



Internal and external green-blue agricultural water footprints of nations and related water and land savings

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The need to increase food production for a growing world population renders important the assessment of global agricultural water productivities and of virtual water flows, which provide teleconnections in the global water systems through international trade. Using the hydrology and agro-biosphere model LPJmL, we quantify, globally at 0.5° resolution, the blue (irrigation water) and green (precipitation water) virtual water content, i.e. the inverse of water productivity, for 11 of the world's major crop types. Based on these, we calculate the water footprints (water footprint) of all countries, for the period 1998-2002, while distinguishing internal and external water footprints (the latter representing the virtual water imported from other countries) and their blue and green components, respectively. Moreover, we calculate water savings and losses, and for the first time also land savings and losses, through international trade with these products.

The consistent separation of blue and green water flows and footprints, which is needed due to the different sources and opportunity costs of these two water pools, shows that green water globally dominates both the internal and external water footprint (84% of the global water footprint and 94% of the external water footprint rely on green water). Accordingly, some of the major exporting countries of the crop types considered here (e.g. Argentina, Canada) export mainly green virtual water, but traditional rice exporters such as India and Pakistan mainly export blue virtual water. The external water footprints are found to be relatively small (6% of the total global blue water footprint, 16% of the total global green water footprint). Nevertheless, current trade saves significant water volumes and land areas (~263 km³ and ~41 Mha, respectively, equivalent to 5% of the sowing area of the crops considered here and 3.5% of the annual precipitation on this area). Linking the proportions of external to internal blue/green water footprint with the per capita water footprints allows recognizing that only a few countries consume more water from abroad than from their own territory and have at the same time above average water footprints. Thus, countries with high levels of per capita water consumption affect mainly the water situation in their own country.