

# Sensitivity to households' expenditure and income variation of the Water Footprint of Spain

## Changes in **final demand**

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*3<sup>o</sup> NATIONAL SEMINAR OF THE WATER OBSERVATORY:*  
**PROS AND CONS OF THE WATER FOOTPRINT**

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Input-output (I-O) framework \* Agroalimentary Disaggr.

\* Water Accounts

To obtain virtual water intensities per unit of **final demand**

**III – Application: Sensitivity** of the WF driven by the **final demand**

a) Expenditure and income

b) Diets

(c) Prices/taxes)

(d) Structural Path Analysis (SPA)

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**IV - Future Work, Discussion, Questions...**

## **I - Introduction: WF and its variations:**

- **Changes in the Climatic conditions and production**  
(precipitations, temperature, productivity,...)
- **Changes in the Exports and imports**  
(sovereignty/self-sufficiency vs. Water saving... )
- **Changes in the goods consumed (households)**  
(diets, savings, due to income variations...)

### **Policy implications:**

- **How important would be the effects?**
- **Is it reasonable to recommend shifts in certain directions?**  
**/ Is it likely that the arguments prevail over other facts ?**  
(benefits, opportunity costs, specialization, endowments...)

## II Methodology: Input-output framework

### Monetary Tables (MIOTs)

They gather all the information of monetary flows among sectors, Institutions and **final demand** in a consistent framework

### Physical IO Tables (PIOTs)

Much less information available regarding flows

The link between them and the Monetary IO comes from the **prices**

### Hybrid IO (mix monetary and physical units)

Interesting when combining IO and analysis of the specific processes

Consistent only for certain analysis, e.g., not valid for **Structural Decomposition Analysis (SDA)**

**Input-output  
Leontief model**

**rows** represent **incomes** or receipts  
**columns** represent **expenditures** or outlays **totals equal.**

**a) Water Accounts**

Homogeneous Branches

$w'$

Homogeneous  
Branches

	Homogeneous Branches			
	1	2	...	n
1	X <sub>11</sub>	X <sub>12</sub>	.	X <sub>1n</sub>
2	X <sub>21</sub>	X <sub>22</sub>	.	X <sub>2n</sub>
...	.	.	.	.
n	X <sub>31</sub>	X <sub>32</sub>	.	X <sub>3n</sub>

FD

$y$

y <sub>1</sub>
y <sub>2</sub>
.
y <sub>n</sub>

E

$x$

X <sub>1</sub>
X <sub>2</sub>
.
X <sub>n</sub>

+  
+  
+  
+

$$y = x$$

+ + + +

$$a_{ij} = \frac{X_{ij}}{X_j}$$

A

AV

$v'$	V <sub>1</sub>	V <sub>2</sub>	.	V <sub>n</sub>
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$$x = (I - A)^{-1} y = (I + A + A^2 + A^3 \dots) y$$

$\Lambda' = \begin{pmatrix} \lambda'_1 \\ \vdots \\ \lambda'_n \end{pmatrix} = w' (I - A)^{-1}$  These values capture the embodied water directly or indirectly (virtual water) by unit of demand.

All in all, we obtain water intensities  
(volume of water/euro of **final demand**)

$$\mathbf{w}' (\mathbf{I} - \mathbf{A})^{-1} \mathbf{y}$$

**III – Application: Sensitivity of the**

**WF driven by the final demand**

$$i \Delta \mathbf{y} ?$$

**a) Sensitivity. Table 2:  $\Delta$ WF** to the expenditure of the WF per capita of Spain in the period 1998-2007 (m<sup>3</sup>)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Cereals and leguminous plants	52	52	52	53	49	49	49	46	38	39
Vegetables and fruits	80	77	78	77	74	70	74	72	67	69
Fishing and aquaculture	5	5	5	5	5	4	5	5	4	2
...	...	...	...	...	...	...	...	...	...	...
Meat industry	157	158	155	159	149	150	142	133	134	140
Dairies	76	76	74	70	66	64	62	59	57	60
Industrial oils and greases	47	50	59	54	49	47	59	57	67	56
Ind. vegetables	20	17	19	17	19	19	19	19	17	18
Ind. milling	10	10	10	10	10	10	10	9	8	8
Ind. bread cakes and biscuits	75	75	76	75	70	70	70	65	54	56
Ind. sugar	6	6	7	6	6	6	6	6	5	5
Cocoa and confectionery ind	15	14	15	15	14	13	14	14	13	14
Ind. feed	17	23	22	20	23	20	19	18	17	18
Other food industries	63	69	73	69	66	63	61	59	53	56
Ind. alcohols and liquors	1	2	2	1	2	1	1	1	1	1
Ind. wines and ciders	3	3	2	2	2	2	2	2	2	2
Ind. beer	6	6	6	6	6	5	5	5	4	5
Ind. non-alcoholic beverages	7	7	7	7	7	7	6	6	6	6
Tobacco industry	18	23	22	21	17	16	16	16	15	16
...	...	...	...	...	...	...	...	...	...	...
<b>Total of agroalim. sectors</b>	<b>908</b>	<b>926</b>	<b>942</b>	<b>929</b>	<b>886</b>	<b>864</b>	<b>867</b>	<b>834</b>	<b>797</b>	<b>821</b>
% change of water	100	102	104	102	98	95	95	92	88	90
<b>Total per capita expenditure (eu)</b>	<b>3,584</b>	<b>3,636</b>	<b>3,697</b>	<b>3,723</b>	<b>3,589</b>	<b>3,495</b>	<b>3,488</b>	<b>3,381</b>	<b>3,249</b>	<b>3,424</b>
% change of expenditure	100	101	103	104	100	98	97	94	91	96

Data of the NSI. Classification of final consumption expenditure of households by purpose (COICOP). Serie 1995-2002 in constant prices and Serie 2000-2008 adjusted with the Chained volume indices, reference year 2000 = 100.

**a) Sensitivity.  $\Delta WF$  expected from  $\Delta Income$  (using elast. of income:  $\Delta demand$  when  $\Delta Income$ )**

Accounts	Income Elasticity	Source
Cereals and leguminous plants	0.77	G
Vegetables and fruits	0.90	G
Bovine	1.03	R
Ovine and caprine	1.34	R
Porcine	0.51	R
Poultry	0.80	R
Fishing and aquaculture	0.81	G
Production and distribution of electricity and gas	0.56	M
Water	0.71	M
Minerals and metals	0.51	M
Mineralas & non-metallic mineral	0.51	M
Chemicals	1	M
Metallurgy and manufacture of metal	1.45	M
Machinery and equipment	1.45	M
Manufacture of machinery and equip	1.45	M
Transport equipment	1.05	M
Transformed Meat (industry)	1.54	G

Accounts	Income Elasticity	Source
Dairies	0.64	G
Industrial oils and greases	0.35	G
Ind. vegetables	0.90	G
Ind. canned fish	0.81	G
Textiles, clothing and fur	1.29	M
Manufacture of leather and footwear	1.29	M
Paper industry	1.35	M
Wood, cork and wood furniture	0.44	M
Rubber, plastics & other manufactures	1.31	M
Construction and engineering	0.75	M
Recovery and Repair	1.31	M
Restaruants	1.7	M
Coffees, bars and similar	1.7	M
Hotels, pensions and similar	1.7	M
Other catering services	1.7	M
Transport and communications	1.14	M
Credit and insurance	1.04	M

G: Gracia et al. (1998); M: Mainar (2010); R: Radwan et al. (2009)



**Table 2:  $\Delta$ WF expected from  $\Delta$ Income (using elast. of income: 1%  $\Delta$ )**

	New expenditure (with 1% rise in income)	Virtual water with the new Income ( $hm^3$ )	% water volume change	% volume change (with respect to the total)
<b>Total Agriculture</b>	6,254	5,921	0.85%	8.96%
...	...	...	...	...
<b>Total Agricultural, Forestry &amp; Fish.</b>	<b>9,212</b>	<b>6,896</b>	0.84%	<b>10.31%</b>
Production and distribution of electricity & gas	6,613	341	0.56%	0.34%
Meat industry	11,967	6,283	1.54%	17.16%
Dairies	6,470	2,734	0.64%	3.13%
Industrial oils and greases	2,015	2,563	0.35%	1.61%
Ind. vegetables	1,879	844	0.90%	1.36%
Ind. canned fish	2,425	198	0.81%	0.29%
Ind. milling	267	424	0.77%	0.58%
<b>Total Agroalimentary industry</b>	<b>42,118</b>	<b>21,889</b>	<b>0.95%</b>	<b>37.24%</b>
Textiles, clothing and fur	9,225	1,432	1.29%	3.28%
Manufacture of leather and footwear	4,129	910	1.29%	2.09%
Wholesale food	27,091	2,366	1.01%	4.28%
Non-food trade	50,226	938	0.96%	1.61%
Restaurants	13,503	1,402	1.70%	4.22%
Coffees, bars and similar	56,905	5,431	1.70%	16.35%
Other services for sale	29,518	818	1.16%	1.69%
<b>Total this selected accouns</b>	<b>264,553</b>	<b>43,325</b>	<b>1.08%</b>	<b>83.67%</b>
<b>Total All Accounts</b>	<b>777,644</b>	<b>53,311</b>	<b>1.05%</b>	<b>100.00%</b>

## PROS & CONS OF THE WATER FOOTPRINT

### - PROS:

- **Contrast water impacts via consumption of goods vs. domestic uses**
- **Think about how to improve water management through trade**
- **Improve communication:** Importance of global dimension, labeling,...
- ...

### CONS: Recommendations to lower water impacts must be balanced with other concerns:

- **National water use:** with water efficiency, productivity
- **Import/export changes:** with other reasons for commerce (trade theories emphasizing comparative advantage, land availability,... )

**\*Variability, predictions?:** with climatic data, possible changes in final demand (past decade, expected with higher income),...

**\*Diet changes:** one should look at the health, the budget,...

Thank you for  
your attention

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