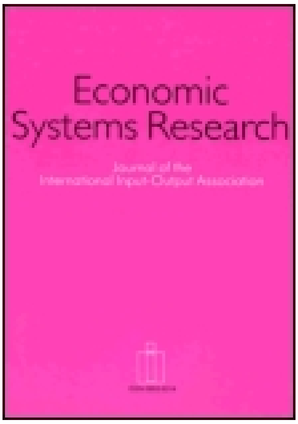

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WATER RATES AND THE RESPONSIBILITIES OF DIRECT, INDIRECT AND END-USERS IN SPAIN

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WATER RATES AND THE RESPONSIBILITIES OF DIRECT, INDIRECT AND END-USERS IN SPAIN

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Irrigation is the main user of water in Spain, and the price paid for this resource has long been lower than its cost. The recent EU Water Framework Directive requires that all costs be recovered, but application has had perverse effects. In some cases, farms have become economically unviable, while in others, cultivation has intensified and water consumption has increased. This paper applies a slightly modified version of the computable general equilibrium model developed by the International Food Policy Research Institute (Lofgren et al., 2002), to a SAM (Social Accounting Matrix) of the province of Huesca in north-eastern Spain. The model disaggregates the agricultural sectors into irrigated and unirrigated farming, taking into account the improvements in irrigation efficiency. Within this framework, we analyse different payment scenarios affecting direct users, exporters and end-users in order to examine user responsibilities, the impact of international markets and macroeconomic effects on agriculture and industry in Spain.

Keywords: CGE; User responsibility; End-user; Water rates; Virtual water

1. INTRODUCTION

Water resources have been crucial to Spanish agriculture since Antiquity, as evidenced by the bronze plaques found at Contrebia Belaisca (near modern-day Botorrita in Aragon), which date from 89 BC and refer to the distribution of water between two communities. For centuries water was considered a communal (almost a *common*) good, and its use was regulated mainly by farmers themselves through local institutions, which also oversaw the construction and upkeep of the necessary infrastructure. This framework changed in the twentieth century. The expansion of irrigation and the creation of large-scale irrigation systems intensified public intervention, with the result that water planning became a key tool for economic development. Investment in reservoirs and canals was initially financed by the state, and a large part of the costs were paid for by all citizens via taxation, and not just by farmers. So water became a productive input, a development that completely undermined the time-honoured local customs that had once governed use of the resource and the apportionment of costs. In addition, the increasing environmental impact of demand for irrigation water in the twentieth century, and the need to modernize and increase the efficiency of irrigation systems, have shifted the issues of costs and financing to the centre of debate. In this context, we address some of the issues raised by the intensification of water use in largely arid regions such as Spain and its Mediterranean neighbours, Australia and certain parts of China.

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The main response to these problems in Spain has been to treat water increasingly as an economic input, ignoring its other functions in the community, and to argue that all costs should be paid by direct users. This is the stance taken not only by the Spanish Water Act of 1985 but also by the EU Water Framework Directive (WFD), which requires the recovery of all costs associated with water provision and obliges national governments to keep continental and maritime waters in pristine condition.

Most water use is, of course, associated with agriculture and therefore with the production of food for domestic consumption and export. In this light, it hardly seems fair that farmers should be the only ones required to pay for agricultural water use, as the benefits are shared by society as a whole (see Lenzen and Foran, 2001; and Lenzen and Peters, 2010). Perhaps, then, it would be more reasonable to spread the associated costs among all beneficiaries, including direct users such as farmers and hydroelectric utilities, indirect users, and end-users, in order to ensure that everyone has an interest in efficiency and the mitigation of adverse environmental impacts. To some extent, this has happened in recent decades in Spain, where taxpayers have in fact been asked to foot the bill for a significant part of water costs.

With these questions in mind, we examine the impact of spreading the high costs required to modernize and improve the efficiency of Spanish irrigation more widely. This approach is in line with recent research into shared environmental responsibility (see Munksgaard and Pedersen, 2001; Peters and Hertwich, 2006; Cadarso et al., 2009; and Lenzen et al., 2007). To this end, we apply a computable general equilibrium model (see Ballard et al., 1985; and Shoven and Whalley, 1992), which includes physical inputs (water), Government, and Trade sectors.[1] The model works in an open economy, allowing joint analysis of the impacts of changes in water costs and agricultural productivity on consumption, exports and imports, and on the associated water savings.

The structure of the paper is as follows. After this introduction, the second section explains the current situation of the *Upper Aragon Irrigation System*, a major irrigation scheme in the province of Huesca in north-eastern Spain, on which this study will focus. Section 3 explains the methodology applied and defines the different payment scenarios for modernization. The fourth, fifth and sixth sections analyse the results obtained from each of the scenarios simulated, and the paper ends with our conclusions and final reflections.

2. THE UPPER ARAGON IRRIGATION SYSTEM

Huesca had 183,142 hectares of irrigated farmland in 2002, of which 122,248 hectares belonged to the Comunidad General de Riegos del Alto Aragón (CGRAA). The scheme also supplies water to several towns and cities, as well as ten industrial estates, and it is highly representative of irrigation in the Ebro valley. Moreover, the ready availability

[1] Lofting and McGauhey (1968) were the first to include water as an input in an Input–Output model. Meanwhile, input–output tables, or Social Accounting Matrices (SAM), and Computable General Equilibrium Models (CGEM) based on them, have become a common instrument in the analysis of water use and demand over the last decade (see, for example, Lenzen, 2009, and Lenzen and Peters, 2010, for Australia; and Duarte et al., 2002, Velázquez et al., 2006, and Cazcarro et al., 2010, for Spain).

of data on water use and efficiency, costs and crop yields, mean that the CGRAA is ideally suited for the purposes of this study.

In recent years, the CGRAA has come close to the physical limits of use, suffering serious water shortages in drought years and intense social pressure. As farmers and other users demand ever more new reservoirs, scientists and green groups have lobbied all the harder for cuts in the area under irrigation to contain and reduce environmental impacts. The current solution, which hinges on modernization by switching from blanket to aspersion or drip irrigation systems, has resulted in efficiency gains of between 10 and 15%.

Modernization has mainly been financed by farmers, who have improved the efficiency of irrigation and economic productivity to cover the additional costs.[2] However, they have also generated even greater pressure on water resources by intensifying output and switching to thirstier crops. Indeed, modernization costs threaten farming itself and could create serious problems for the rural community. In Table 1, the *cost of water* reflects payments to Government (taxes, investments and maintenance) and the irrigation communities, and the *cost of irrigation* represents other associated costs. The cost of water is 13.24% of the total cost, while modernization costs account for 66.65%, amounting to €552.77 per hectare. The problem for farmers, then, is to pay their modernization and irrigation costs.

Can CGRAA farmers afford modernization in this scenario? While the average net margins in the area are around €641 per harvest and hectare, their response has been to intensify production, increasing water demand across the board, despite adverse environmental outcomes. A possible solution would be to shift a part of the burden of modernization costs off the backs of direct users, which would reduce the pressure on the environment. The viability of this solution is supported by other cases, like the Northern Victoria Irrigation Renewal Project in Australia, where the modernization of irrigation paid for both by government and by farmers has increased the efficiency of irrigation water use and made room for significant water savings, (see NVIRP, 2011).

Meanwhile, there is a clear consensus (see Lenzen et al., 2010; and Dey et al., 2007) that direct and indirect water uses are an important factor in any environmental analysis. The water embodied in products, dubbed "virtual water" by Allan (1993), is relevant both from a theoretical standpoint and for practitioners and politicians. In this regard, Hoekstra and Hung (2002) quantify the volume of virtual water in trade flows and identify the countries responsible for net imports and exports of virtual water.

Table 2 shows per-capita direct and virtual water use in the Spanish province of Huesca.[3] Households consume 161 litres/day/person, but total water use per capita is 26,432 litres/day, more than 160 times direct household consumption. Moreover, 6,645 litres of total per-capita use are imported from other regions of Spain or from abroad,

[2] To date, over 56,630 hectares have been modernized or are in the process of modernization. In recent years, the profitability of irrigated crops like alfalfa and corn has been above average for Spain. Meanwhile, the transformation process has generated improvements in water productivity of around 150% and similar land productivity gains. Current irrigation water use efficiency is over 60%, approximately 5% of which is attributable to the partial modernization already completed. Hence, the expected improvement will be between 10% and 15% at the end of the process. See DGA (2011).

[3] We account only for blue water use, and we identify 'water use' with 'physical consumption plus returns'. Thus, 'virtual water' means the embodied water use, not the embodied physical consumption. More details will be found in Cazcarro et al. (2010).

TABLE 1. Annual cost of modernized irrigation in the CGRAA, 2006.

	Average modernization cost	
(A) Cost of water to farmers	(€/ha)	(%)
Payments to Government	45.29	5.46
Payments to the Irrigation Community and the CGRAA	64.47	7.77
Total cost of water to farmers	*109.76*	*13.24*
(B) Cost of irrigation	(€/ha)	(%)
Labour	79.51	9.59
Modernization of general networks	136.65	16.48
Equipment	230.33	27.77
Power (field pumping)	169.96	20.49
Field adaptation	15.83	1.91
Sundry expenses	87.26	10.52
Total cost of irrigation	*719.54*	*86.76*
Total cost associated with water use (A + B)	829.3	100

Source: Own estimations based on Groot (2006).

while 18,134 litres, more than 2/3 of total domestic and imported uses, are exported. This means that the economy of Huesca is a net exporter of water.

According to Table 2, agriculture uses 17,571 litres, of which only 1,178 end up as virtual water in the products sold to households. Indeed, the embodied water in products sold to households by the Agri-Food industry and Hotels and restaurants is greater than

TABLE 2. Per-capita virtual water use (litres/day) in Huesca (Spain).

Sector	Water use[3]	Virtual water use in household consumption	Virtual water use in exports
Agriculture	17,571	1,178	6,384
Livestock	440	15	1,117
Energy products and Water utilities	429	124	92
Agri-Food industry	19	2,077	5,208
Chemicals	858	62	281
Other industry	151	111	455
Construction & Engineering	6	13	0
Retailing	10	78	37
Hotels & Restaurants	31	1,537	25
Transport & Communications	3	18	7
Other Services	107	127	16
Soc., Gov., S/I	0	581	82
Households	161	161	0
Domestic total	19,786	6,082	13,704
Rest of Spain	4,729	1,631	3,099
European Union	1,774	532	1,242
Rest of the World	142	54	89
Total Foreign Sector	6,645	2,216	4,429
Total	26,432	8,298	18,134

Source: Cazcarro et al. (2010).

direct use by these sectors. The Agri-Food industry in fact uses only 19 litres per capita/day, but its products contain over 2,000 litres.

In light of the above, it would seem reasonable to apply different distribution criteria that would combine both payments for direct water use and payments for virtual water, which is to say payments by direct users, indirect users and end-users. If direct (mainly agricultural) users paid a part of the significant costs involved, they would have an incentive to save and modernize, which would ease the financial burden on farmers and relieve pressure on the environment. In arid countries such as Spain and Australia, payments for the virtual water embodied in exports would undoubtedly encourage more rational water use and would probably produce savings. Finally, if end consumers had to pay for the water embodied in their consumption, they would be more likely to support saving and sustainability.

The use of these payment criteria requires reflection and more research, however. In this study, exporters' and consumers' contributions are paid by way of green export or consumption taxes levied in proportion to the amount of virtual water embodied in products. The model can also incorporate temporary and/or permanent changes in levels of water use, efficiency and technology through changes in the coefficients, production functions, consumption patterns, and tax rates, although these possibilities are limited by the scope of the study.

To sum up, mixed payment criteria are more complex but they have the potential to enhance environmental co-responsibility. This is the starting point for this paper, although the principle may also be applicable to other environmental problems, such as water pollution and atmospheric emissions.

3. METHODOLOGY

General Equilibrium Models (GEMs) are widely applied as a tool for economic policy analysis, because they capture the general features and functioning of an economy and the interrelationships between producers, consumers, trade, government and other institutions. Models of this kind have been applied to environmental and water management in recent years. For example, Berck et al. (1990) used a CGEM to examine the utility of reducing water consumption to solve drainage problems in the San Joaquin Valley in California, and Dixon (1990) applied a model of this kind to analyse the impact and efficiency of water pricing in Melbourne, Sydney and Perth. Various studies employing CGEMs have been performed in Spain, including Velázquez et al. (2006), who examine the effects of raising the rates charged for water consumption in agriculture, and Gómez et al. (2004), who simulate possible water savings in the Balearic Islands.

A base scenario is a prerequisite for the application of any CGE model. This is usually a Social Accounting Matrix or SAM (see Kehoe, 1996). We use the 2002 SAM for the province of Huesca obtained from Cazcarro et al. (2010) as our base scenario (see point (a) in the Appendix). The information for this SAM was obtained mainly from the 2002 MAPA (Spanish Ministry of Agriculture, Fisheries and Food) Agrarian Accounting Network, the National Statistics Institute of Spain and the regional Statistics Institute of Aragon.[4]

[4] As explained in Cazcarro et al. (2010), the 2002 SAM for Huesca was built in two steps. The first was the 1999 SAM for Aragon, and then the 2002 SAM for Huesca was obtained using the GRAS method described by Junius and Oosterhaven (2003) to update and regionalize data.

As 2002 saw average rainfall in Huesca, the conclusions reached with regard to water use and savings will be correct on average. Finally, we built the CGEM taking the International Food Policy Research Institute (IFPRI) model as a guide (Lofgren et al., 2002). This IFPRI model was defined and adapted to suit the objectives of the study, and it was solved using GAMS and calibrated to the 2002 SAM for Huesca. Hence, it describes the exact values of parameters and variables obtained in the base scenario.[5]

3.1. The Model

The model used comprises 29 productive sectors, including irrigated and unirrigated farming. Livestock is represented by a separate sector. The model also includes three production factors (labour, capital and water), accounts representing households and firms, a saving/investment account, a Government account, six tax accounts, and three trade sectors (Rest of Spain, European Union and Rest of the world). The water consumption data utilised were taken from Cazcarro et al. (2010).

Leontief production functions are used except for Irrigated Farming, because the use of a CES function for this sector provides an easy approximation to the efficiency gains obtained from the modernization of irrigation. Water is a physical input and the third factor of production. All prices are equal to 1 in the base scenario, except in the case of water. The water prices in the industrial accounts are obtained from AEAS (2002) and the price in the Irrigated Farming account is taken from Groot (2006). Hydroelectric plants also use water, of course, but they do not consume it physically, so these generating activities pay for water in the form of a tax. The model uses the demand elasticity coefficients obtained from the relevant literature for the Spanish economy, as shown in Table A.1 of the Appendix. It is assumed that Government savings are flexible while tax rates are fixed. The exchange rate is also fixed, as the province of Huesca trades mainly in euros with the rest of Spain and the European Union. Finally, the total value of private saving is equal to investment in the model.

3.2. Virtual Water

As explained above, the virtual or embodied water in a product is the water directly and indirectly required to produce it. In order to calculate the virtual water necessary to meet household and export demand, we will use the Leontief open linear model. If **A** is the Huesca matrix of total technical coefficients and **c** is its vector of unit water uses or water coefficients, the following equations

$$\boldsymbol{\lambda}' = \mathbf{c}'(\mathbf{I} - \mathbf{A})^{-1} = \mathbf{c}'\mathbf{M}$$

$$\Lambda(\mathbf{z}) = \boldsymbol{\lambda}'\mathbf{z}$$

can be used to obtain the vector of water values, $\boldsymbol{\lambda}$, which represents the water embodied in each unit of domestically produced goods, while $\Lambda(\mathbf{z})$ is the valuation of water for a given

[5] Key modifications of the IFPRI model are shown in the Appendix.

output **z**. Both **A** and **c** can be changed in the simulations, the components a_{ij} of **A** being the ratio between input *i* utilised in activity *j* and total output *j* (i.e. domestic output plus imports), while the components, c_j, of **c** are the ratio between water used directly in *j* and total output *j*.

We also assume that the water value of imports by Huesca province can be calculated with the above equations, using the Spanish unit coefficients as vector **c**, and the total technical coefficients for the Spanish economy as matrix **A**, since 60% of Huesca's imports are sourced from other regions of Spain.

3.3. Description of Scenarios

The five scenarios described below simulate modernization for the total irrigated farmland in Huesca. We assume that farmers themselves always pay the annual modernization costs associated with equipment, the adaptation of fields, and 50% of the energy costs, included in the model as input costs (see Table 1), and they also make an additional annual payment of €40 million to Government for domestically used water to cover the remaining modernization costs.[6] These contributions to Government are paid by way of taxes on users based on the criteria employed in each scenario (i.e. payments for activity, exports or consumption). According to the available data, these annual farmers' payments approximately cover the total modernization cost of the province's irrigated farmland.

Scenario 1. The distribution of additional payments is similar to that currently existing: direct users pay according to the quantity of water used, weighted on the basis of their returns, so that these payments are shared among irrigated farming, industry and services, and hydroelectric power plants at the percentages obtained in Table 3.

Scenario 2. In this scenario, direct users pay in proportion to their water use without corrective weightings. Equivalent consumption equal to 12.52% of irrigation uses is assumed to estimate payments by hydroelectric plants, which account for 84% of total payments in the Energy products sector.[7]

Scenario 3. Only exporters pay in relation to the virtual water embodied in their exports. The real virtual water payment of the Energy products sector is increased by 543%, the better to capture payments by hydroelectric power plants.

Scenario 4. Only end consumers pay in proportion to the virtual water embodied in the product. Again, the real virtual water payment of the Energy products sector is increased by 543% for payments by hydroelectric power plants.

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[6] The figure of €40 million includes modernization of general networks, 50% of energy costs and one and one half times the payment made to Government (see Table 3). The latter payment is due to the current low level of payments, which has been sharply criticized by the green lobby because the amounts collected do not cover real costs or the cost of additional flow regulation requirements. According to these criteria, the exact payment based on Table 3 and the 183,142 hectares of Irrigated farming in Huesca in 2002 would be: $(183{,}142/122{,}248) \times 4{,}236{,}133 \times (16.48/5.46 + 20.49/(2 \times 5.46)) + 1.5) = 40{,}582{,}162$.

[7] According to Table 3, equivalent consumption associated with hydroelectric plants will be a percentage of irrigation uses obtained as: $(17.53/4)/(70.03/2) \times 100 = 12.52$. Irrigation uses in Huesca's economy are around 1,355,069.33 Dm^3, so equivalent consumption will be: $0.1252 \times 1{,}355{,}069.33 = 169{,}654.68$ Dm^3. Energy products uses (not hydroelectric plants) are 31,223 Dm^3 according to the available data, so equivalent consumption by hydroelectric plants is 543% of real Energy products uses (not hydroelectric plants). Consequently, we multiply the virtual water payments in scenarios 3 and 4 by 6.43 (i.e. $1 + 5.43$), to approximate the payments made by hydroelectric power plants.

TABLE 3. Payments to government in 2002 in the CGRAA.

Direct users	CGRAA	%	Weightings on returns
Irrigation	4,236,133	70.03	2
Industry and services	752,898	12.45	10
Hydroelectric plants	1,060,355	17.53	4
Total	6,049,386	100.00	

Source: Own estimations based on Groot (2006).

Scenario 5. Mixed payment: one third is paid by direct users based on water use, and 2/3 by exporters and consumers in proportion to the virtual water in products.

4. EFFECTS OF MODERNIZATION WITHOUT PRODUCTIVITY GAINS

For ease of understanding, we separate the direct effects of modernization from indirect effects, which consist of agents' reactions to changes in prices, production and foreign trade. Direct effects always occur, but indirect effects depend on farmers' responses to higher costs, which is to say on final productivity. In this and the following section we therefore assume that farmers achieve 10% efficiency gains in their use of water for irrigation and the use coefficient for Irrigated farming is reduced accordingly, but farmers do not increase their productivity. In Section 6, we also assume that farmers react to the increase in their costs by raising productivity, to obtain a general overview of the effects. In both cases, we shall focus especially on water savings.

Let us begin with the effects in scenario 1, which is the most similar to the current situation and is therefore the most likely under current political conditions. The increased payments arising from modernization are presented in Table 4, while changes in prices, exports and imports are shown in Tables 5 and 6.

Tax payments in scenario 1 are made basically by four sectors, namely Irrigated farming, Energy products, Chemicals, and Livestock, which account for over 97% of the total. Payments from other accounts are negligible. As shown in Table 5, meanwhile, the accounts with the highest percentage price increases are Irrigated farming (13.91%), Energy products (1.84%) and Agri-Food industry (3.06%). In the latter case, the price increment is a consequence of dependence on Irrigated farming. In contrast, prices fall in relative terms in other sectors such as Livestock, Water, Chemicals, Transport material and Rubber, plastics and other manufactures, because they are accounts with low payments.[8] Table 6 also reveals that the biggest falls in exports in scenario 1 are in Irrigated farming, Unirrigated farming and the Agri-food industry. Imports also shrink, but the percentage decline is less than in the case of exports, because some imported goods

[8] One would expect Livestock sector prices to raise as a consequence of dependence on Irrigated farming. However, we have to take into account that the Livestock sector also depends on Unirrigated farming (a similar volume to the Irrigated farming demand), Chemicals, Metal products and machinery, Construction and engineering and Transport and communications, whose prices fall. Moreover, Huesca's Livestock sector demands a relevant part of the livestock feed from the rest of Spain, the EU and the rest of the world, whose prices in the model are constant.

TABLE 4 Accounts with the top six tax payments (thousands of €) and no irrigation productivity gains.

Account	Scenario 1	%	Scenario 2	%	Scenario 3	%	Scenario 4	%	Scenario 5	%
Irrigated farming	28,010	70.03	31,967	79.92	16,932	42.33	6,107	15.27	19,846	49.61
Unirrigated farming	0	0.00	0	0.00	368	0.92	185	0.46	210	0.52
Livestock	988	2.47	800	2.00	3,110	7.77	96	0.24	1,756	4.39
Energy products	7,921	19.80	4,739	11.85	1,487	3.72	4,829	12.07	3,219	8.05
Chemicals	1,928	4.82	1,561	3.90	786	1.96	482	1.21	985	2.46
Agri-food industry	43	0.11	35	0.09	16,047	40.12	15,734	39.33	10,649	26.62
Rubber, plastics and other manufactures	271	0.68	220	0.55	266	0.67	230	0.57	243	0.61
Retailing	22	0.05	18	0.04	53	0.13	342	0.86	97	0.24
Hotels and restaurants	70	0.18	57	0.14	77	0.19	10,742	26.85	2,137	5.34
Households	363	0.91	294	0.73	0	0.00	0	0.00	98	0.24
Total	40,000	100	40,000	100.00	40,000	100.00	40,000	100.00	40,000	100.00

TABLE 5. Accounts with the six biggest percentage change in prices (absolute value) and no irrigation productivity gains.

Account	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Irrigated farming	13.91	15.37	7.39	6.48	10.46
Livestock	−2.87	−3.24	−2.36	−1.78	−1.70
Energy products	1.84	−0.82	−3.18	0.36	−2.12
Water	−6.91	−7.86	−9.09	−3.12	−6.67
Chemicals	−2.29	−2.62	−2.91	−1.18	−2.14
Transport material	−2.88	−3.01	−2.30	−4.29	−3.27
Agri-food industry	3.06	3.36	3.50	3.40	3.84
Rubber, plastics and other manufactures	−2.54	−2.84	−2.89	−1.66	−2.39
Hotels and restaurants	−0.02	0.06	0.15	1.38	0.40
Average change	−0.07	−0.15	−0.39	−0.56	−0.37
Standard deviation of price increase	3.20	3.59	2.67	1.96	2.73

become relatively cheaper than domestic goods. An exception is Energy products, where imports increase due to rising demand after modernization because of dependence on external markets.

Total tax payments are the same in all scenarios, but their distribution and tax nature differ, as in scenario 2, where direct users pay in proportion to domestic water use, but without the profitability weightings established in scenario 1. The distribution of payments is very similar to scenario 1, which indicates that the weightings have little effect. This is relevant because changing these weightings has been widely mooted in political debate. In Table 4, the four highest paying accounts are the same as in scenario 1, and in the same order, accounting for 97.67% of payments in scenario 2 and 97.12% in scenario 1. However, the payments made by Energy products fall from 19.80% of the total in scenario 1 to 11.85% in scenario 2.

In scenario 3, where exporters pay taxes in proportion to the virtual water embodied in their exports, the highest-paying accounts are Irrigated farming and Agri-Food industry, which respectively account for 42.33% and 40.12% of the total, due to their share in exports. Agri-Food industry is particularly significant, representing more than 40% of payments, compared with less than 0.2% in scenarios 1 and 2.

In scenario 4, tax charges are paid only by the end consumer. The top positions in Table 4 are occupied by the Agri-Food industry and Hotels and restaurants, which respectively account for 39.33% and 26.85% of payments. This is due both to the significant share of their products in Household spending and to virtual water values. In contrast, the share of the Hotels and restaurants account was minimal in scenario 3 because the sector does not export.

Scenario 5 is based on a mixed payment criterion, as explained above, so its rankings are a combination of the preceding scenarios. The highest paying accounts in descending order are Irrigated farming, Agri-food industry, Hotels and restaurants, Energy products, and Livestock.

Table 5 presents changes in prices in each of the scenarios. Scenarios with tax charges for virtual use are less inflationary in Irrigated farming, while their standard deviations are smaller. The steepest falls in prices are found in the same accounts in all scenarios, namely

TABLE 6. Sectors with the six biggest percentage changes (absolute value) in exports and imports and no irrigation productivity gains.

	Exports					Imports				
Account	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Irrigated farming	−40.92	−43.74	−47.52	−16.30	−33.24	−3.94	−4.12	−11.55	−6.51	−6.33
Unirrigated farming	−9.34	−10.23	−16.76	−5.98	−12.23	−11.06	−11.91	−14.22	−8.28	−11.36
Livestock	−0.76	−0.18	−9.27	−3.83	−9.10	−16.17	−17.51	−19.27	−11.25	−15.13
Energy products	2.75	13.41	16.50	15.70	15.04	10.84	9.61	8.29	7.27	7.75
Chemicals	20.54	24.23	25.57	7.26	12.29	1.95	2.49	1.91	0.30	−0.05
Transport material	35.03	36.88	28.49	36.40	28.68	4.84	5.07	5.23	2.05	3.61
Agri-food industry	−18.67	−20.16	−24.20	−11.55	−17.76	−5.07	−5.42	−5.60	−6.67	−5.10
Rubber, plastics and other manufactures	15.23	17.01	16.80	7.65	10.43	1.94	1.97	2.01	0.74	1.27
Recoveries and repairs	18.59	19.71	15.52	23.44	16.98	8.32	8.84	6.81	10.60	7.47

Water utilities, Livestock, Chemicals, Transport material, and Rubber, plastics and other manufactures. Meanwhile, Irrigated farming and Agri-food industry are the two sectors with the highest increments, as was to be expected. Changes in scenario 2 are again similar to those in scenario 1, confirming the weakness of the policies to change the profitability weightings when the payments are shared out.

In terms of trade (see Table 6), farm exports fall in all scenarios because of rising costs, and Agri-Food industry exports also shrink. In scenario 3, the effects on exports are stronger than in any of the other scenarios because modernization is paid for by exporters alone through tax charges.

To sum up, the *payment criterion* is a relevant economic and environmental policy issue, given the differing impacts on the distribution of payments, prices, exports and imports.

5. WATER SAVINGS IN DOMESTIC AND TRADE MARKETS

As in the preceding section, we shall assume that farmers do not obtain any productivity gains. Within this framework, let us estimate water savings as the difference between initial virtual water and final virtual water in products.[9] The results for household consumption and exports are presented in Table 7, which refers only to domestic water uses.[10]

The key result from Table 7 is that significant water savings are obtained through a decline in farm exports in all of the scenarios, driven mainly by falling demand in the Irrigated farming and Agri-Food industry accounts, while increased water use is found mainly in industrial and service sectors. Export savings are, then, clearly related with price increases in the different accounts, although water values and demand elasticities also play a role.

Table 7 also shows that export savings are above 7.55% in all of the scenarios, rising to 14.23% in scenario 3. The meaning of these figures can best be understood in light of the efficiency gains in water use by Irrigated farming (10% of use in this sector), which drives a reduction of approximately 8.88% in total domestic uses.[11]

Table 7 also shows that domestic use tends to rise with modernization except in scenario 4, especially in the Agri-Food industry, Hotels and restaurants and Irrigated farming accounts, because domestic consumption by households substitutes exports.

6. MODERNIZATION WITH AGRICULTURAL PRODUCTIVITY GAINS

Let us now incorporate the agricultural productivity gains to capture all of the general effects. These productivity gains are the result of farmers' reactions to increasing modern-

[9] Water savings are defined in Appendix b.

[10] We also estimated water savings taking all uses (domestic and imported water) into account. Both the total figures and percentages found are slightly higher than in the case of domestic water uses alone, but the qualitative conclusions are the same (see Table 10).

[11] Total water use in Huesca's economy is around 1,525,910 Dm^3, and efficiency gains from Irrigated farming produce a saving of 135,506.93 Dm^3.

TABLE 7. Changes in domestic water use (Dm^3) and no irrigation productivity gains.

	Households					Exports				
Sector	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Irrigated farming	2,582	3,083	9,177	−4,352	2,267	−157,585	−167,890	−177,624	−72,805	−126,302
Unirrigated farming	157	178	225	−70	88	−237	−232	−924	−528	−836
Livestock	184	208	245	−4	126	12,145	14,379	6,307	−433	440
Energy products	1,549	2,001	2,488	445	1,557	1,638	2,920	3,465	1,724	2,490
Water utilities	88	97	117	17	75	8	10	10	1	4
Minerals and metals	0	0	0	0	0	32	36	39	18	28
Minerals and non-metal products	6	7	8	2	5	254	292	315	142	228
Chemicals	1,685	1,893	2,251	364	1,355	11,872	13,850	14,925	4,083	8,106
Metal products and machinery	88	98	121	17	76	2,424	2,676	2,604	1,715	2,105
Transport material	62	68	76	24	52	814	892	785	610	650
Agri-food industry	6,689	7,937	15,782	−11,418	3,258	−60,595	−64,118	−75,305	−53,380	−63,333
Textiles, leather and footwear	282	317	468	−90	227	232	257	325	6	186
Paper, stationery and printing	216	243	323	14	182	2,136	2,401	2,296	1,526	1,680
Wood, cork and wooden furniture	14	17	24	−1	12	359	415	382	553	399
Rubber, plastics and other manufactures	816	907	1,092	143	667	3,522	3,970	4,134	1,412	2,595
Construction and engineering	0	0	0	0	0	5	5	6	2	4
Recoveries and repairs	0	0	0	0	0	7	8	7	5	6
Retailing	746	859	1,082	95	639	415	473	539	144	343
Hotels and restaurants	7,144	8,097	16,975	−11,996	5,081	123	137	234	−163	77
Transport and communications	176	208	271	17	159	73	86	97	29	63
Banking and insurance	42	53	82	−32	32	2	3	4	−1	2
Real estate	366	418	529	45	303	34	38	45	9	27
Private education	49	56	75	−4	39	3	3	4	0	2
Private healthcare	323	365	451	37	258	9	11	12	2	7
Retailing	244	277	358	12	205	123	139	153	47	100
Domestic service	0	0	0	0	0	0	0	0	0	0
Public education	4	5	6	0	3	0	0	0	0	0
Public healthcare	64	72	88	9	51	2	3	3	1	2
Public services	29	32	44	−3	24	1	1	1	0	1
Total variation in water use (Dm^3)	23,605	27,496	52,359	−26,731	16,741	−182,182	−189,237	−217,161	−115,281	−170,925
% Total variation in water use	1.55	1.80	3.43	−1.75	1.10	−11.94	−12.40	−14.23	−7.55	−11.20

ization costs. Therefore, we shall now change the efficiency parameter of the CES functions for Irrigated farming. The remaining accounts continue to be based on a Leontief technology.[12] As productivity gains depend on multiple factors (e.g. irrigation know-how, agricultural research and product marketing), we shall examine the problem at three levels of gains (5%, 10% and 15%), seeking qualitative data. Tables 8 and 9 show the main effects on prices and exports in each of the five scenarios.

As shown in Table 8, prices in Irrigated farming are lower in all scenarios as productivity increases, and in some cases they even fall. The same effect occurs in the Agri-Food industry, indicating that agricultural productivity gains are the correct response to increasing modernization costs.

Table 9 shows the effects of productivity gains on exports. In all of the scenarios, rising productivity mitigates the fall in Irrigated and Unirrigated farming exports, and the contraction observed in Livestock and Agri-food industry exports in Table 6. In some cases, in fact, exports actually grow. In other words, these productivity gains neutralise or reduce the effects of modernization costs (see Tables 5 and 6).

Let us now turn to water saving and use. Table 10 compares the use of domestic water in percentage terms and reveals some of the trends caused by productivity gains. On the one hand, savings via exports fall with higher productivity in all scenarios, because productivity gains boost output and exports. However, productivity gains also cause a reduction in the virtual water consumed by households, with the result that savings are achieved in all sectors in the case of a 15% gain. Nevertheless, the levels of saving achieved via household consumption vary widely, between 0.49% in scenario 3 and 5.89% in scenario 4. This variability once again demonstrates the importance of payment criteria for environmental policy design.

Considering households and exports together, savings are achieved in all scenarios at the level of 15%, varying between 8.90% and 9.30%. These savings are slightly lower than those obtained without productivity gains. This is because output will tend to increase in step with productivity gains. Let us recall here that efficiency gains in water use (due to agricultural productivity gains) were approximately 8.88% in total domestic uses. Therefore, at the level of 15% productivity gains the water saving is reduced to that obtained via technology.

On a scenario-by-scenario basis, Table 10 reflects very similar results for scenarios 1 and 2 (direct user payments), although the saving is less in scenario 1 and is achieved mainly via exports. Scenario 3 produces the highest savings via exports for all three levels of productivity gains, as was to be expected. It is also the scenario that displays the biggest water demand via households in all three cases, resulting in savings of 0.49% for a 15% productivity gain. The highest savings via households are found in scenario 4, which was also the case without productivity gains. However, this scenario provides the smallest savings via exports (3.04% at the 15% level). Finally, the mixed scenario again reflects the general trend: savings via exports decline with productivity gains while household savings increase.

[12] CES technology is used for the Irrigated farming account because it facilitates the estimation of changes in productivity. However, we also estimated changes in Irrigated farming on the basis of Leontief technology, obtaining qualitatively similar results.

TABLE 8. Percentage effects on prices with agricultural productivity gains.

Productivity	5%					10%					15%				
Account*	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Irrigated farming	9.12	10.56	3.04	1.41	5.58	4.59	6.02	−1.07	−3.40	0.98	0.27	1.69	−4.97	−7.98	−3.37
Livestock	−2.55	−2.96	−2.20	−1.50	−1.68	−2.13	−2.57	−1.95	−1.12	−1.58	−1.59	−2.08	−1.61	−0.64	−1.40
Energy products	2.77	0.09	−2.45	1.39	−1.38	3.76	1.04	−1.68	2.47	−0.61	4.81	2.06	−0.86	3.61	0.19
Water	−5.50	−6.53	−8.03	−1.51	−5.60	−3.92	−5.04	−6.86	0.27	−4.44	−2.13	−3.36	−5.53	2.26	−3.16
Chemicals	−1.79	−2.14	−2.52	−0.66	−1.77	−1.25	−1.62	−2.09	−0.10	−1.37	−0.67	−1.06	−1.63	0.51	−0.95
Transport material	−1.81	−1.94	−1.38	−2.91	−2.07	−0.84	−0.97	−0.55	−1.67	−0.98	0.04	−0.08	0.20	−0.54	0.01
Agri-food industry	1.89	2.19	2.46	2.04	2.58	0.77	1.06	1.46	0.73	1.37	−0.31	−0.01	0.51	−0.52	0.21
Rubber, plastics and other manufactures	−1.93	−2.25	−2.39	−0.99	−1.87	−1.28	−1.62	−1.87	−0.29	−1.33	−0.59	−0.95	−1.31	0.44	−0.77
Hotels and restaurants	−0.07	0.01	0.11	1.31	0.35	−0.12	−0.04	0.07	1.24	0.29	−0.18	−0.10	0.02	1.16	0.22
Average change	−0.03	−0.12	−0.37	−0.48	−0.32	0.03	−0.06	−0.33	−0.38	−0.26	0.11	0.01	−0.28	−0.26	−0.19
Standard deviation of price increase	2.27	2.61	1.99	1.08	1.79	1.50	1.70	1.57	0.99	1.07	1.08	0.99	1.54	1.76	0.97

* The accounts in this table are the same as in Table 5.

TABLE 9. Percentage effects on exports with agricultural productivity gains.

Productivity	5%					10%					15%				
Account*	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Irrigated farming	−29.86	−33.30	−38.30	−3.51	−24.04	−16.92	−21.13	−27.67	11.08	−13.76	−1.74	−6.89	−15.38	27.80	−2.24
Unirrigated farming	−5.40	−6.32	−13.57	−1.93	−8.77	−1.48	−2.42	−10.43	2.09	−5.32	2.41	1.46	−7.34	6.07	−1.90
Livestock	2.74	3.52	−5.94	−0.15	−5.27	5.60	6.61	−3.09	3.11	−1.70	7.75	9.01	−0.77	5.90	1.58
Energy products	−0.62	9.66	13.30	12.74	12.89	−4.07	5.83	10.01	9.71	10.69	−7.62	1.91	6.60	6.59	8.42
Chemicals	15.53	19.16	21.34	4.09	9.87	10.43	14.01	16.98	0.87	7.39	5.23	8.78	12.47	−2.43	4.83
Transport material	20.19	21.77	16.63	21.70	16.94	8.47	9.86	7.02	10.13	7.48	−1.07	0.18	−0.97	0.75	−0.34
Agri-food industry	−12.63	−14.23	−19.26	−5.85	−12.97	−6.45	−8.14	−14.24	−0.07	−8.14	−0.12	−1.91	−9.16	5.80	−3.26
Rubber, plastics and other manufactures	10.95	12.74	13.27	4.28	7.72	6.79	8.59	9.80	1.04	5.10	2.68	4.51	6.36	−2.12	2.54
Recoveries and repairs	11.68	12.77	9.63	16.45	11.09	5.42	6.49	4.29	10.16	5.79	−0.26	0.78	−0.57	4.50	1.01

* The accounts in this table are the same as in Table 6.

TABLE 10. Total water changes (%) in the different scenarios.

		Via households					Via exports					Via households + Via exports				
		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Domestic water	0% productivity gains	1.55	1.80	3.43	−1.75	1.10	−11.94	−12.40	−14.23	−7.55	−11.20	−10.39	−10.60	−10.80	−9.31	−10.10
	10% productivity gains	−1.28	−0.92	0.89	−4.46	−1.17	−7.96	−8.46	−10.56	−4.42	−8.06	−9.24	−9.38	−9.67	−8.88	−9.23
	15% productivity gains	−2.81	−2.39	−0.49	−5.89	−2.37	−6.09	−6.60	−8.81	−3.04	−6.62	−8.90	−8.99	−9.30	−8.93	−8.99
Total water (domestic and imported)	0% productivity gains	1.82	2.05	3.69	−1.26	1.49	−9.77	−10.17	−11.98	−5.82	−9.22	−7.95	−8.11	−8.29	−7.07	−7.73

7. CONCLUSIONS AND FINAL REMARKS

The study looks at water use in the province of Huesca in north-eastern Spain. Many scientists believe that economic uses of water are very close to the sustainable maximum in this region, as is indeed the case in the rest of Spain and in other arid countries, such as Australia.

In accordance with the Water Framework Directive and recent Spanish legislation, the costs of modernization must be paid largely by direct water users, which is to say by farmers. Table 1 shows annual modernization costs for the Upper Aragon Irrigation System, a major scheme in the Ebro valley, which we have taken as our benchmark. These modernization costs are very high, placing a barely sustainable burden on farmers, and their response has either been to abandon farming or to intensify cropping, increasing the pressure on water resources.

However, this modernization benefits society as a whole and, although irrigation does generate income for farmers, it is also essential to produce many goods for export, which generate earnings for the region, and provide basic inputs for other sectors. In this light, it has been widely argued that all water users are to some degree responsible for modernization, and its costs should be shared more fairly among direct users (e.g. farmers and hydroelectric plants), indirect users (e.g. Agri-Food industry) and end users like households and exporters. This ties in with the debate about how the liability for atmospheric emissions should be shared among different users and countries. It is also an advance in the analysis of green tax policy for consumers, exporters and the Agri-food industry to favour more efficient water use.

The study assumes that the modernization cost is borne by farmers and Government, which recovers its investment through an annual tax charge of €40 million payable by users. Our analysis focuses on the outcomes produced by five different distribution criteria for tax payments. In two of these scenarios (1 and 2), payments are made only by direct users. In scenario 3 only exporters pay, and in scenario 4 only households. Scenario 5 combines the criteria employed in scenarios 2, 3 and 4. The five scenarios were examined in two situations, with and without agricultural productivity gains. The comparison of the two situations reveals initially that it is necessary to promote productivity gains to compensate for modernization costs, but also to neutralize the negative effects of these costs.

Another clear conclusion is that the distribution of payments is far from being a secondary matter but has important macroeconomic and social consequences that should be taken into account in environmental water policy. Farmers' payments in scenarios 3, 4 and 5 would be much smaller than in scenarios 1 and 2, which would certainly increase the viability of existing farms and would reduce the upward pressure on water demand caused by modernization. Payments have very significant effects on prices (see Table 5), but these price shifts also depend to a great extent on the type of payment made. Irrigated farming and Agri-Food industry display the largest price increases in all scenarios. However, scenarios 3 and 4 have much smaller inflationary effects and distort prices less. A policy of sharing water costs among direct users, indirect users and end-users is difficult to apply. In the case of exporters, the main problem would be to differentiate between products, because the policy could cause problems of competitiveness in an integrated trade block like the European Union (EU). In the case of payments for the virtual water embodied in consumption, it would be similar to a green tax that would mainly affect products from the Agri-food industry and Hotels and restaurants. Moreover, the hydrological, agronomic and geographical variables affecting the virtual water embodied in products need to be taken into account. Therefore, reforms of this kind require unanimity between the trade block's member nations, new tax criteria and detailed regional studies. Even so, now may be the moment to consider a green tax in proportion to the virtual water embodied in products, in light of the insights gleaned from current and future research.

Modernization also has significant effects on trade. Table 6 reveals export contraction under the assumption of no productivity gains. The four accounts showing the largest percentage falls in exports are Irrigated farming, Unirrigated farming, Livestock and Agri-Food industry, although the decline in exports substantially depends on the nature of the payments. As was to be expected, the sharpest fall is found in scenario 3, where tax payments are assigned to exporters in their entirety. The smallest drop is in scenario 4, where the tax is paid by households. These results change, however, when productivity gains are included in the model. In general, these gains reduce or neutralize the effects presented in Table 5. In fact, prices may even fall when productivity gains are at the 15% level.

A similar result was found for exports: productivity gains make products associated with Irrigated farming cheaper (e.g. Agri-food industry products), thereby boosting demand. As a consequence, the falls in exports found when the scenarios were estimated without productivity gains either disappear or shrink.

Let now us consider how modernization affects the environment through water use. Table 7 reflects changes in water demand without productivity gains, and Table 10 presents the aggregate figures for all sectors. Let us remember here that the figures shown in these tables reflect virtual water values (i.e. the water directly and indirectly necessary to obtain a given product). As Table 10 shows, there is a clear difference between the savings obtained in exports and households. If productivity gains are at the 0% level, all sectors save water via exports, but the water embodied in household consumption increases (except in scenario 4). This difference is to some extent valid for the other productivity levels, since savings in households and exports move in opposite directions when productivity increases.

The aggregate saving (see Table 10) varies surprisingly little in the different situations and scenarios proposed, fluctuating between 8.88% and 10.80% of total water uses. In fact, the saving is around 9% in all cases, which is the level of technological saving produced by modernization. In other words, water savings are mainly produced by improvements in technological use, and farmers are the main agents of these savings. Furthermore, the savings achieved by changes in consumption and export patterns are socially and culturally very important, but less so quantitatively. The 8.88% of savings produced by technological innovation hardly varies. This is a crucial result for environmental policy and water management.

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APPENDIX

(a) About the SAM Used in the Model

The Social Accounting Matrix for Huesca province used in this study has the following basic structure:

	1	2	3	4	5	6	7	Total
1. Productive Activities	C_{11}	0	0	C_{14}	C_{15}	C_{16}	C_{17}	C_{1j}
2. Productive Factors	C_{21}	0	0	0	0	0	0	C_{2j}
3. Firms	0	C_{32}	C_{33}	C_{34}	0	C_{36}	C_{37}	C_{3j}
4. Public Sector	C_{41}	C_{42}	C_{43}	0	C_{45}	C_{46}	C_{47}	C_{4j}
5. Savings-Investments	0	0	C_{53}	C_{54}	0	0	C_{57}	C_{5j}
6. Foreign Sector	C_{61}	0	C_{63}	C_{64}	C_{65}	0	C_{67}	C_{6j}
7. Households	0	C_{72}	C_{73}	C_{74}	0	C_{76}	C_{77}	C_{7j}
Total	C_{i1}	C_{i2}	C_{i3}	C_{i4}	C_{i5}	C_{i6}	C_{i7}	

The SAM for Huesca comprises 29 productive sectors, including irrigated and unirrigated farming, three production factors (labour, capital and water), accounts representing households and firms, a saving/investment account, seven accounts for the Public Sector (a Government account and six tax accounts), and three trade sectors (Rest of Spain, European Union and Rest of the world). The water consumption data utilised were taken from Cazcarro et al. (2010).

(b) About the CGEM Used

Taxes are included in the model after calibration as follows:

$$TAXPAR(\text{`}TX\text{'}, AC) = TAXPAR(\text{`}TX\text{'}, AC) + Scenario(\text{`}TX\text{'}, AC)$$

using the tax rates defined by

$$t_{AC} = \frac{TAXPAR(\text{`}TX\text{'}, AC)}{SAM(AC,\ \text{`}TOTAL\text{'})}$$

where *TAXPAR* is the set of tax accounts, *TX* comprises activity taxes, export taxes and consumption taxes, *AC* represents activities or commodities, and *Scenario* is the increment in payments in each scenario.

A CES production technology is used for irrigated farming, given by:

$$QA_a = \alpha_a^a \left(\delta_a^a \cdot QVA_a^{-\rho_a^a} + (1 - \delta_a^a) \cdot QINTA_a^{-\rho_a^a}\right)^{\frac{-1}{-\rho_a^a}}$$

$$\frac{QVA_a}{QINTA_a} = \left(\frac{PINTA_a}{PVA_a}\frac{\delta_a^a}{1 - \delta_a^a}\right)^{\frac{1}{1+\rho_a^a}}$$

and α_a^a is used to change the level of agricultural productivity. The production technology for the rest of the activities is a Leontief technology, represented by:

$$QVA_a = iva_a \cdot QA_a$$

$$QINTA_a = \text{int}a_a \cdot QA_a$$

We estimate the water savings in the model as the following differences:

$$water\,saving\,via\,exports_c = \lambda^1 \cdot QE.L_c - \lambda^0 \cdot QEC_c$$

$$water\,saving\,via\,households_{c,h} = \lambda^1 \cdot QH.L_{c,h} - \lambda^0 - QHC_{c,h}$$

where QEC_c are the exports in the calibration scenario; $QE.L_c$ are exports in the final scenario; $QHC_{c,h}$ is household consumption in the calibration scenario; $QH.L_{c,h}$ is household consumption in the final scenario; $\boldsymbol{\lambda^0}$ is the vector of water values in the calibration scenario; and $\boldsymbol{\lambda^1}$ is the vector of water values in the final scenario.

Finally, the consumer price index *(CPI)* is fixed and functions as the numéraire in the model.

$$\overline{CPI} = \sum_{c \in C} PQ_c - cwts_c$$

where $cwts_c$ is the weight of commodity c in the consumer price index and PQ_c is the price of composite good c.

(c) About the Elasticity Coefficients

TABLE A.1. The elasticity coefficients.

Armington elasticity			0.8
CET elasticity			1.6
Demand elasticity coefficients			
Irrigated land and unirrigated farming	0.83	Construction and engineering	0.75
Livestock	0.92	Recoveries and repairs	1.31
Energy products	0.56	Retailing	0.96
Water	0.71	Hotels and restaurants	1.7
Minerals and metals	1.45	Transport and communications	1.14
Minerals and non-metal products	0.51	Banking and insurance	1.04
Chemicals	1	Real estate	0.46
Metal products and machinery	1.45	Private education	0.65
Transport material	1.05	Private healthcare	0.64
Food, beverages and tobacco	0.83	Retailing	1.16
Textiles, leather and footwear	1.29	Domestic service	1.16
Paper, stationery and printing	1.35	Public education	0.65
Wood, cork and wooden furniture	0.44	Public healthcare	0.64
Rubber, plastics and other manufactures	1.31	Public services	1.16

Note: All demand elasticity coefficients taken from Mainar (2010), except for Livestock, which is taken from Radwan et al. (2009).