Tracking Footprints at the micro and meso scale: An application to the Spanish tourism by regions and municipalities

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Abstract

The differences between the footprints estimations at the consumer and producer levels have been widely discussed in the literature of input-output with different treatment of responsibilities. Some methodological questions related to this are those related to the assumptions on the treatment of imports or sectoral scale at which the analysis are performed. In this case, we highlight the capabilities of combining the meso level input-output models with the GIS and micro data to lower the spatial scale, especially in order to provide information to local municipalities/villages/business on how to track their footprints, further than the level (17 Spanish regions or Autonomous Regions) at which we are capable of having economic input-output data. Previously we had developed a multiregional input-output model for these regions and the regions of European Union and Rest of the World, to move again towards the explicit spatial identification of areas of strong final demands (normally the most populated) linking them to the original hotspots or vulnerable areas, where most direct grey water consumption had taken place. Now we present a very specific application, where these aspects are shown more clearly since consumers and producers usually have very different origins, in particular looking at the tourism statistics, lifestyles and type of expenditures.

Keywords: water footprints, tourism, downscaling, regional science, input-output, GIS, Spain.

Abbreviations: VW, Virtual Water; WF, Water Footprint; MRIO, Multi-Regional Input-Output; IO, Input-Output; GIS, Geographic Information Systems; AR, Autonomous Regions; RS, Rest of Spain; EU; European Union; RW, Rest of the World.

1 Introduction

The level at which most meso and macro-economic policies take place is usually the national or at the smallest, regional level, and below that level economic input-output (IO) data compiled by national or regional statistical institutes can rarely be localized in greater detail. In previous works, we have considered the inter-regional flows at the regional level, but now we can also combine this information with spatially explicit information on polluting activities - the key point being the combination of IO (economic) and GIS (geographical specification of impacts) models. Many key scenarios or political/economic decisions occur at the regional or national level, and hence relate directly to the economic model. However, these all have effects in the local economies, which is why GIS models allow us to localize the impacts that those scenarios have in specific areas, as in our study, of towns, villages, municipalities, and river systems.

More specifically, now we present a very specific application, where these aspects are shown more clearly since consumers and producers usually have very different origins, in particular looking at the tourism statistics, lifestyles and type of expenditures. The main objective is to identify how those lifestyles or types of consumption affect resources in specific areas and how they are affected by policies at a higher administrative level. We depart from the estimation of water footprints (WFs) for the 17 Spanish autonomous regions (AR from now) through a MRIO model which also includes the regions of European Union (EU) and Rest of the World (RW). We then move toward the explicit spatial identification of areas of water impact (use, pollution, etc.) by origin, identifying hotspots (high use, pollution, vulnerable areas…), and linking these areas with responsibilities of final consumers, identifying several types of consumption there, as the main improvement in this article. We proceed, as an example of the potential value of this combined methodology, to design and evaluate the effects on water of tourism consumption and scenarios about it. The importance of tourism is in Spain higher than in many other countries, with 50 million tourists every year and accounting for more than 10% of Spanish GDP, and even more relatively with respect to other activities in regions such as the Balearic or Canary islands, in the biggest regions and cities (as Madrid and Barcelona) as attractors of business trips and recreational tourism.

Moreover, our developed analysis allows us to identify and visualize the specific geographical areas affected by changes in the macroeconomic policies affecting tourism and eventually a specific local area or sector, serving as an informative instrument to identify the underlying forces associated with goods, services and resources (such as water) demands in Spain.

2 Background

In this section we review some of the works of IO and GIS, related to localizing economic data and environmental hotspots, while some tourism IO related works and statistics are briefly introduced and completed for the particularities of the study in the methodology and data section. GIS have played an evolving role in planning, socio-economic, and environmental analyses (Malczewski, 2004). The use of GIS to create economic detailed data in detail has been done by (Döll et al., 2000), (Sutton and Costanza, 2002; Sutton et al., 2007), the Global Risk Data Platform (UNEP/GRID, 2013), (Ghosh et al., 2010); and (Nordhaus, 2006). On the one hand, the latter has less resolution than the former (1 degree Longitude/Latitude rather than 30 arc-seconds), but on the other hand it uses population data (rural/urban) as well as income/labour data (regional by industry), land area, and some estimates of minerals production, from statistical agencies.

As far as we know, our work is one of the first attempts to combine the MRIO with GIS analysis. The combined use of IO and GIS has been recently analyzed or applied by (Hubacek and Sun, 2001), implementing in GIS the biophysical attributes of land and demographic data at the county level, to assess how different development paths influence the available land and trade flows of primary products. (Albino et al., 2007a; Albino et al., 2007b), combine the tools based on IO and specific processes to represent and describe the logistic flows of an industrial supply chain. (Weinstein and Clower, 2012), use them to assess economic (fiscal, labour, property income, etc.) and the developmental impacts of toll roads.

(Haddad and Teixeira, 2013) examined the regional economic impacts of natural disasters in the megacity of São Paulo, through the use of a spatial CGE model integrated to GIS information related to the location of points of floods and the firms within their influence. A somewhat similar approach is being developed, based on the concept of the "mother table" and Virtual Laboratories, for spatial and sectorial detail of meaningful environmental footprints and LCA applications (Lenzen et al., 2013; Wiedmann et al., 2013).

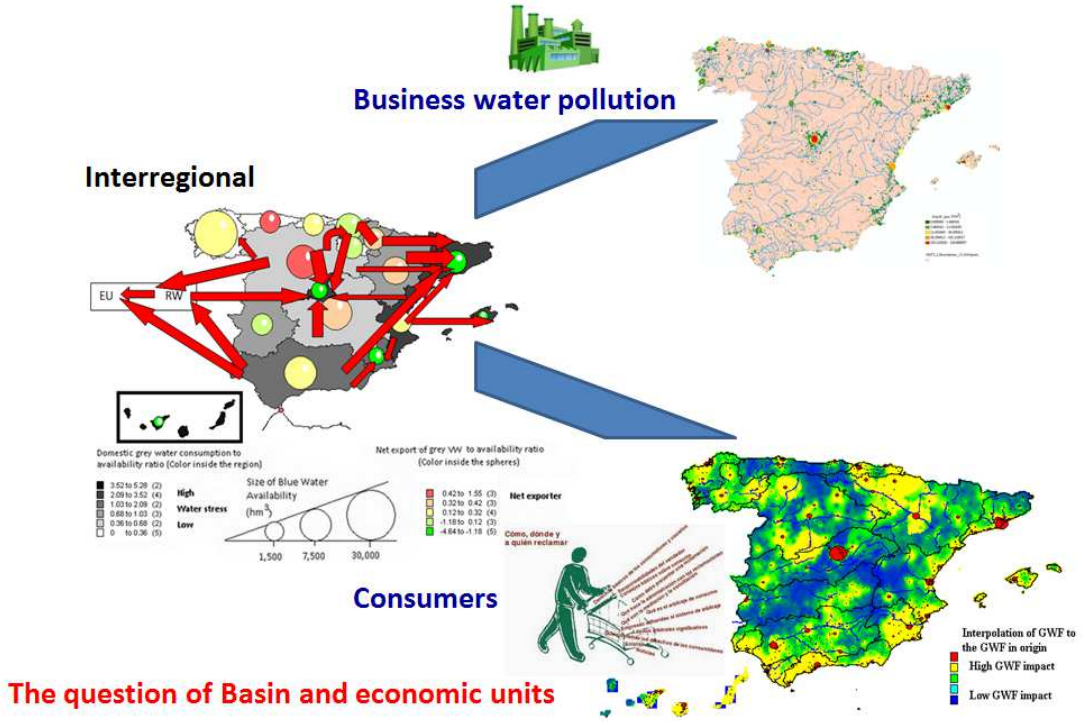
Recent IO and tourism studies can be found and reviewed in the proceedings of the recent tourism-IO sessions and articles of the International Input-Output conferences, and at the special issue of Economic Systems Research (Los and Steenge, 2010), where we highlight the references to those related to the environment, e.g. (Cline and Seidl, 2010) on the sensitivity of tourism visits to changes in local environmental attributes (land and water quality) or (Surugiu et al., 2012) on the CO_2 emissions in tourism in post-communist Romania.

3 Methodology and Data Sources

Our starting point is a MRIO model developed in previous works, constructed on the basis of the regional Spanish IO tables (19 regions corresponding to the 17 Spanish Autonomous Regions, AR), Rest of Spain (RS), EU and RW, for 2005 and with 40

economic sectors, with trade data from the structural database C-INTEREG. That is the central part depicted on the left side in Figure 1, the interregional model at the regional scale. The information of impacts and water footprints, is localized in origin with the business level data, as shown on the upper right corner. The main advancement in this work is to localize the final demand (mainly of the consumers) further, i.e., at the destination, represented by the map of the lower right corner.
Final demand data, covering consumption of households, NPISH, government; gross capital formation and variation of existences and exports (Rest of Spain, EU and RW) was already obtained within that framework, but now we detail and split the consumption of tourists, both national and foreign.

Figure 1: Downscaling water footprints, from the interregional model to the origin and to the destination.



Source: Own elaboration.

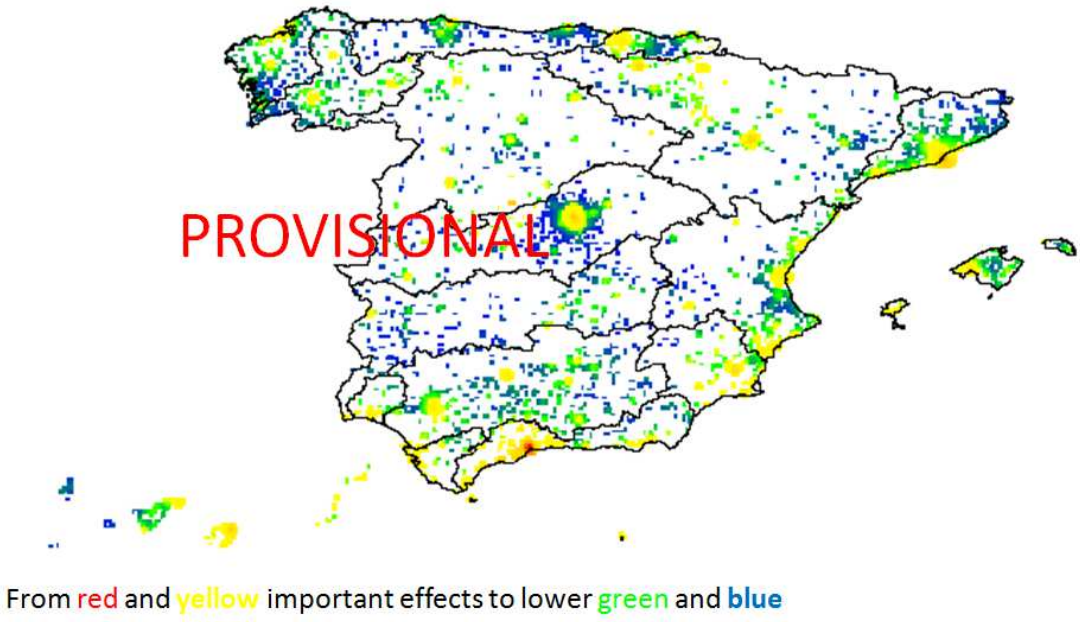
The main sources of data for tourism in Spain are the Institute of Tourism Studies (EGATUR, FAMILITUR) and the Tourism Satellite Accounts for Spain (TSA, which can be reached from the National Statistics Institute, NSI) (see (Cañada Martínez, 2002), for the methodology; and (Tarancón, 2005), as example of integration with IO models/databases). From these tourism statistics of Spain, the main bodies of information are:
- General expenditure by domestic and foreign tourism expenditure in Spain, by goods and services (converted to sectors, something which was completed –especially for non-characteristic touristic activities) with complementary information and reports in (Cazcarro et al., 2014)).

- Expenditure of tourists by region/AR (low detail levels).
- Travel and overnight stays by region of origin and destination (hotels, rented housing, own housing, other).
- Means of transport on the trip (Car, Bus, Plane, Train, Other).
- Total of final demand from the domestic and foreign tourism expenditure by Autonomous Region of destination.
- Census of Population and Housing (2011) to distinguish between residents and non-resident/visitor population (by provinces/municipalities/towns (this may lead to comparisons of domestic vs. foreign tourism impact, although the NSI indicates that the distinction between main and secondary houses is not given due to confidentiality issues[1]).
- Number of tourists (and some reports on expenditure, although little sectoral detail is one of the major problems of the work) by province.

4 Results and discussion

The main type of results obtained are on embodied grey water of tourism (distinguishing domestic and foreign) per city/province, and its (re)presentation of impacts.

Figure 2: Distribution of water footprint impacts/pressures of tourism in Spain.



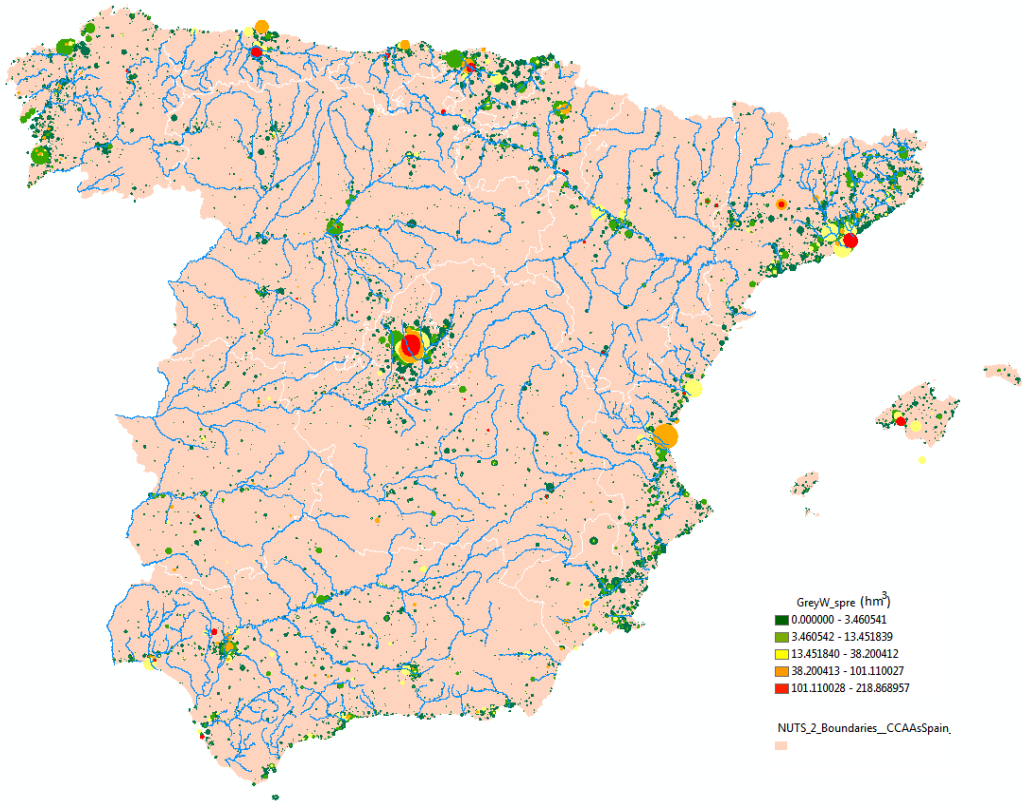
Source: Own elaboration, model results.

Making the path back from the final impact to the origin, one may locate the points that suffered environmental pressures in origin in order to sustain the tourism in Spain, for which several options and algorithms in the distribution occur (e.g., interpolation, or simple allocation within the region by importance of the point of pressure in origin, considering or

[1] http://www.ine.es/censos2011/tablas/Wizard.do?WIZARD=4&reqCode=paso2

not the proximity towards the location of the final demand pressure, etc.). When looking at the path to the origin in order to localize the impacts, despite obviously being smaller the absolute pressures of tourists than households, in general (for most algorithms) the distribution is very similar to the pressures of the population as a whole, but the per capita pressure is superior for the (domestic and foreign) tourism.

Figure 3: Relative distribution of Impacts/pressures of water footprint in origin, by business (size of spheres by turnover).



The direct water by business is shown by the green (less grey water)-yellow-red (more) scale, bringing forward the hotspots of the highest Grey water.
The size of the spheres represents the size of the business (measured by the turnover).
Regions (ARs) are delimited in white, and rivers and reservoirs are shown in blue.

Source: Own elaboration, with databases on rivers.
http://servicios2.marm.es/sia/visualizacion/descargas/mapas.jsp

All in all, it is emphasized the importance of IO studies in analysing the macroeconomic structures of regions and the environmental impacts associated with domestic final demands and trade, and in particular of consumption and even more specifically of a type of consumption, tourism, allowing us to conclude that, in order to avoid or minimize impacts on water and other resources, we must consider technological options, industrial demands, trade patterns, and the lifestyles of citizens and their particular behavior as tourists.

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