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THE IMPORTANCE OF VIRTUAL WATER CONSUMPTION FOR SÃO PAULO STATE AND REST OF BRAZIL: AN INPUT-OUTPUT ANALYSIS

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ABSTRACT

Following the United Nations, in general, Brazil is in a comfortable situation with respect to water, with a satisfactory *per capita* water availability situation when compared to other countries. However, despite this apparent comfort, there is an uneven spatial distribution between water supply and demand in Brazil. In this scenario, the proper allocation of water resources can ease the pressure on the demand for water needed for economic and social development. However, this allocation requires the identification of the main water demanding sectors, directly and indirectly, in the two regions considered in the model, São Paulo state and Rest of Brazil. We use an inter-regional input-output model to estimate the importance of the virtual water contained in goods and services, consumed and traded in these regions. General results show that the state of São Paulo is a liquid importer of virtual water from the Rest of Brazil.

EXPANDED ABSTRACT

Water is a non-replaceable good and 100% essential, all life on earth depends on this resource and, in particular, human life depends on the availability of fresh water, which corresponds to only a small fraction of all water available on the planet (Daly & Farley, 2004). Following the United Nations, in general, Brazil is in a comfortable situation in respect to water, with a satisfactory *per capita* water availability situation when compared to other countries. However, despite this apparent comfort, there is an uneven spatial distribution of water resources in Brazil. About 80% of its water availability is concentrated in the Amazon River Basin region, where is find the lower

population contingent and reduced values of consumptive demands[1]. (ANA, 2013). On the other hand, the Hydrographic Region of Paraná represents the largest population group of the country, 32.1%. Consequently, this region has the highest demand for water resources of Brazil, accounting for 31% of domestic demand, despite holds less than 7% of water availability of country. (ANA, 2015; MMA, 2006).

Analogously, one can cite the case of São Paulo state as an example of inequality in spatial distribution of water. That is, it is the richest and most populous state of Brazil insofar it accounts for only 1.6% of national water resources. (Sabesp, 2015). However, this does not necessarily mean that it has low water availability in the region, but in the same time this did not prevent the emergence of the current water crisis in Metropolitan Region of São Paulo city. Since the beginning of 2014, this region has been on alert due to the worsening of the water crisis that started around to 2010. Given this scenario, the responsible institutions have adopted policies to reduce the pressure in the pipes, program to encourage the responsible consumption of water, reducing the price of water for those who save this feature, and they has been studying the idea of establishing a drastic rotation of this resource in the region.

In this context, the proper allocation of water resources can ease the pressure on the demand for water needed for economic and social development. However, a better allocation requires the identification of the main sectors water consumers, directly and indirectly. Therefore, the main objective of present paper is to estimate the virtual water consumption of economic sectors of São Paulo state and Rest of Brazil (all states of country except the São Paulo state), and to verify if São Paulo state is a net exporter or importer of water resources. Knowing that is of great significance for supporting regional water and trade policies. The results can contribute to a better understanding of water scarcity problems and provide pertinent measures, helpful to the sustainable management of water resources and to evaluate the impacts of trade on water resources of each region.

To attend the paper objective, it was used an inter-regional input-output model, distinguishing between domestic (i.e. São Paulo state) and other region (i.e. Rest of Brazil), whereby it is calculated how much water consumption should be attributed to each sector and final demand elements. This allows one to determine the trade of water that is directly and indirectly embodied in, for example, the exported products and

[1] Part of water resources withdrawed and consumed in the production process so as not to return to the course of the water. (ANA, 2013).

services between considered regions. The approach implements the concept of virtual water within an input-output framework. It is defined as the volume of water required to produce a commodity or service. (Chapagain and Hoekstra, 2004). It should be noted, however, that the term 'required' covers more than just the physical water content of a product and includes all the water that has been consumed in its production process. Input-output analysis is a suitable tool for determining the virtual water content of U$$1 of product *i*. It covers the (direct) water consumption in production process *i*, the water consumption to produce the amount of each good *k* that is used as an input in process *i*, the water consumption to produce the inputs necessary for producing this input of *k*, etc. Summing all the requirements gives the amount of virtual water, i.e. the total amount of water embodied in US$1 of final demand for product *i*. (Dietzenbacher and Velázquez, 2007).

The paper is structured as follows. The second section presents the input-output framework in relation to water consumption. As descriptive measures, the direct water coefficients and virtual water multipliers are discussed. The third section appropriates water consumption to the actual final demands to determine virtual water contents. The fourth section deals with the virtual water content of imports and exports of São Paulo state and Rest of Brazil, to assess the trade balance water. Conclusions are given in the fifth section.