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Assessing the Macroeconomic Impact of Water Supply Restrictions Through an Input–Output Analysis

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Abstract Water supply restrictions due to droughts generate significant costs to many economic agents. Although these costs are difficult to assess, this article presents a methodology to quantify, from a general equilibrium perspective, the macroeconomic impact of water supply restrictions through the estimation of aggregate production functions that include water consumption by sectors. Simulations with an Input–output model suggest a loss of 0.34% of GDP in the case of modest restrictions on the water supply and 2.8% in the case of more extreme restrictions for 2005 for the Catalonia region in Spain.

Keywords Input–output analysis · Water scarcity · Aggregate production functions · Water restrictions · Macroeconomic impact

1 Introduction

Water is essential for life in Earth and also to develop socio-economic activities conducted by humans. The Mediterranean area is known for its susceptibility to water stress conditions resulting from great variability in precipitation (Brandimarte et al. 2010). In this context of shortage of water, studies related to water use, which analyze structural relationships between economic activities and the use of water, become important. Some of them are based on virtual water analysis or water

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footprint (Allan 1993, 1994; Chapagain and Hoekstra 2004; Velázquez et al. 2010; Wang et al. 2009, among others).

However, assessing the economic impact of water supply restrictions produced by droughts is difficult, especially from a general equilibrium perspective. From a productive point of view, water is a critical element for the development of any economic activity, to the extent that many activities could not be carried out without this basic resource. Under certain circumstances, water supply reductions lead to diminished production, which in turn affects other activities through inter-sectoral relations in the economy.

There is not much empirical literature about the assessment of economic impacts of water supply restrictions from a general equilibrium perspective. In earlier contributions, Berck et al. (1991) used a regional computable general equilibrium (CGE) model to analyze reductions in water use due to drainage problems in California. Decaluwé et al. (1999) analyzed the effect of different water pricing schemes on demand and supply of water in Morocco through a general equilibrium model. Gómez et al. (2004) analyzed the welfare gains of improved allocation of water rights in the Balearic Islands.

In an international context, Berrittella et al. (2007) used a multi-region CGE model to analyze implications of reduced supply of water based on the GTAP-W model.[1] Calzadilla et al. (2010) also used the GTAP-W model to analyze the economy-wide impacts of more sustainable water use in the agricultural sector in different countries.

This article presents a model that simulates the macroeconomic impact of water restrictions on certain economic sectors in Catalonia. It offers a different and simple way to account for the economic impacts of water supply restrictions in economic activities. Most of the existent literature previously referred needs a development of specific computable general equilibrium models for the regions in order to apply the described methodologies. However, the methodology developed in this paper can be easily transferred to other regions, since only the existence of Input–output tables is required (and they are common in National Accounting Systems from National or regional Statistics Institutes). In this sense, this paper represents an important contribution for policy makers and other agents to a more efficient management of water resources in water scarcity contexts, since it is a simple way to address macroeconomic impacts from water use.

First, the estimation of sectoral aggregate production functions with the introduction of water as a production factor has been carried out, and then, the simulation in the input–output tables for Catalonia for 2005 (TIOC-05) has been carried out, so a hybrid model, combining Input–output modeling and econometric analysis has been developed. For this purpose, two water restriction scenarios have been identified: exceptionality, and emergency. Those scenarios are used by the Catalan water administration in the management of droughts.

Despite some limitations, this exercise has a great interest in order to consider the macroeconomic impact on various productive sectors in case of implementing certain water supply restrictions, given a particular production structure. Models should be further developed in future research as more data become available in order to incorporate more realistic hypotheses about the behavior of the different agents.

[1] For more information on the GTAP model, see Hertel (1997).

2 Water Consumption and Water Supply Restriction Scenarios

Water consumption by sectors has been identified with the support of experts from the Catalan Water Agency (ACA, in Catalan), as well as the definition of the exceptionality and emergency scenarios. For the first scenario a minor drought has been considered, with no restrictions on priority water uses. In the second scenario, an extreme drought has been considered, with larger restrictions, affecting urban water supply networks (sectors 6–14 in Table 1).

Table 1 shows the percentages of guaranteed water demand for each economic sector as an approximation to the scenarios. Columns 3 and 4 represent the percentage of guaranteed water demand for each economic sector during a whole year, compared to normal consumption of the sector in a normal situation.

Table 1 Water consumption by sector in Catalonia and guaranteed percentages of water demand by scenarios, 2005

Economic sector	Estimated direct consumption by sectors (m^3/year)	% Guaranteed demand in the exceptionality scenario	% Guaranteed demand in the emergency scenario
(1) Agriculture, animal husbandry, hunting, forestry, fishing	2,166,733,333	80	50
(2) Extractive industries (mining)	23,333,333	99	90
(3) Manufacturing	220,695,208	99	90
(4) Energy	21,666,666[a]	99	90
(5) Construction	11,666,666	99	90
(6) Retail business	4,627,143	99	90
(7) Hotels	54,106,026	99	90
(8) Transport and communications	5,741,864	99	90
(9) Finance	210,324	99	90
(10) Real estate and business services	420,649	99	90
(11) Public administration[b]	10,475,460	99	90
(12) Education	5,586,912	99	90
(13) Health and social care	6,704,294	99	90
(14) Other social activities[c]	54,947,325	95	80
TOTAL	2,586,915,203	83	56

Source: own from Freire González and Puig Ventosa (2009) and Agència Catalana de l'Aigua (2010)

[a] Since only consumptive uses of water are considered, water used for hydroelectric plants or cooling water used in the generation of electricity is not included

[b] This sector includes general activities of public administration, defense, justice, civil defense, and compulsory social security, among others

[c] This sector includes the activities of public sanitation, association and recreation activities, culture, and sports, among others

In the exceptionality scenario the most affected sector would be *Agriculture, animal husbandry, hunting, forestry and fishing*. The sector *Other social activities* would be less affected. For other activities a restriction of 1% has been assigned, considering that in a drought context they would also be affected. The guaranteed demand in the agricultural sector would be reduced to 50% in an emergency scenario, the sector *Other social activities* would lose a 20%, and for the rest of economic activities it has been applied a 10% reduction.

3 Estimation of Aggregate Production Functions by Sectors

In order to estimate the effects of variations in the amount of water used by economic sectors on their aggregate production, an econometric model has been prepared prior to simulation in a general equilibrium context. An estimation by sectors of aggregate production functions with Cobb–Douglas functional specifications has been carried out (Cobb and Douglas 1928). These functional forms have been widely used in the literature on estimating aggregate production functions and in empirical studies of growth and productivity (Aschauer 1989; Raymond 1989; Álvarez et al. 2003). Water consumption by sectors has been included in the specification:

$$Y_{it} = A_{it} K_{it}^{\alpha} L_{it}^{\beta} W_{it}^{\gamma} \tag{1}$$

Where Y_{it} is the total output of sector i in period t; A represents the total factor productivity or the technological level of sector i in period t; K_{it} is the stock of capital of sector i in period t; L_{it} is the employed population in sector i in period t; W_{it} is the water consumption of sector i in period t; α, β and γ are the output elasticities of capital, labor and water, respectively.

In order to facilitate the econometric estimations, Eq. 1 can be transformed in logarithms:

$$\ln(Y_{it}) = a + \alpha \ln(K_{it}) + \beta \ln(L_{it}) + \gamma \ln(W_{it}) + u_{it} \tag{2}$$

The estimation of the models was performed with data on Value Added (VA) and the number of employees by sector for the 17 Spanish regions extracted from the "Contabilidad Regional de España" (Regional Accounting of Spain) from the National Statistics Institute of Spain (INE). On the other hand, data on regional stock of net capital was obtained from the BBVA Foundation and the Instituto Valenciano de Investigaciones Económicas (IVIE),[2] and data on water consumption performing sectors was obtained from the "Survey on water use in agriculture", the "Survey on the use of water in the industrial sector" and the "Survey on water supply and treatment", the last one related to urban uses, from the INE.

To obtain a sector by sector correspondence among the data of all the used variables, the sectors have been aggregated into five: agriculture (AGR), extractive industries (EXT), manufacturing industries (MAN), market services (MKT) and non-market services (NMKT), so the parameters of five models have been simultaneously estimated. Since data of all variables are from 1999 because the available data of water consumption is of that year, it has been assumed that the estimated

[2] Methodological issues of data can be found in Mas et al. (2005).

coefficients will be the same for 2005 (the year for which the Input–output Tables of Catalonia are available).

An estimation of an equations system with the five specified models has been performed, establishing common coefficients for the intercept and for the variables *employed population* and *stock of capital*. The estimation methodology used has been the SUR method (Seemingly Unrelated Regressions method).

Table 2 shows the results of the estimations. The estimated coefficients obtained from econometric models transform variations of water supply into changes in VA in a partial equilibrium context. The macroeconomic implications in a general equilibrium framework can be obtained by introducing the estimated values by sectors in a general equilibrium model, such as the Input–output model developed below.

Table 2 Estimation of the equations system by the SUR method

Total system observations: 82

	Coefficient	Std. Error	t-Statistic	Prob.
a	4.301880	1.161274	3.704450	0.0004
α	0.398186	0.098849	4.028222	0.0001
β	0.383759	0.092979	4.127394	0.0001
γ_1	0.161376	0.011944	13.51146	0.0000
γ_2	0.082288	0.019506	4.218598	0.0001
γ_3	0.258894	0.018754	13.80483	0.0000
γ_4	0.277144	0.018639	14.86918	0.0000
γ_5	0.240351	0.020084	11.96738	0.0000
Determinant residual covariance		1.53×10^{-06}		
Agriculture: $\text{Ln}(Y_{AGR}) = a + \alpha * \text{Ln}(K_{AGR}) + \beta * \text{Ln}(L_{AGR}) + \gamma_1 * \text{Ln}(W_{AGR})$				
R-squared	0.904671	Mean dependent var	13.81419	
Adjusted R-squared	0.876072	S.D. dependent var	0.899323	
S.E. of regression	0.316592	Sum squared resid	1.002306	
Durbin–Watson stat	2.733172			
Extractive industries: $\text{Ln}(Y_{EXT}) = a + \alpha * \text{Ln}(K_{EXT}) + \beta * \text{Ln}(L_{EXT}) + \gamma_2 * \text{Ln}(W_{EXT})$				
R-squared	0.807872	Mean dependent var	11.86167	
Adjusted R-squared	0.763535	S.D. dependent var	1.485169	
S.E. of regression	0.722203	Sum squared resid	6.780513	
Durbin–Watson stat	1.772315			
Manufacturering industries: $\text{Ln}(Y_{MAN}) = a + \alpha * \text{Ln}(K_{MAN}) + \beta * \text{Ln}(L_{MAN}) + \gamma_3 * \text{Ln}(W_{MAN})$				
R-squared	0.874195	Mean dependent var	14.95489	
Adjusted R-squared	0.845163	S.D. dependent var	1.068458	
S.E. of regression	0.420431	Sum squared resid	2.297913	
Durbin–Watson stat	1.458327			
Market services: $\text{Ln}(Y_{MKT}) = a + \alpha * \text{Ln}(K_{MKT}) + \beta * \text{Ln}(L_{MKT}) + \gamma_4 * \text{Ln}(W_{MKT})$				
R-squared	0.981002	Mean dependent var	16.02247	
Adjusted R-squared	0.976618	S.D. dependent var	0.990151	
S.E. of regression	0.151406	Sum squared resid	0.298010	
Durbin–Watson stat	1.960714			
Non-market services: $\text{Ln}(Y_{NMKT}) = a + \alpha * \text{Ln}(K_{NMKT}) + \beta * \text{Ln}(L_{NMKT}) + \gamma_5 * \text{Ln}(W_{NMKT})$				
R-squared	0.927483	Mean dependent var	14.82440	
Adjusted R-squared	0.910749	S.D. dependent var	0.920355	
S.E. of regression	0.274956	Sum squared resid	0.982809	
Durbin–Watson stat	1.281211			

4 Macroeconomic Impact from the Leontief Supply Model (or Ghosh Model)

From a macroeconomic perspective of general equilibrium, impacts of water supply restrictions can be assessed with the Input–output methodology. This methodology obtains the consequences of changing an exogenous variable over the productive structure of an economy.

These applied analysis models allow the simulation of economic policies and estimate their macroeconomic impact, using data from the National Accounting Systems. Theoretical foundations of general equilibrium models can be found in the Arrow–Debreu model (Arrow and Debreu 1954) and in the notion of Walrasian equilibrium (Walras 1954).

Wasilly Leontief developed the analytical framework to empirically estimate the relations between economic sectors in a general equilibrium context based in input–output tables (Leontief 1936, 1941). Then, it was developed the Leontief supply model or Ghosh model (Ghosh 1958). This is based on the development of an alternative model to Leontief's demand-side model, but developed for the supply side,[3] in which the coefficients are horizontally determined rather than vertically (allocation coefficients, instead of technical coefficients). In this case, the strategic variable, exogenously determined, is the value added, instead of the final demand.

This approach assumes the same analogous simplifying assumptions than the Leontief demand model. Those are (Chenery and Clark 1959; Miller and Blair 2009):

1. Each sector produces a single product. This implies constant allocation coefficients[4] (so there is no technical change) and no substitution between inputs.
2. Consideration of the same number of supplier and consumer sectors. There should be a correspondence between the total number of products employed in production processes and the number of sectors that produce them.
3. The inputs of each sector are exclusively a function of the production level of that sector. That means that production functions are lineal and homogeneous, so the inputs are proportional to the production level.
4. Exogeneity of values added. This assumption implies that values added of each sector are not explained within the model, but are considered as exogenous variables. A variation of this variable would lead to a change of total output, as a measure of economic impact.

Assuming a Walrasian general equilibrium context (Walras 1954), the total production of an individual sector j can be disaggregated as the sum of the productive inputs used in its production x_{ij} plus its added value:

$$x_j = x_{1j} + x_{2j} + ... + x_{nj} + g_j \tag{3}$$

[3]For more details on the Leontief demand-side model and for more information on the Input-output analysis see Miller and Blair (2009).

[4]An allocation coefficient is the distributed amount of a good, expressed in monetary units, between the total production of a sector. These coefficients are mathematically defined below.

Generalizing, this can be expressed in matrix terms as:

$$x' = i'X + g' \tag{4}$$

Where X is the total output of the economy; x' is the sectoral output and g' is a vector of sectoral added values.

Next, the allocation coefficients are defined. They represent the amount of distributed production over its total distribution:

$$d_{ij} = x_{ij}/x_i \tag{5}$$

Where d_{ij} is the corresponding allocation coefficient; x_{ij} is the production of sector i distributed to sector j; and x_i is the total production of sector i.

If Eq. 5 is substituted in Eq. 4, the model can also be expressed as:

$$[x_1 \quad x_2 \ \cdots \ x_n] = [x_1 \quad x_2 \ \cdots \ x_n] \begin{bmatrix} d_{11} & d_{12} & \cdots & d_{1n} \\ d_{21} & d_{22} & \cdots & d_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ d_{n1} & d_{n2} & \cdots & d_{nn} \end{bmatrix} + \left[g_1 \quad g_2 \ \cdots \ g_n\right] \tag{6}$$

Namely:

$$x' = x'D + g' \tag{7}$$

Where g_i represents the sectoral VA.

Performing matrix calculations, x can be expressed as:

$$x = g'(I - D)^{-1} \tag{8}$$

This expression allows determining the direct and indirect effects of sectoral variations of value added over the final production. The final effect on all sectors of increasing one unit in the value added of sector i (g_i) is given by the sum of the corresponding row elements of the inverse matrix, which constitute the supply or inputs multiplier. It measures the forward linkages, that is, when the product of one industry is used as raw material of other industries impulsing the overall economy.

Since the total output in the TIOC-05 is equal to the addition of intermediate consumption, value added, and net taxes on products, the latter have also been included in the model:

$$\begin{array}{c} x_1 = d_{11}x_1 + d_{21}x_2 + ... + d_{n1}x_n + g_1 + tr_1 \\ x_2 = d_{12}x_1 + d_{22}x_2 + ... + d_{n2}x_n + g_2 + tr_2 \\ \cdots\cdots\cdots\cdots\cdots\cdots \\ x_n = d_{1n}x_1 + d_{2n}x_2 + ... + d_{nn}x_n + g_n + tr_n \end{array} \tag{9}$$

Where x_i are the sectoral productions, d_{ij} are the allocation coefficients, g_i is the value added of each sector and tr_i are the net taxes on products of sector i.

Finally:

$$x = \left[g' + tr'\right](I - D)^{-1} \tag{10}$$

Where the exogenous variables of the model are the VA and the net taxes on products.

5 Estimated Loss of Production and Gross Domestic Product in Catalonia

Table 3 shows the loss of VA in the exceptionality and emergency scenarios from the simulation carried out on the Ghosh model for Catalonia, developed in the previous section.

Gross Domestic Product (GDP) can be considered, at the aggregate level, as the sum of the sectoral VA. Therefore, from Table 3, the loss of GDP in the exceptionality scenario would be approximately 552 million Euros or 0.34% of total GDP in Catalonia for 2005. In the emergency scenario this loss would be around 4,541 million Euros, representing 2.80% of total GDP in Catalonia for 2005.

As shown in Table 4, in both scenarios, the most affected economic sector would be *Agriculture, animal husbandry, hunting, forestry and fishing*, with a reduction of

Table 3 Estimated loss of sectoral VA due to water supply restrictions, in the exceptionality and emergency scenarios, 2005

Economic sectors	Estimated sectoral VA losses de in the exceptionality scenario (thousand €)	% VA losses in the exceptionality scenario	Estimated sectoral VA losses in the emergency scenario (thousand €)	% VA losses in the emergency scenario
(1) Agriculture, animal husbandry, hunting, forestry, fishing	−62,841	−3.23	−157,103	−8.07
(2) Extractive industries (mining)	−216	−0.08	−2,158	−0.82
(3) Manufacturing	−88,710	−0.26	−887,097	−2.59
(4) Energy	−2,082	−0.08	−20,825	−0.82
(5) Construction	−42,756	−0.26	−427,563	−2.59
(6) Retail business	−58,987	−0.28	−589,870	−2.77
(7) Hotels	−30,201	−0.28	−302,012	−2.77
(8) Transport and communications	−31,956	−0.28	−319,555	−2.77
(9) Finance	−20,659	−0.28	−206,588	−2.77
(10) Real estate and business services	−81,203	−0.28	−812,032	−2.77
(11) Public administration	−13,397	−0.24	−133,974	−2.40
(12) Education	−15,128	−0.26	−151,284	−2.57
(13) Health and social care	−18,930	−0.24	−189,297	−2.40
(14) Other social activities	−85,298	−1.20	−341,194	−4.81
TOTAL	−552,365	−0.34	−4,540,552	−2.80

Table 4 Estimated loss of total sectoral production for cause of water supply restrictions in exceptionality and emergency scenarios, 2005

Economic sectors	Estimated sectoral production losses de in the exceptionality scenario (thousand €)	% Production losses in the exceptionality scenario	Estimated sectoral production losses in the emergency scenario (thousand €)	% Production losses in the emergency scenario
(1) Agriculture, animal husbandry, hunting, forestry, fishing	−73,022	−1.81	−218,888	−5.42
(2) Extractive industries (mining)	−1,365	−0.23	−11,038	−1.83
(3) Manufacturing	−489,436	−0.41	−3,385,094	−2.84
(4) Energy	−14,577	−0.21	−116,037	−1.70
(5) Construction	−117,024	−0.31	−1,016,033	−2.65
(6) Retail business	−112,273	−0.30	−1,022,068	−2.75
(7) Hotels	−65,112	−0.34	−532,401	−2.80
(8) Transport and communications	−79,035	−0.30	−715,606	−2.74
(9) Finance	−32,921	−0.28	−303,680	−2.63
(10) Real estate and business services	−132,015	−0.30	−1,218,849	−2.72
(11) Public administration	−22,783	−0.27	−202,224	−2.38
(12) Education	−20,632	−0.27	−192,672	−2.52
(13) Health and social care	−32,215	−0.27	−287,355	−2.42
(14) Other social activities	−110,474	−0.90	−489,945	−4.00
TOTAL	−1,302,883	−0.37	−9,711,889	−2.79

1.81% of its production in the exceptionality scenario and 5.42% in the emergency scenario. Next, there is the *Other social activities* sector (0.9% and 4%), and the *Manufacturing industries* (0.41% and 2.84%).

6 Effects on Other Macroeconomic Variables: Profits, Wages and Jobs

The TIOC-05 allow to obtain the effects of an impact on other macroeconomic indicators such as profits, measured as Gross Operating Surplus, wages or job losses derived from production losses.

- Benefits and wages: coefficients for benefits and wages have been estimated in order to calculate these losses. The proportions of wages and benefits in relation to total VA for each productive sector have been calculated. These coefficients have subsequently been applied to the loss of VA to obtain the new estimated benefits and wages.

- Employment: similarly, employment coefficients have been estimated. They represent the proportion of workers in each sector, relative to the VA. Next, the new VA has been multiplied by these coefficients.

Losses are theoretical, assuming the aforementioned restrictions on water supply and assuming that all other variables remain constant, as well as the basic assumptions of the Leontief model are satisfied (see Section 4).

As shown in Table 5, in the exceptionality scenario, the loss of profits in the agricultural sector is the largest (19.1% of total losses). *Other social activities*, followed by *Manufacturing industries* are the most affected sectors as regards wages (19.4% and 19.3% of the total losses, respectively). In this scenario, reduction of employment is more noticeable in the *Other social activities* sector, with 25.8% of the job losses.

In the case of emergency scenario (Table 6) the most affected sector in terms of profit losses is the *Real estate and business services* sector (with 22.8% of the losses). As for lost wages, the most affected sector is *manufacturing industries* (with 23.1% of the losses). Regarding employment, *manufacturing industries* are the most affected (with 20.3% of total loss in the number of jobs) followed by the *retail business* sector (15.7%) and *other social activities* (14.4%).

Table 5 Estimated loss of profits, wages and jobs due to water supply restrictions in an exceptionality scenario, 2005

Economic sectors	Estimated profits losses (thousand €)	Estimated wages losses (thousand €)	Estimated job losses (number of person-year)
(1) Agriculture, animal husbandry, hunting, forestry, fishing	−53,123	−17,574	−2,370
(2) Extractive industries (mining)	−133	−83	−3
(3) Manufacturing	−34,992	−53,856	−1,957
(4) Energy	−1,502	−518	−9
(5) Construction	−20,796	−21,527	−878
(6) Retail business	−29,331	−29,819	−1,512
(7) Hotels	−18,224	−11,972	−531
(8) Transport and communications	−19,226	−12,702	−487
(9) Finance	−9,589	−10,926	−213
(10) Real estate and business services	−50,007	−28,327	−946
(11) Public administration	−3,180	−10,164	−309
(12) Education	−1,835	−13,287	−358
(13) Health and social care	−4,949	−13,969	−443
(14) Other social activities	−30,886	−54,124	−3,477
TOTAL	−277,772	−278,849	−13,490

Table 6 Estimated loss of profits, wages and jobs, for cause of water supply restrictions in an emergency scenario, 2005

Economic sectors	Estimated profits losses (thousands €)	Estimated wages losses (thousands €)	Estimated jobs losses (number of person-year)
(1) Agriculture, animal husbandry, hunting, forestry, fishing	−132,807	−43,935	−5,925
(2) Extractive industries (mining)	−1,325	−835	−26
(3) Manufacturing	−349,921	−538,563	−19,570
(4) Energy	−15,018	−5,183	−90
(5) Construction	−207,964	−215,272	−8,776
(6) Retail business	−293,315	−298,186	−15,115
(7) Hotels	−182,244	−119,719	−5,306
(8) Transport and communications	−192,255	−127,023	−4,867
(9) Finance	−95,888	−109,258	−2,130
(10) Real estate and business services	−500,073	−283,272	−9,460
(11) Public administration	−31,798	−101,638	−3,089
(12) Education	−18,346	−132,874	−3,576
(13) Health and social care	−49,487	−139,687	−4, 431
(14) Other social activities	−123,544	−216,495	−13,908
TOTAL	−2,193,984	−2,331,939	−96,268

7 Conclusions

Water supply restrictions on certain economic sectors produce a variety of economic effects. Part of the macroeconomic impacts can be addressed from an empirical perspective with the construction and simulation in a general equilibrium model.

This article shows how water supply restrictions have effects on macroeconomic variables such as GDP, value added of different sectors and employment, and how the economic consequences would be greater in the emergency scenarios, where the water restrictions would be more severe.

Despite the usefulness of these models, estimated results are based on a number of hypotheses. This is basically due to the assumptions of the econometric models and of input–output modeling. Results are also limited by the availability of both quantitative and qualitative data for empirical analysis. There is also some uncertainty about the behavior of the economic agents and other qualitative aspects that are difficult to consider in the models. These effects may distort the results provided by the simulations.

Further investigations would be necessary to move towards a greater development of econometric models, improving the availability of data for the modeling of specific production functions for each economic sector or activity in order to incorporate more realistic assumptions about the behavior of economic agents in situations of water supply restrictions.

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