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The drought in Andalusia: Analysis of the economic impact and evaluation of the SOS Plan

La sequía en Andalucía: Análisis del impacto económico y evaluación del Plan SOS

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ABSTRACT

The objective of this study is to estimate the impact of the drought in which the region finds itself and the SOS Plan launched by the Junta de Andalucía to address the water shortage on the Andalusian economy. For this, we carry out two simulations using input-output methodology and the Social Accounting Matrix of Andalusia database.

The results obtained reveal notable consequences of the drought on the economy (-6.2% in terms of income and -7.4% in terms of GDP) that could be reduced in the event of good execution of the aforementioned plan (-3.2% in terms of income and -3.9% in terms of GDP).

RESUMEN

El objetivo de este estudio es estimar el impacto económico de la sequía y del Plan SOS puesto en marcha por la Junta de Andalucía para hacer frente a la escasez de agua sobre la economía andaluza. Para ello, hemos realizado dos simulaciones utilizando metodología input-output y la Matriz de Contabilidad Social de Andalucía como base de datos.

Los resultados obtenidos revelan notables consecuencias de la sequía sobre la economía (-6,2% en términos de renta y -7,4% en términos de PIB) que podrían reducirse en caso de una buena ejecución del citado plan (-3,2% en términos de renta y -3,9% en términos de PIB).

1. INTRODUCTION

Drought is a recurring feature of the climate that is characterized by the temporary shortage of water in relation to the normal supply in a given period of time (droughts can affect regions for weeks, months or years) and can cause serious impacts on the environment, society and the economy (Espinosa-Tasón et al., 2022; Stahl et al., 2016). A distinction is made between drought mainly caused by a lack of rainfall in a region for a certain time and drought caused by water shortages that occur when reservoir flow rates and storage levels fall below normal (Canto, 2001) and limit the demand for water for human consumption and by industry.

Jenkins et al. (2021) state that the effects of this natural phenomenon can be direct and/or indirect. Direct effects are those specific to a sector, with changes in production, added value or employment focused on activities that use water as a critical or important part of the production process, such as the public water supply, agriculture or electricity (Freire-González et al., 2017). Indirect effects are derived from the former, that is, a reduction in supply can affect the productivity of a company and, therefore, the flow of goods and services through sectoral interconnections and supply chains. Both factors motivate this research, as severe droughts affect the demand for goods and impact the main economic aggregates.

According to the Environmental Portal of Andalusia, droughts are a major risk in the region. The Environmental Information Network of Andalusia (REDIAM, acronym in Spanish), which belongs to the Ministry of Sustainability, Environment and Blue Economy of the Junta de Andalucía prepares monthly reports (Junta de Andalucía, 2022a) of the incidence of droughts by agricultural region based on the joint study of precipitation and vegetation stress, and forecasts are established with regard to the persistence of the phenomenon in the coming months.

Public participation is one of the guiding principles that governs the actions derived from Law 8/2018, of October 8, on measures against climate change and for the transition towards a new energy model in Andalusia. The law defines two bodies for participation in matters of climate change: the Interdepartmental Commission on Climate Change and the Andalusian Climate Council. Both commissions work in the fight against climate change. At the end of 2021, the Hydrographic Confederation of the Guadalquivir (CHG), an agency under the Ministry for the Ecological Transition and the

Demographic Challenge (MITECO, acronym in Spanish), decreed a drought in 80% of the basin, highlighting the exceptional situation in the reservoirs of the community, an event that was not seen since the drought of 2008 (CHG, 2021).

This natural phenomenon is currently a topic of special relevance and interest worldwide. Numerous studies have analysed the impact of drought in different countries, such as Mexico (Baja California Sur and northwest), Venezuela, Peru and Uruguay, based on climatic indicators and focused on ecological, agricultural and hydraulic applications (Troyo et al., 2014; Cruz et al., 2014; Sosa, 2016; Olivares and Zingaretti, 2018). At the regional level, there are also previous studies that have analysed this problem, for example, a comparative analysis of drought indices in Andalusia for the period 1901-2012 (Gallardo et al., 2016); climate change and drought in Andalusia (Vargas, 2013); economic challenges and opportunities of climate change adaptation: the case of Catalonia (Freire-González y Puig-Ventosa, 2014); the socioeconomic impact of drought in the agricultural sector in the period 2005-2008 (Espinosa-Tasón et al., 2022); and an analysis of the evolution of water use in agriculture in the period 2004-2012 in the Guadalquivir basin through System of Environmental Economic Accounting – Water (SEE-W) tables (Borrego-Marín et al., 2015). The aim of this study is to estimate the economic impact of the drought in Andalusia and of the SOS Plan (Solutions and Works against Drought) proposed by the Junta de Andalucía to address the situation of water scarcity in the Autonomous Community. To achieve this objective, multisectoral modelling based on social accounting matrices applied to Andalusia is used.

This paper is divided into the following sections. In section two, the methodology used is explained. Then, in section three, the database used is detailed, and the simulations carried out are explained. Section four shows the results obtained. Finally, in section five, the main conclusions drawn from this study are presented.

2. METHODOLOGY

The theory of general equilibrium initiated by Walras (1874) has been put into practice thanks to the development in principle of input-output tables that were later completed with a social accounting matrix (SAM).

The input-output analysis proposed by Leontief (1936, 1941) marks the beginning of general equilibrium models using a multisectoral approach; however, his model ignores economic relations as a whole and does not take into account the effect of prices on final demand. Kantorovich (1939) and Koopmans (1951) introduced optimization to traditional input-output analysis and improved the conductive technique towards a general equilibrium model.

The information contained in a SAM describes the economic relations of a region and, in turn, is taken as a database for the construction of economic models. Linear models are part of this group of SAM-based models, allowing the analysis of the capacity of the different agents of the economy to generate and absorb increases in income.

Linear SAM models are based on obtaining a multiplier matrix that incorporates the set of interdependence effects between all endogenous sectors of the model. They are an extension of the input-output models and include the relations between the productive sectors and the flows that are produced from the agents receiving income from the productive sectors. In addition, they allow the endogenization of households and treat them in a manner analogous to the productive sectors. Thus, intersectoral relationships analysed, as are the links between household income and spending. The public sector, investment or the foreign sector can also be endogenized (Sánchez et al., 2014). In summary, the advantage of using a SAM is that it includes all the information reflected in the input-output table plus the flows between added value and final demand. In this way, in a SAM, the circular flow of income of an economy is perfectly reflected. A SAM has been applied to conduct impact analyses of European countries (Campoy-Muñoz et al., 2017), American countries (Beltrán et al., 2017) and water price analyses at a regional level (Cardenete and Hewings, 2011).

For the matrix equation, following Stone (1978) and Pyatt and Round (1979), the exogenous accounts determined outside the economic system and the endogenous accounts are defined, a change in these exogenous accounts is introduced, and the change simulated in endogenous accounts is analysed.

As a preamble to the mathematical formulation of the model, Table 1 shows the composition of the SAM and its accounting relationships after the endogenous and exogenous accounts are determined. The subscript m refers to the endogenous accounts and the subscript k to the exogenous accounts.

TABLE 1
SAM SUBMATRICES

	Endogenous accounts	Exogenous accounts	Total
Endogenous accounts	Y_{mm}	X_{mk}	Y'_m
Exogenous accounts	X_{km}	X_{kk}	Y'_k
Total	Y_m	Y_k	

Source: Own elaboration based on Cámara y Marcos (2007).

Thus, Y_{mm} is a matrix containing the relationships between endogenous accounts; X_{km} contains the relationships between endogenous and exogenous accounts; X_{mk} represents the shocks of the exogenous accounts on the endogenous ones; X_{kk} contains only the relationships between exogenous accounts. The totals will be as follows: Y_m and Y_k are column matrices totalling the revenues and expenditures of the endogenous accounts and, Y'_m and Y'_k are row matrices totalling the expenditures of the endogenous and exogenous accounts respectively.

Once is defined exogenous and endogenous accounts a matrix of average propensities to spend is constructed; the payments made to account *i* for each unit of income of *j* is calculated as follows:

$$a_{ij} = \frac{Y_{ij}}{Y_j}, \quad i, j = 1, \dots, n \tag{1}$$

This is done by dividing each element of the matrix Y_{mm} and X_{km} by the total of the column to form A_{mm}, the base matrix of the analysis. Table 2 presents the structure of the matrix A_{mm}.

TABLE 2
STRUCTURE OF THE AVERAGE PROPENSITY TO SPEND MATRIX

	Activities	Factors	Private Sector	Capital
Activities	C_I		C_F	I
Factors	W			
Private Sectors		R	T	
Capital			S	

Source: Own elaboration based on Cámara (2006).

Where, C_I is the input-output matrix of technical coefficients; W is the matrix of coefficients of retribution to factor owners from the productive

sectors; *R* is the matrix of coefficients of distribution of income generated during the whole productive process from the factors of production to private institutions; C_F is the matrix of average propensities to consume; *T* are the coefficients of transfers between sectors; *S* are the propensities to save; *I* are the investment coefficients.

Table 2 is completed with three vectors as a follow: the exogenous income components of the endogenous accounts are represented by X_A, X_F, X_P and X_K; the income levels of the endogenous accounts are collected in the vectors Y_A, Y_F, Y_P and Y_K; and a vector of payments from endogenous to exogenous accounts is added, represented by P_A, P_F, P_P and P_K.

Based on this, the following is obtained:

$$Y_i = \sum_{j=1}^{n} \left(\frac{Y_{ij}}{Y_j}\right) Y_j = \sum_{j=1}^{m} a_{ij}\, Y_j + \sum_{j=m+1}^{m+k} a_{ij} Y_j; \quad n = m + k \tag{2}$$

where *m* and *k* represent the endogenous and exogenous accounts, displayed as a matrix below:

$$\begin{bmatrix} Y_A \\ Y_F \\ Y_P \\ Y_K \end{bmatrix} = \begin{bmatrix} C_I & 0 & C_F & I \\ W & 0 & 0 & 0 \\ 0 & R & T & 0 \\ 0 & 0 & S & 0 \end{bmatrix} \cdot \begin{bmatrix} Y_A \\ Y_F \\ Y_P \\ Y_K \end{bmatrix} + \begin{bmatrix} X_A \\ X_F \\ X_P \\ X_K \end{bmatrix} \tag{3}$$

The matrix is divided into four submatrices: A_{mm}, A_{mk}, A_{km} and A_{kk}, as follows:

$$Y_m = A_{mm} Y_m + A_{mk} Y_k \tag{4}$$

where Y_m and Y_k represent total income, both from endogenous and exogenous accounts and A_{mm} corresponds to the productive activities, which are the technical coefficients obtained with the input-output analysis.

Finally, it clears Y_m, leaving the matrix equation as follows:

$$Y_m = (I - A_{mm})^{-1} \cdot A_{mk} \cdot Y_k \tag{5}$$

$$Y = M \cdot X_m \tag{6}$$

where $(I - A_{mm})^{-1}$ is presented as *M* and is the matrix of linear multipliers. This matrix is interpreted as the impact generated by a unit increase in the exogenous accounts on the income of each of the endogenous accounts.

$A_{mk} \cdot Y_k$ as X_m represents the income injections issued by the exogenous accounts and received by the endogenous ones. Based on the SAM of Andalusia in 2016 (IECA, 2021), a linear model was developed following the classic criteria of endogeneity. Matrix M indicates the accounts that generate the greatest expansionary effects on the income of the economy.

3. DATABASE AND SIMULATIONS

The database used in this model is the SAM built for Andalusia from the input-output table published by the Institute of Statistics and Cartography of Andalusia (IECA, 2020) for 2016. The SAM is composed of 81 sectors and describes the flows in the Andalusian economy for that year. A SAM has been chosen over the input-output table because it allows the homogenization and completion of the microeconomic information on the circular flow of income, production and expenditures. That is, in addition to the productive sectors, a SAM identifies capital and labour as productive factors and a savings-investment account, the government and consumers as institutional sectors, disaggregates different taxes and includes the foreign sector.

Spain has officially settled into a drought. Because of the scarcity of water resources, among the Autonomous Communities, Galicia, Castilla y León, Extremadura, Andalusia, Catalonia and Navarra are in a more serious situation (Hydrological Bulletin of the Ministry of Ecological Transition, 2022). Andalusia has experienced one of the driest hydrological moments in the last 25 years. According to information provided by the Guadalquivir Hydrographic Confederation, in the fourth quarter of 2022, swamps are already at 28% capacity, 11% less than the national average. Given that the reservoirs, both Spanish and Andalusian, are always below their capacity, 100% is not the starting point for full capacity. For this reason, instead of applying a 72% drought forecast, the forecast is estimated at 60%. To carry out the calculations, we apply a weighting percentage, calculated based on the water use of each sector according to the information obtained through the satellite water account for Spain (INE, 2014) and subsequently extrapolated to Andalusia for the total output to obtain the total weighted output.

Despite being one of the driest regions in Spain, Andalusia is experiencing a historical drought situation. For this reason, at the end of October

2022, the Junta de Andalucía announced a plan to combat this phenomenon that required a total of 4,047 million euros distributed in eight main axes: purification and sanitation; high supply; drought; irrigation; reclaimed waters; new water resources, transport infrastructure and digitalization of water (desalination); flood risk mitigation, restoration and renaturation of rivers and streams; protection and recovery of groundwater masses; and awareness campaigns. This plan, called the SOS Plan, will promote crucial works and measures until 2027 (Junta de Andalucía, 2022b).

We investigate two scenarios: the decrease to 60% for the drought estimate and the injection, also weighted, of 4,000 million euros into the economy through the SOS Plan of the Junta de Andalucía.

The annex (Table 6) shows the simulation carried out. Firstly, a weighting percentage calculated according to water use from the satellite water accounts obtained from the INE (2023) has been applied to the total output of each sector.

Then, 60% is applied to the weighted total output because, at the moment of this analysis, the reservoirs were at a capacity of 28%, which translates into a lack of water of 72%. Considering that the water reservoirs are never at 100% capacity, reducing the impact by 10% is considered appropriate. Thus, we get an approximation of the current situation of the sectors as a result of the drought (simulation scenario), reflected in the results obtained in absolute and percentage terms.

The scenario including the investment proposed in the SOS Plan has been defined along the same lines. For its construction, an exogenous impact of 4.000 million euros has been added to scenario 1, distributed under the criterion of water use (in accordance with the satellite water accounts), in such a way as to compensate for the negative impact. This approach makes it possible to simulate the response of productive activities following an investment designed to minimise the effects of drought.

Detailed information on the calculation of the impact vectors for the economic sectors can be seen in the annex. Notably, 90% of water use is attributed to the agricultural sector. As Dietzenbacher and Velázquez (2007) indicate, Andalusian agricultural sectors are relatively small, but they account for 90% of annual water consumption.

4. RESULTS

Table 3 presents the simulation results. The most affected sector is agriculture, livestock and hunting (1), with a decrease of 52.63% in terms of sectoral value-added GDP. This sector shows the greatest reduction because it accounts for the most intensive water use; therefore, the impact is more striking in this sector, as it causes production losses.

Next are the food and tobacco industries (11), with a reduction of 15.48% in GDP due to the need for water during production processes. The veterinary activities sector (62) is also affected through its relationship with agriculture, livestock and hunting (1), with a decrease of 14.56%. The water collection, purification and distribution (37) and production, transportation and distribution of electricity (35) sectors are also affected but to a lesser extent, reporting reductions of 13.73% and 6.54%, respectively.

TABLE 3
SECTORS MOST AFFECTED BY THE IMPACT IN TERMS OF INCOME AND GDP (THOUSANDS OF EUROS)

No.	Sector	Production/income		GDP	
		Absolute	%	Absolute	%
1	Agriculture, livestock and hunting	-8,783,389.89	-52.63	-5.594,760.14	-52.63
11	Other food industries. Tobacco	-617,217.41	-15.48	-31,795.05	-15.48
62	Veterinary activities	-23,475.33	-14.56	-4,572.96	-14.56
37	Collection, purification and distribution of water	-236,657.54	-13.73	-113,027.88	-13.73
35	Production, transmission and distribution of electrical energy	-540,468.15	-6.54	-195,000.13	-6.54
Total impact of drought		-21,183,831.62	-6.29	-10,673,576.62	-7.39

Source: Own elaboration.

These results are consistent with those obtained by Alonso (2003), whose work indicated that the agricultural sectors consume much more water directly than do the industrial and service sectors. These findings confirm that agriculture in Andalusia is the largest consumer of water resources.

Table 3 shows the aggregate impact in terms of income and GDP. According to the estimated model, the impact on the Andalusian economy as a result of the drought will be a decrease of 6.29% in income and 7.3% in GDP.

Table 4 provide data regarding the impact of the drought offset by the monetary injection proposed in the SOS Plan. The most affected sectors are similar to those in the previous simulation; however, the decrease is less due to the investment foreseen through the SOS Plan. For example, the decrease in the agricultural sector would lessen by approximately 20%, i.e., from 52% to less than 30%. For the remaining four sectors, the impact would decrease by approximately 50%.

TABLE 4
SECTORS MOST AFFECTED BY THE IMPACT IN TERMS OF INCOME AND GDP (THOUSANDS OF EUROS)

No.	Sector	Income		GDP	
		Absolute	%	Absolute	%
1	Agriculture, livestock and hunting	-4,884,953.78	-29.27	-3,111,571.39	-29.27
11	Other food industries. Tobacco	-315,552.41	-7.91	-16,255.22	-7.91
37	Collection, purification and distribution of water	-123,324.97	-7.15	-58,900.13	-7.15
62	Veterinary activities	-11,299.06	-7.01	-2,201.04	-7.01
35	Production, transmission and distribution of electrical energy	-279,368.46	-3.38	-100,795.74	-3.38
Drought + SOS Plan		-10,851,703.11	-3.22	-5,611,641.03	-3.89

Source: Own elaboration.

Finally, the total impact on the Andalusian economy would also be less. Specifically, there would be a decrease of 3.2% in income and 3.9% in GDP, as shown in Table 4.

Therefore, although drought is a high-impact phenomenon in the Andalusian region, translated into an impact of 7.39% in terms of GDP, the SOS Plan would help alleviate the consequences in the most important sectors affected, reducing the impact to 3.89% in terms of GDP. However, this decrease would only occur if the other factors that affect the current regional conditions remain constant.

In terms of jobs (Table 5), the simulation of the impact of the drought reflects a loss of approximately 122,000 jobs, decreasing to 63,550 with the effective implementation of the SOS Plan of the Junta de Andalucía.

TABLE 5
SUMMARY OF THE IMPACT IN TERMS OF JOBS (THOUSANDS OF EUROS)

	Drought impact		Drought impact + SOS Plan	
	Absolute	**%**	**Absolute**	**%**
Loss of jobs	-122,032	-4.0	-63,557	-2.1

Source: Own elaboration.

As seen in the previous results, drought affects production, sales and commercial operations in the markets; that is, it generates direct economic impacts. In turn, it generates impacts as a result of the interactions between the different sectors. However, in addition, it generates environmental and social impacts that are not accounted for in this simulation (Ding et al., 2011).

5. CONCLUSIONS

From the simulations carried out and with the results obtained, we conclude that Andalusia has a serious present and future problem that must be faced to try to reduce the damage that could be caused to the entire economy at the regional level.

According to our model, the impact on the Andalusian economy of a 60% drought will be approximately 7% in terms of income and GDP. However, the SOS Plan of the Junta de Andalucía, if well executed, would reduce the impact by almost half. The most affected sector is agriculture, livestock and hunting because it accounts for the most intensive use of this natural resource.

To highlight the above effects would take place as long as the current conditions remain unchanged (*ceteris paribus*), i.e. without any reaction from stakeholders, affected sectors and government. In the same line, as indicated above, if the SOS plan were fully implemented, the impact would be reduced by half. Therefore, to compensate for the full impact of the drought on the economy, government spending would have to be more than double that proposed in the current regional government plan.

In addition to the quantitative results and methodological aspects, other interesting conclusions are raised. Beyond the economic impact, other types

of issues will also arise, such as social or political concerns. On a social level, due to the drought situation in Seville (capital province of Andalusia) and its metropolitan area, the municipalities supplied by EMASESA (acronym in Spanish of Empresa Metropolitana de Abastecimiento y Saneamiento de Agua de Sevilla, SA) has published municipal bulletins placing certain limitations on the use of water. Specifically, the use of drinking water for the irrigation of gardens, meadows, green areas and sports fields, of a public or private nature, is prohibited; the irrigation or flushing of roads, streets, paths and sidewalks, of a public or private nature, is prohibited; hose use to wash vehicles, except if the washing is carried out by a company dedicated to this activity, is prohibited; the filling of swimming pools, ponds and fountains, private or public, that do not have a closed circuit recovery system or fountains for human consumption that do not have automatic closing elements, is prohibited. These measures are intended to achieve the so-called 90 target, that is, 90 litres per person per day.

At the political level, if those responsible intend to change this situation to reach a more sustainable economy that uses scarce resources in a less intensive way, there are several options, as already indicated by Dietzenbacher and Velázquez (2007). The first option is technological changes. By investing in research and development, new techniques could be developed (irrigation systems) that reduce the direct coefficients of water, and additional investments would allow their implementation.

The second possible option, which is usually not taken into account, is restructuring the production structure. In other words, the possibility of a change in production specialization should be considered given that Andalusia, despite being a region with water scarcity, has an economic structure specialized in water-consuming sectors.

The third option is to increase the current price of water. On the one hand, this action saves water because it encourages producers to use water more efficiently, for example, by reducing water deterioration. On the other hand, it will increase the prices of products and, in particular, the prices of water-intensive products. In turn, this will reduce the demand for these products and thus lead to water savings. Although this measure is presented as an option, a next step would be to quantify the economic and social impacts.

REFERENCES

ALONSO, E. V. (2003): "Modelo Input-Output de Agua. Análisis de las relaciones intersectoriales de agua en Andalucía". *Centro de Estudios Andaluces*. No. E2003/01.

BELTRÁN, L. D., DELGADO, M. C., & RÍOS, H. (2017): "Análisis multisectorial y de cambio estructural de la economía Mexicana para el periodo 2003-2012". *Revista de Estudios Regionales*, (110), 69-97.

Boletín Oficial del Estado (BOE). (2018): Ley 8/2018, de 8 de octubre, de medidas frente al cambio climático y para la transición hacia un nuevo modelo energético en Andalucía.

BORREGO-MARÍN, M. M., PERALES, J. M., POSADILLO, A., GUTIÉRREZ-MARTÍN, C., & BERBEL, J. (2015): Analysis of Guadalquivir droughts 2004–2012 based on SEEA-W tables. In *DROUGHT: Research and Science-Policy Interfacing, Proceeding of the International Conference on DROUGHT: Research and Science-Policy Interfacing*, pp. 79-84. Leiden, The Netherlands: CRC Press.

CÁMARA, A. (2006): "Estimación de la matriz de contabilidad social de la comunidad de Madrid para el año 2000: Análisis del impacto de los Fondos Europeos 2000-2006 en la región aplicando la metodología de multiplicadores lineales". Tesis doctoral, Universidad Rey Juan Carlos.

CÁMARA, A. y MARCOS, M. (2007): "Análisis del impacto de los Fondos Europeos 2000-2006 en la comunidad de Madrid a partir de la matriz de contabilidad social del año 2000". *Investigaciones Regionales*, 16, pp. 71-92.

CÁMARA, A., CARDENETE, M. A, & ALCÁNTARA, J. R. M. (2014): "Matrices de Contabilidad Social y Modelos de Equilibrio General Aplicado elaborados en España a nivel regional". *Studies of Applied Economics*, 32(1), 427-454.

CAMPOY-MUÑOZ, P., CARDENETE, M. A., & DELGADO, M. C. (2017): "Economic impact assessment of food waste reduction on European countries through social accounting matrices". *Resources, Conservation and Recycling*, 122, 202-209.

CANTOS, J. O. (2001): "Tipología de sequías en España". *Ería*, (56), 201-227.

CARDENETE, M. A., & HEWINGS, G. (2011): "Water Price and Water Sectoral Reallocation in Andalusia. A Computable General Equilibrium Approach". *Environmental Economics*, 2(1), 17-27.

Confederación Hidrográfica del Guadalquivir (CHG). Organismo dependiente del Ministerio para la Transición Ecológica y el reto demográfico. (2021): Noticia "Se constituye la Comisión Permanente que asumirá la toma de decisiones y el cumplimiento del Plan de sequía durante la situación extraordinaria declarada en la cuenca".

CRUZ, G., BAETHGEN, W., PICASSO, V., & TERRA, R. (2014): "Análisis de sequías agronómicas en dos regiones ganaderas de Uruguay". *Agrociencia* (Uruguay), 18(1), 126-132.

DIETZENBACHER, E., & VELÁZQUEZ, E. (2007): "Analysing Andalusian virtual water trade in an input–output framework". *Regional studies*, 41(2), 185-196.

DING, Y., HAYES, M. J., & WIDHALM, M. (2011): "Measuring economic impacts of drought: a review and discussion". *Disaster Prevention and Management: An International Journal*.

ESPINOSA-TASÓN, J., BERBEL, J., GUTIÉRREZ-MARTÍN, C., & MUSOLINO, D. A. (2022): "Socioeconomic impact of 2005–2008 drought in Andalusian agriculture". *Science of The Total Environment*, *826*, 154148.

FREIRE-GONZÁLEZ, J., y PUIG-VENTOSA, I. (2014): "Retos y oportunidades económicas de la adaptación al cambio climático: El caso de Cataluña". *Revista de Estudios Regionales, (99), 47-73.*

FREIRE-GONZÁLEZ, J., DECKER, C., & HALL, J. (2022a): "The economic impacts of droughts: A framework for analysis". *Ecological Economics*, 132, 196– 204.

GALLARDO, M. P., FORTIS, S. G., DÍEZ, A. y. C., & ESTEBAN-PARRA, M. J. (2016): "Análisis comparativo de índices de sequía en Andalucía para el periodo 1901-2012". *Cuadernos de investigación geográfica/Geographical Research Letters,* (42), 67-88.

INSTITUTO DE ESTADÍSTICA Y CARTOGRAFÍA DE ANDALUCÍA (IECA). (2020): Marco Input-Output de Andalucía 2016.

INSTITUTO DE ESTADÍSTICA Y CARTOGRAFÍA DE ANDALUCÍA (IECA). (2021): Matriz de Contabilidad Social de Andalucía año 2016.

INSTITUTO NACIONAL DE ESTADÍSTICA (INE) (2014): Cuentas satélites del agua en España.

JENKINS, K., DOBSON, B., DECKER, C., & HALL, J. W. (2021): "An Integrated Framework for Risk-Based Analysis of Economic Impacts of Drought and Water Scarcity in England and Wales". *Water Resources Research*, 57(8), e2020WR027715.

JUNTA DE ANDALUCÍA. (2022): Informe mensual de análisis de la sequía en Andalucía. Línea de trabajo de la REDIAM "Sistema integral de seguimiento de la sequía con información a escala comarcal".

JUNTA DE ANDALUCÍA (2022b): Andalucía impulsa el Plan SOS 2022-2027 dotado con 4.047 millones de euros.

KANTOROVICH, L. (1939): "Mathematical methods of organizing and planning production". *Management Science*, 6, 363-422.

KOOPMANS, T. (1951): "Analysis of Production as an Efficient Combination of Activities". *En T. Koopmans, Activity Analysis of Production and Allocation*. New York: T. C. Koopmans (ed.), pp 33-97.

LEONTIEF, W. (1936): "Quantitative Input-Output relations in the economic system of the United States". *Review of Economics and Statistics*, 18, 105-125.

LEONTIEF, W. (1941): *The Structure of American Economy, 1919-1929:an Empirical Application of Equilibrium Analysis*. Cambridge: Harvard University Press.

MINISTERIO DE ESPAÑA. (2022): Boletín Hidrológico del Ministerio para la Transición Ecológica y el Reto Demográfico.

OLIVARES, B. O., & ZINGARETTI, M. L. (2018): "Análisis de la sequía meteorológica en cuatro localidades agrícolas de Venezuela mediante la combinación de métodos multivariados". *Cuadernos de Investigación UNED*, 10(1), 192-203.

PYATT, G., & ROUND, J. (1979): "Accounting and Fixed Price Multipliers in a Social Accounting Matrix Framework". *The Economic Journal,* 89 (356), 850-873.

SISTO, N. P., GUAJARDO-QUIROGA, R., & AGUILAR-BARAJAS, I. (2011): "Estimating the economic impacts of drought". *Tecnología y ciencias del agua*, 2(2), 111-123.

SOSA, J. D. (2016). "Análisis de la sequía hidrológica en el Perú". Tesis doctoral, Universidad Nacional Agraria La Molina.

STAHL, K., KOHN, I., BLAUHUT, V., URQUIJO, J., DE STEFANO, L., ACÁCIO, V., & VAN LANEN, H. A. (2016): "Impacts of European drought events: insights from an international database of text-based reports". *Natural Hazards and Earth System Sciences*, 16(3), 801-819.

STONE, R. (1978): *The Disaggregation of the Household Sector in the National Accounts*. World Bank Conference on Social Accounting Methods in Development Planning. Cambridge.

TROYO, E., MERCADO, G., CRUZ, A., NIETO, A., VALDEZ, R. D., GARCÍA, J. L., & MURILLO, B. (2014): "Análisis de la sequía y desertificación mediante índices de aridez y estimación de

la brecha hídrica en Baja California Sur, noroeste de México". *Investigaciones geográficas*, (85), 66-81.

VARGAS, J. (2013): "El cambio climático y el problema de la sequía en Andalucía" Facultad de Comunicación de la Universidad de Sevilla, pp.371-382.

WALRAS, L. (1874): *Elements d'economie politique pure ou Théorie de la richesse sociale*, Lausanne: Corbaz.

ANNEX

TABLE 6

CALCULATION OF THE IMPACT VECTOR AND SIMULATION WITH A 60% DROUGHT FORECAST

No.	Sector	Total output	Weighting	Weighted total output		Impact	
				Drought	SOS plan	Drought	SOS plan
1	Agriculture, livestock and hunting	15,194,505.00	91.05%	13,834,038.27	3,641,852.96	-8,300,422.96	-4,658,570.00
2	Silviculture and logging	325,811.00	3.09%	10,055.46	123,451.44	-6,033.28	117,418.17
3	Fishing and aquaculture	801,577.00	0.00%	0	0	0	0
4	Extractive Industries	9,590,969.00	0.02%	2,214.15	923.43	-1,328.49	-405.06
5	Processing and preserving of meat and production of meat products	3,773,264.00	0.07%	2,647.60	19,602.53	-1,588.56	18,013.97
6	Processing and conservation of fish, crustaceans and molluscs	1,174,737.00	0.02%	256.62	19,602.53	-153.97	19,448.55
7	Preparation and preservation of fruits and vegetables	2,391,410.00	0.04%	1,063.47	19,602.53	-638.08	18,964.44
8	Manufacture of fats and oils	7,622,820.00	0.14%	10,805.59	19,602.53	-6,483.36	13,119.17
9	Manufacture of dairy products	1,554,178.00	0.03%	449.18	19,602.53	-269.51	19,333.02
10	Manufacture of milling, bakery and pasta products	2,494,301.00	0.05%	1,156.95	19,602.53	-694.17	18,908.36
11	Other food industries, Tobacco	3,980,551.00	0.07%	2,946.48	19,602.53	-1,767.89	17,834.64
12	Manufacture of beverages	3,362,024.00	0.06%	2,101.93	19,602.53	-1,261.16	18,341.37
13	Textile industry, garment manufacturing, leather and footwear industry	4,007,362.00	0.05%	1,938.47	1,934.91	-1,163.08	771.83
14	Wood and cork industry	901,332.00	0.01%	56.62	251.26	-33.97	217.29

continue...

TABLE 6

CALCULATION OF THE IMPACT VECTOR AND SIMULATION WITH A 60% DROUGHT FORECAST (CONTINUATION)

No.	Sector	Total output	Weighting	Weighted total output		Impact	
				Drought	SOS plan	Drought	SOS plan
15	Paper industry	1,519,542.00	0.06%	939.23	2,472.39	-563.54	1,908.86
16	Graphic arts and reproduction of recorded media	457,268.00	0.02%	97.39	851.96	-58.44	793.52
17	Coke plants and petroleum refining. Chemical manufacturing	17,573,915.00	0.26%	45,882.73	10,443.37	-27,529.64	-17,086.27
18	Manufacture of paints, cleaning supplies, perfumes, cosmetics and other chemical products	3,170,338.00	0.29%	9,169.05	11,568.54	-5,501.43	6,067.11
19	Manufacture of pharmaceutical products	3,270,700.00	0.14%	4,693.81	5,740.44	-2,816.29	2,924.15
20	Manufacture of rubber and plastic products	2,412,028.00	0.03%	699.28	1,159.66	-419.57	740.09
21	Manufacture of cement, lime, gypsum and its derivatives	1,176,630.00	0.02%	268.85	2,010.08	-161.31	1,848.77
22	Manufacture of ceramic products, tiles, bricks and other fired earth for construction	430,896.00	0.01%	36.06	2,010.08	-21.63	1,988.44
23	Glass and stone industries	980,231.00	0.02%	186.59	2,010.08	-111.95	1,898.12
24	Metallurgy Manufacture of iron, steel and ferro-alloy products	6,936,837.00	0.10%	7,184.19	4,142.63	-4,310.51	-167.88
25	Manufacture of metal products, except machinery and equipment	3,351,379.00	0.10%	3,477.96	4,151.08	-2,086.77	2,064.30
26	Manufacture of computer, electronic and optical products	2,432,293.00	0.05%	1,107.04	1,820.56	-664.22	1,156.34
27	Manufacture of electrical material and equipment	3,040,040.00	0.05%	1,581.94	2,081.47	-949.16	1,132.31
28	Manufacture of machinery and equipment	3,249,166.00	0.01%	341.9	420.91	-205.14	215.77

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TABLE 6

CALCULATION OF THE IMPACT VECTOR AND SIMULATION WITH A 60% DROUGHT FORECAST (CONTINUATION)

No.	Sector	Total output	Weighting	Weighted total output		Impact	
				Drought	SOS plan	Drought	SOS plan
29	Manufacture of motor vehicles, trailers and semi-trailers	4,439,247.00	0.04%	1,947.16	1,754.49	-1,168.29	586.2
30	Shipbuilding	290,416.00	0.05%	132.53	1,825.39	-79.52	1,745.87
31	Manufacture of other transport material, except shipbuilding	3,385,823.00	0.01%	270.87	320.01	-162.52	157.48
32	Furniture manufacturing	1,474,341.00	0.01%	182.79	495.93	-109.68	386.26
33	Other manufacturing industries	1,760,862.00	0.00%	0	0	0	0
34	Repair and installation of machinery and equipment	2,550,386.00	0.01%	304.06	476.89	-182.44	294.45
35	Production, transmission and distribution of electrical energy	8,094,425.00	0.14%	11,555.38	6,700.25	-6,933.23	-232.98
36	Gas, steam and air conditioning supply	1,403,281.00	0.02%	347.3	6,700.25	-208.38	6,491.87
37	Collection, purification and distribution of water	1,723,807.00	0.15%	2,545.06	5,905.67	-1,527.04	4,378.63
38	Collection and treatment of wastewater; collection, treatment and disposal of waste; valuation; decontamination activities and other waste management services	2,587,670.00	0.45%	11,517.01	17,802.91	-6,910.21	10,892.70
39	Construction	18,854,302.00	0.05%	8,604.11	1,825.39	-5,162.46	-3,337.08
40	Sale and repair of motor vehicles and motorcycles	3,681,342.00	0.07%	2,565.35	2,787.41	-1,539.21	1,248.20
41	Wholesale trade and trade intermediaries, except motor vehicles and motorcycles	13,599,478.00	0.29%	39,253.95	11,545.72	-23,552.37	-12,006.65

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TABLE 6

CALCULATION OF THE IMPACT VECTOR AND SIMULATION WITH A 60% DROUGHT FORECAST (CONTINUATION)

No.	Sector	Total output	Weighting	Weighted total output		Impact	
				Drought	SOS plan	Drought	SOS plan
42	Retail trade, except of motor vehicles and motorcycles	12,995,987.00	0.22%	27,974.55	8,610.21	-16,784.73	-8,174.52
43	Land and pipeline transportation	9,248,417.00	0.13%	12,328.77	5,332.27	-7,397.26	-2,064.99
44	Maritime and inland waterway transport. Air transportation	1,294,031.00	0.03%	361.18	1,116.43	-216.71	899.73
45	Storage and activities related to transport	5,358,270.00	0.14%	7,271.79	5,428.46	-4,363.07	1,065.39
46	Postal and postal activities	564,167.00	0.01%	81.89	580.59	-49.13	531.46
47	Accommodation services	4,130,033.00	0.06%	2,585.98	11,151.94	-1,551.59	9,600.35
48	Food and beverage services	14,259,537.00	0.22%	30,826.88	11,151.94	-18,496.13	-7,344.19
49	Printing	774,457.00	0.03%	207.44	1,071.43	-124.47	946.97
50	Cinematographic, video and television program activities, sound recording and music publishing; radio and television programming and broadcasting activities	735,290.00	0.03%	224.3	1,220.20	-134.58	1,085.62
51	Telecommunications	4,616,970.00	0.08%	3,757.84	3,255.67	-2,254.70	1,000.97
52	Programming, consultancy and other computer-related activities; information services	2,389,326.00	0.09%	2,174.23	3,639.90	-1,304.54	2,335.36
53	Financial services, except insurance and pension funds	5,037,126.00	0.10%	5,083.05	4,036.47	-3,049.83	986.64
54	Insurance, reinsurance and pension funds, except mandatory Social Security	2,210,500.00	0.05%	1,081.98	1,957.89	-649.19	1,308.70

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TABLE 6

CALCULATION OF THE IMPACT VECTOR AND SIMULATION WITH A 60% DROUGHT FORECAST (CONTINUATION)

No.	Sector	Total output	Weighting	Weighted total output		Impact	
				Drought	SOS plan	Drought	SOS plan
55	Auxiliary activities to financial services and insurance	2,235,750.00	0.04%	882.29	1,578.51	-529.37	1,049.14
56	Real estate activities	24,715,561.00	0.38%	93,530.88	15,137.16	-56,118.53	-40,981.36
57	Legal and accounting activities; activities of the headquarters; business management consulting activities	4,636,880.00	0.11%	4,986.18	4,301.33	-2,991.71	1,309.62
58	Architectural and engineering technical services; technical tests and analyses	3,141,506.00	0.07%	2,226.05	2,834.38	-1,335.63	1,498.74
59	Research and development	2,132,798.00	0.04%	954.91	1,790.90	-572.94	1,217.96
60	Advertising and market research	2,437,896.00	0.04%	1,040.53	1,707.26	-624.32	1,082.94
61	Other professional, scientific and technical activities	1,008,301.00	0.03%	284.39	1,304.79	-170.63	1,134.16
62	Veterinary activities	157,848.00	0.00%	6.97	1,304.79	-4.18	1,300.61
63	Rental activities	2,229,909.00	0.04%	826.06	1,481.79	-495.64	986.15
64	Employment-related activities	462,114.00	0.01%	65.39	566.02	-39.23	526.78
65	Activities of travel agencies, tour operators, reservation services and related activities	1,552,837.00	0.04%	645.09	1,661.70	-387.05	1,274.65
66	Security and investigation activities	929,436.00	0.12%	1,155.11	4,971.21	-693.06	4,278.15
67	Services to buildings and gardening activities	2,361,279.00	0.02%	546.51	7,014.99	-327.91	6,687.08
68	Administrative office activities and other auxiliary activities to companies	1,597,147.00	0.02%	250.03	7,014.99	-150.02	6,864.97

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TABLE 6

CALCULATION OF THE IMPACT VECTOR AND SIMULATION WITH A 60% DROUGHT FORECAST (CONCLUSION)

No.	Sector	Total output	Weighting	Weighted total output		Impact	
				Drought	SOS plan	Drought	SOS plan
69	Public administration and defense; compulsory social security, Extraterritorial organizations	13,933,781.00	0.14%	19,030.10	7,014.99	-11,418.06	-4,403.07
70	Market education	3,300,378.00	0.05%	1,635.11	6,246.81	-981.06	5,265.75
71	Non-market education	7,103,132.00	0.11%	7,573.88	6,246.81	-4,544.33	1,702.49
72	Health activities market	4,417,763.00	0.07%	3,151.47	7,740.78	-1,890.88	5,849.90
73	Non-market health activities	7,566,641.00	0.12%	9,245.16	7,740.78	-5,547.09	2,193.68
74	Market social services activities	1,457,972.00	0.02%	351.23	2,186.41	-210.74	1,975.67
75	Non-market social service activities	1,850,127.00	0.03%	565.58	2,186.41	-339.35	1,847.06
76	Creative, artistic and entertainment activities; activities of libraries, archives, museums and other cultural activities; gambling and betting activities	2,416,220.00	0.04%	1,071.91	1,774.52	-643.15	1,131.38
77	Sports, recreational and entertainment activities	2,249,474.00	0.05%	1,021.16	1,815.83	-612.7	1,203.13
78	Associative activities	1,678,575.00	0.03%	522.46	1,245.01	-313.48	931.53
79	Repair of computers, personal effects and household items	638,052.00	0.01%	56.13	351.9	-33.68	318.22
80	Other personal services	2,448,466.00	0.04%	859.57	1,404.26	-515.74	888.52
81	Household activities as employers of domestic staff or as producers of goods and services for their own use	1,302,160.00	0.02%	321.85	988.67	-193.11	795.56

Source: Own elaboration.