Changing patterns of global agri-food trade and virtual water flows

Paper to be submitted as contributed paper to the 11th Biennal Conference of the European Society for Ecological Economics on 'Transformations'; 30 June – 3 July, 2015; Leeds, UK

Theme: 3. Development, consumption and well-being

Subtheme(s): 3.5 Patterns of trade, production, and consumption

Summary

In this paper we analyze the relation between the expansion and changing composition of global agri-food trade and flows of virtual water between world regions. Our database includes annual trade data of 101 countries from 1986 to 2011 trading 256 crop and livestock products which we classify into four commodity groups. The findings show that over time trade values have increased more than virtual water volumes; especially in Africa and South America where virtual water exports have roughly quadrupled since 1986. In all regions staples and industrial products account for the largest share in virtual water trade (>70%) whereas high-value products and animal products are of increasing importance for developing regions' export values. Water efficiency of trade, i.e. the money earned (spent) per unit of virtual water exported (imported) has increased in all regions since 2000 and export water efficiency is especially high in Europe.

Extended abstract

International agri-food trade has expanded rapidly during the past decades and changed considerably in structure. Specifically, trade in high-value food products (including fruits, vegetables, and products of animal origin) has increased sharply whereas at the same time, the importance of trade of staple food products and traditional tropical commodities such as coffee and cocoa has decreased. This has important implications especially for developing economies where high-value products have replaced traditional tropical commodities as the main agri-food export category. The social implications of these trends are being widely discussed in the literature and many studies point towards positive welfare effects of expanding food trade and changing trade patterns on a macro- as well as on a micro-level. However, environmental

implications have received much less attention although most of the concerns regarding international agri-food trade are environmental ones. One main concern is about the exploitation and redistribution of water resources through trade and it has been estimated that 15% of the world's agricultural water use is used for producing export products (Chapagain and Hoekstra, 2008). A concept which is increasingly used for analyzing the relation between trade flows and water resources is that of virtual water. It is based on the idea that there is a hypothetical water flow from an exporting to an importing nation through the consumption and use of water resources during the entire production process of an export product. Quantities and efficiencies of global virtual water trade have been estimated on a global scale. However, there are very few studies analyzing the evolution of annual virtual water volumes over time and there is a lack of studies on the link between changing trade patterns, trade values and virtual water flows. With this paper we contribute to the literature by analyzing the relation between changing patterns of agri-food trade and related water flows between world regions in the period of 1986 to 2011 during which many structural changes have happened. Specifically, we focus on five world regions (Africa, Asia, Southern America, Northern America and Europe) and compare (i) the growth rates of trade values and related virtual water volumes, (ii) the composition of trade values and virtual water trade, and (iii) the economic water-efficiency of imports and exports.

Our database consists of bilateral import and export data of 101 countries trading 256 agri-food products in the period of 1986 to 2011 (FAO, 2014). For the calculation of virtual water flows, annual product-specific trade flows have been multiplied with their respective national product-specific water footprint[1] of production in the exporting country (Mekonnen and Hoekstra 2012, 2011). The traded products have then been classified into four major commodity groups being high-value products (fruits, vegetables, nuts, spices), animal products (livestock, products from live and slaughtered animals), staple crops (cereals, pulses, roots and tubers), and industrial products (stimulants, sugar crops, oilbearing crops, oils, fats and tobacco). Trade values and related virtual water volumes have then been summed up for each world region and commodity group, only considering interregional trade. Based on this dataset we calculate (i) annual growth rates of total trade values and virtual water flows by setting the year 1986 as the baseline year, (ii) the composition of trade values and related virtual water exports and imports as the annual share of each commodity group to the total value or volume of trade, (iii) water efficiency of trade

[1] In our analysis we are considering only the blue (surface and groundwater) and green (rainwater) component of the water footprint.

(USD/m^3) by dividing the total value of exports and imports of each region by the associated virtual water volumes.

First, our findings show that export values have increased in real terms in all export regions since 2000. Related virtual water exports have also increased although at a lower rate and since 2005 the value of exports has increased at a higher rate than the associated virtual water flows. The highest growth rates can be observed in Africa and South America where export values and virtual water volumes have roughly increased fourfold between 1986 and 2011. In Europe and North America virtual water growth rates have remained relatively stable during the period under study whereas export values have doubled. Similarly, growth rates of import values and virtual water imports have increased especially in Africa, Asia and Southern America.

Second, the composition of trade shows that in the three developing regions the largest share of export value is earned with industrial products which have a very high associated volume of virtual water. However, the importance of high value exports has increased in Asia and Africa over time, in the latter case from 28% of the total export value in the years 1987-1991 to 38% in the period 2007-2011. The associated virtual water exports are rather low, representing only 8% of the total virtual water exports in 1987-1991 and 18% in 2007-2011. At the same time, the share of staple crop exports has decreased over time, being responsible for less than 20% of the export value in 2007-2011 and for around 25% of the virtual water exports of Asia and Southern America during the same period. In the developed regions (Europe and Northern America) animal products are more important for export earnings, accounting for one quarter of Europe's export value in 2007-2011. However, industrial products and staple crops are responsible for the largest share of export earnings (65% in Europe and 77% in Northern America, with a decreasing share) and account for nearly 90% of Northern America's virtual water exports in 2007-2011.

Third, we find that water efficiency of imports and exports has increased in all world regions since 2000. In Africa and Southern America, efficiency of exports and imports is of similar magnitude at around 0.2 USD per m^3 of virtual water exported. Large differences between water efficiency of exports and imports can be observed in Northern America and Europe: Europe has the highest water efficiency of agricultural exports, increasing from around 0.3 USD/m^3 in 1999 to 0.6 USD/m^3 in 2011. In contrast the price paid per unit of virtual water imported is roughly 0.2 USD/m^3. Northern America pays the highest price per unit of virtual water imported (more than

0.4 USD/m^3 in 2011) whereas export earnings are of the same magnitude as those of the developing regions.

Our findings suggest that generally, trade values have increased more rapidly than related virtual water flows over time. Staples and industrial crops account for the largest share of virtual water trade. However, the importance of animal products and high-value products is increasing especially in developing regions. Virtual water flows related to the latter are relatively small and thus, from a national virtual water perspective, increasing high-value exports from developing countries is efficient. Regarding overall water efficiency we show that differences between efficiency of imports and exports are largest in Europe and Northern America and that water efficiency has increased in all regions since 2000.

References

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