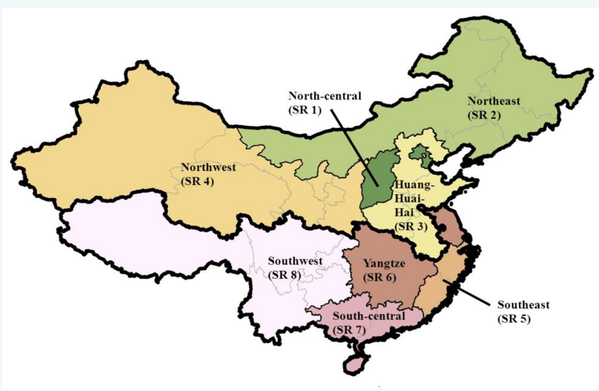

Fig. 1 Delimitation of eight sub-regions in China (SR 1-4: north China, SR 5-8: south China) (source: own figure)

- Economic input data is provided by the MAgPIE model[1,2], blue and green virtual water content information by LPJmL[3]. Both models are developed at the Potsdam Institute for Climate Impact Research (PIK) and provide the data on a 0.5 degree grid cell resolution for the year 2005.
- The data and method allow a distinction of virtual water flows into its green and blue share.

Virtual water trade between eight sub-regions in China

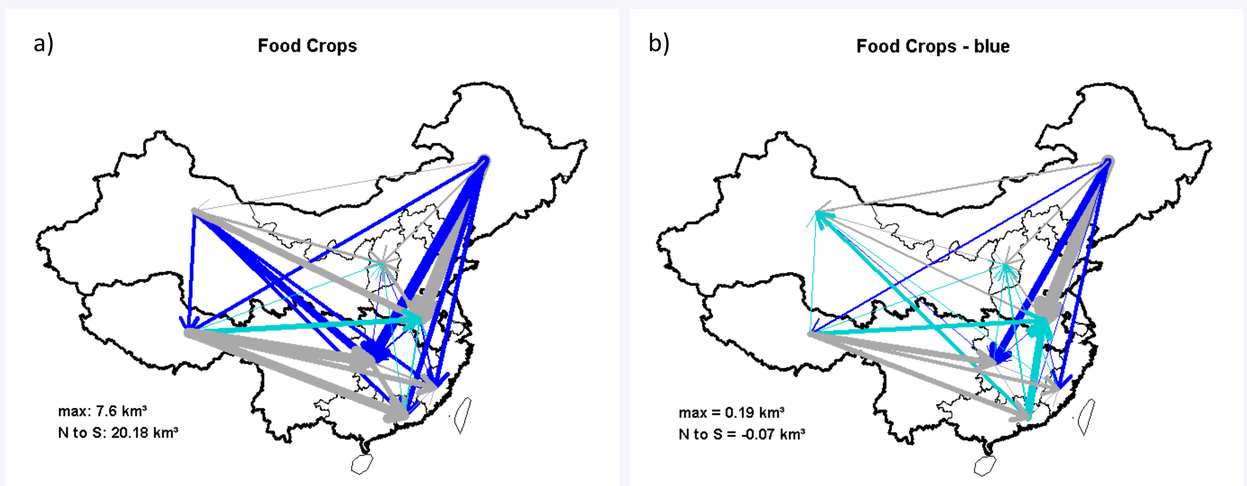

Fig. 2 Total (a) and blue (b) virtual water trade flows between eight sub-regions in China (max: trade volume of the thickest arrow. N to S: net trade volume from north to south, grey arrows: trade flows between sub-regions within north or south China, dark blue arrows: trade flows from north to south China, light blue arrows: trade flows from south to north China) (source: own figure)

Tab. 1 Net virtual water export, total and blue, from north China (in km³) (positive values: export to south, negative values: import from south) (source: own table)

Crop category	Net virtual water export from north China	
	Total	Blue
Temperate cereals	-2.59	-0.03
Maize	0	0
Tropical cereals	-1.01	-0.01
Rice	6.69	0.08
Soybeans	0.15	0
Rapeseeds	0	0
Groundnut	-1.07	-0.05
Sunflower	3.72	0
Oil crops	0	0
Pulses	1.68	0.03
Potato	-0.21	0
Cassava	-7.35	-0.29
Sugar cane	0	0
Sugar beet	-0.61	0
Vegetables/Fruits/Nuts	20.79	0.20
Net all food crops	**20.18**	**-0.07**

- Biggest sub-regional virtual water volumes, resulting from commodity trade of 15 food crop categories, are traded between northeast (SR 2) and the densly populated sub-region Huang-Huai-Hai (SR 3) within north China.
- Net trade from north to south China amounts to 20.18 km³ of virtual water, whereas trade flows of blue virtual water are almost balanced.
- Most important crop categories contributing to a trade flow from north to south China are rice and vegetables/fruits/nuts.
- Cassava is the dominant crop category traded into the opposite direction.

Virtual water export and resource scarcity

- Water and land shadow prices per 0.5 degree grid cell are used as an indicator for water and land scarcity in this study.
- Water scarcity in grid cells with virtual water exports is higher in north China, compared to the south. Highest mean values are located in the northeast (SR 2), the sub-region with the highest net export of virtual water.
- In contrast to water, the land shadow price of exporting cells shows higher values in southern China. Sub-regions with the highest mean land shadow prices are southwest (SR 8) and southeast China (SR 5).

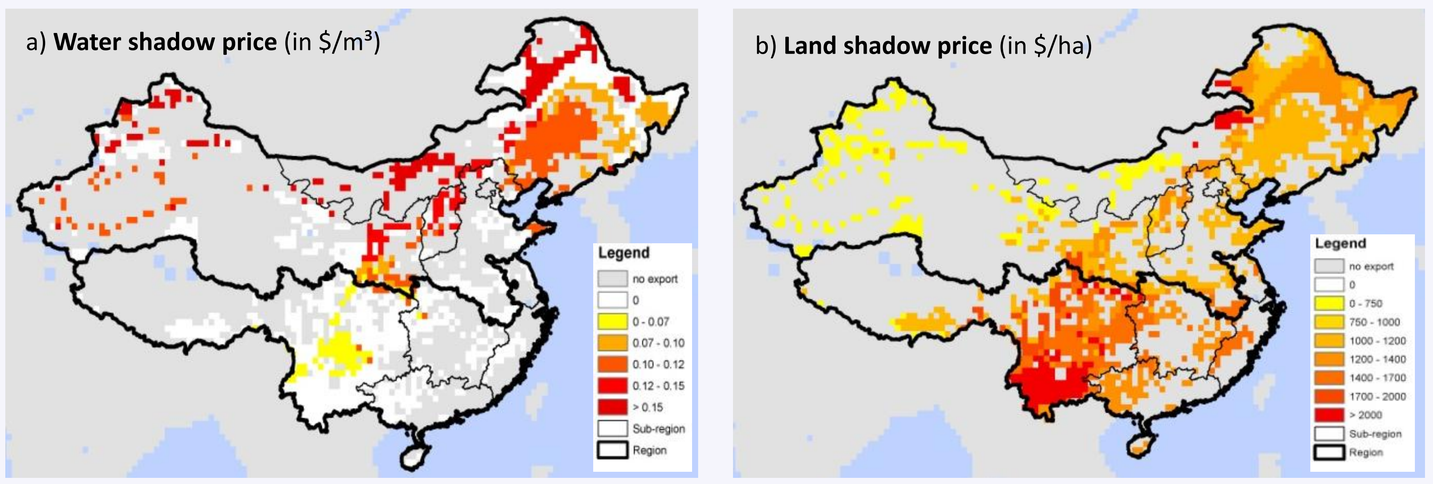

Fig. 3 Water (a) and land (b) shadow price of exporting cells (grey cells are not defined as exporting cells) (source: own figure)

Pros and cons of model data

- Advantages of the method and the application of model data:
  - Model data provides consistent data on a high resolution and allows the distinction between green and blue virtual water
- Limitations of the method and the application of model data:
  - Methodological simplifications of the “real” situation
  - Groundwater as an important source for irrigation water is not included in the model

Conclusions

- The results of this study deliver information about virtual water flows and the situation of water and land scarcity at its originating locations.
- The large discrepancy between total and blue virtual water trade flows underlines the importance of a separate calculation and interpretation of blue water.
- The dominant share of green virtual water on the inter-regional virtual water flows from north to south China emphasises that the aspect of land plays an important role for the application of the virtual water concept as a political water management tool.

[1]Lotze-Campen et al., *Agric. Econ. 39(3):*325-338 (2008); [2]Biewald et al., *EAAE congress paper* (2011); [3]Bondeau et al., *Glob. Change Biol. 13(3):* 679-709 (2007)

Contact:
Pia Rothe
Petersburger Str. 71
10249 Berlin
PiaRothe@gmx.de