Disaggregating agricultural water flows in the world

Water resources are growingly transferred embodied in products internationally traded. These water displacements often involve global inequalities that need to be addressed by setting consumption and production responsibilities. Although Multi-Regional Input Output models are powerful tools to assess the interrelations among countries and sectors in global supply chains, the lack of sufficiently disaggregated sectorial data in the empirical applications may entail a notable drawback for assessing some regional problems. This is particularly important when studying water resources, since agriculture accounts for 70% of water consumption all over the world. Therefore, in this paper we will try to join bilateral trade data on agricultural products with WIOD multiregional tables. This will allow us to analyze water consumption trends and to deepen into different productive specializations that could be triggering the increasing global water consumption happened from 1995 to 2009. By applying a Structural Decomposition Analysis that will divide the sample into groups depending on the level of income of countries, we aim to explain water consumption trajectories on the basis of water intensities variations, changes on domestic or imported technologies and trends in demand patterns.

We will use the environmentally extended input-output approach to obtain the volume of water embodied in domestic production and in trade flows. The MRIO model will allow us to calculate consumer and producer responsibilities of water consumption, distinguishing by regions and sectors. We will use a structure of input-output table, based on the model of Isard (1951) and further explained in Miller and Blair (2009) and Cazcarro et al. (2010 and 2013). For the 41 regions it will be possible to represent the multiregional matrix of technical coefficients and the Leontief inverse. Defining a vector of coefficients of water consumption per output of region, we will estimate the consumption of water associated with the production of each region. Thus, we will obtain the consumption of direct and indirect water necessary to meet the demands of each region for each sector. Estimates of water consumption will allow us to know the embodied water in trade flows between regions and estimate their water footprints. The pressure of countries on the global water resources (which we associate with the blue and green WF consumption), comes from the domestic water consumptive use (W_{dom}), plus the embodied water in imports (virtual water imports, VWM), minus embodied water in exports (virtual water export, VWX).

In this context, SDA will be applied to synthesize the driving forces underlying the changes in water embodied in regional domestic and traded production. As long term effects of development on environment seem to be different regarding the economic features of regions, we will classify countries depending on their level of per capita gross domestic product, dividing the sample into high and low-middle income countries. This will be done following the criteria of the World Bank (2013). We will consider as high income countries those who have a per capita gross national income equal or more than $12,476. On the contrary, low-middle income areas are under $12,476.

Thus, it will possible to observe the different effects depending on countries classification. We will obtain the intensity effect, which quantifies the contribution of changes in high income countries water intensities to water consumption trends. Secondly, we will get the technology effect that links variations in water consumption with changes in the technology of production. The technological effect will be also separated into changes in domestic technology (domestic technology effect), changes in imported technology from low income areas (backward technology effect from low) and variations in imported technology from high income countries (backward technology effect from high). Finally, we will have the scale effect, which quantifies how much of the change in water consumption is due to changes in the volume of final demand. All the components will be obtained in a matrix fully disaggregated by country and sector, aggregating the data only for the final presentation of the results. Therefore, all the components can be particularized by sector, country or group of countries, generating important information in the identification of national footprints and their evolution.

In the empirical analysis, we will use MRIO tables data from the World Input Output Database (WIOD) (WIOD, 2012; Dietzenbacher et al., 2013). This database offers economic information for 35 economic sectors in 40 countries and a region called Rest of the World (ROW) from 1995 to 2009. IO tables are expressed in current monetary units and in previous year prices. Thus, in order to accurately make the comparison between these two years, it will be necessary to deflate 2009 data. Once we deflate 2009 economic data, the next step will involve applying a GRAS adjustment; a generalization of RAS proposed by Junius and Oosterhaven (2003) and improved by Lenzen et al. (2007). Furthermore, following the Statistical classification of economic activities in the European Community (NACE Rev. 2), the Agriculture sector in the Multiregional Input-Output tables from WIOD will be disaggregated into approximately 13 agricultural sub-sectors. To that aim, it will be necessary to obtain information on the composition of production, exports and imports in each of the 41 countries. On the one hand, data on agricultural domestic production will be taken from the Food and Agriculture Organization (FAO, 2014). On the other hand, the product composition of bilateral trade flows among countries will be obtained from UN COMTRADE database (2014).

Preliminary results seem to indicate an increase in virtual water trade chiefly due to the great boost of demand during these years. Changes in water intensities would be responsible for a partial moderation of water consumption increase in both high and low income countries. Finally, technological changes in low income nations would boost water consumption. All the results will be obtained for green, blue and grey water.

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