From Growth to Development: Spanish Cities and their "Water Footprint"

José Antonio Sotelo Navalpotro
University Institute of Environmental Science
Complutense University of Madrid
Madrid, Spain

María Sotelo Pérez
Departament of Education Sciences, Language, Arts and
Culture, Legal History and Humanistic sciences and Modern Languages
Rey Juan Carlos University (URJC)
Madrid, Spain

Ignacio Sotelo Pérez
University Institute of Environmental Science
Complutense University of Madrid
Madrid, Spain

Fernando García Quiroga
Department of Geography
Complutense University of Madrid
Madrid, Spain

Abstract

The continuous and exaggerated urban growth that occurred in Spain during the last decades, has occurred as a consequence of the continuous construction of residential areas scattered throughout the territory. These areas have presented poor urban planning and very little protection of the environment. This model of urban development has required increasing demands for water with the serious repercussions that this entails. In this article an estimate of the demands of water resources is made, through the index known as "Water Footprint", from an economic and environmental perspective, in order to know the link between these demands and consumption with the endogenous urban development itself of Spanish cities.

Keywords: urban system; "Water Footprint"; "Virtual Water"; development; urban growth.

1. Introduction

Water scarcity is among the main problems faced by many societies. Growing water demands put increasing pressure on local water resources, especially in water-short countries (Chouchane, Krol and Hoekstra, 2018). The development of territories and cities depends largely on the availability of human, natural and economic resources, in addition to the interactions of forces and mechanisms that generate endogenous development, especially the flexible organization of production, diffusion of innovations, urban land development, and water availability. Factors such as the export and import of commodities may have scope beyond the system of interest and can be associated with key sustainable development issues such as virtual water trade and reducing carbon footprints (Biggs et al., 2015). It is in this context, from the point of view of the production of urban spaces, that the studies of sustainability indicators such as the "Water Footprint" are particularly important. This is because in large cities in general, and in Spanish cities in particular, the flows of materials and energy require an increase in external metabolism.

The study is framed within the scope of the five areas that Professor Carlos Jerez Mir (2011) points out: "public, social, productive, environmental and programmatic", and that represent the essential factors of life and human work that must be defended and exalted in the planning of the territory. It is especially in environmental safeguarding of resources where special emphasis must be placed on the preservation of natural resources for the benefit of all citizens.

2. Methodology for the Calculation of the "Water Footprint" for the Spanish Cities

Carrying out the study of the "Water Footprint" at lower and specific territorial levels allows us to know exactly how much water, and in what conditions it is used in the local water systems, in addition to how much water would be necessary to counteract the polluted currents (Chapagain and Orr, 2009). The study uses a methodology of calculation of the "Water Footprint" developed by Chapagain and Hoekstra (2004), updated in Hoekstra and alii. (2009), later in Hoekstra and alii. (2011) and finally in Sotelo Navalpotro, J.A. (2010, 2011, 2012) in which the calculation standards have been established both globally and at the Spanish level (autonomous, provincial and municipal). Our methodology has been adapted to the available data to carry out a more detailed and precise analysis of the general aspects of the demand for water resources in Spanish cities. Among the main statistical sources used for realizing the calculations of the study are the databases of the National Statistics Institute of Spain, Eurostat of the Ministry of Agriculture, Food and Environment of Spain, the World Bank, Aquastat-FAO and the "Water Footprint Network".

To calculate the values of the "water footprint" in Spanish cities, the following formulation is used:

The "Water Footprint" of a group of consumers is equal to the sum of the "Water Footprint" of individual consumers. It is calculated by adding the direct "Water Footprint" of the person and his indirect "Water Footprint":

WFcons = WFcons.dir — WFcons.indir

Where:

• *WFcons.dir* is the direct "Water Footprint", which refers to the consumption and contamination of water related to its use in the home or in the garden.

• *WFcons.indir* is the indirect "Water Footprint", which refers to the consumption and pollution of water associated with the production of goods and services consumed by the consumer. That is to say, the water that was used to produce food, clothing, paper, energy and industrial goods consumed.

The indirect use of water is calculated by multiplying all consumed products by their respective water footprints:

*WFcons.indir = Σp(C(p) *WF*prod (p))*

Where:

• *C(p)* is the consumption of the product *p* (product units / time).

• *WFprod(p)* is the "Water Footprint" of this product (volumen of water / product units).

The total consumed product *p* usually comes from different places *x*.

The average "Water Footprint" of a consumed product p is:

$$WF^{*}_{prod}(p) = \frac{\sum_{x}(C(x,p) * WF^{*}_{prod}(x,p))}{\sum_{x} C(x,p)}$$

Where:

• *C (x,p)* is the consumption of p products from *x* (product units/time).

• WFprod(x,p) is the "Water Footprint" of the products *p* coming from *x* (volume of water / product units).

Specifically, the calculation of the "Water Footprint" of Spain, from the reality of demand, brings us closer to the demand for water in agricultural uses, in industrial uses and in domestic uses, tourism and services, from the perspective of the large Spanish cities.

3. Consumption of Water Resources in Spanish Cities.

In a world of proliferating sustainability indicators, and more specifically those related to water, such as the "Water Footprint" or the "Virtual Water", it is essential to unify and standardize both the calculation and the generation of statistical and cartographic bases. Currently, standardized systems of water indicators at different territorial scales are not yet available, both for water consumption and for its price, as established in the "Living Planet Report" (WWW, 2014), something that would allow optimal management and governance of Spanish water resources.

This report established a "Water Footprint" of annual production in Spain of 94km3, and a "Water Footprint" per capita of 2,325m3/inhabitant/year, where the origin of "Virtual Water" is 64% internal and 36% external. In the present investigation we study the weight that most of Spanish cities have in terms of trade of "Virtual Water", and its "Water Footprint"[5].

The water consumed in cities is only a part of the "Water Footprint" generated by themselves, and at first, the one that seems to have a greater reliability of the sources, as not all water consumed is billed and measured. The difference between the water distributed by the public supply networks and the "efficiently used" water resources greatly complicate this approach to the urban "Water Footprint". For this reason, there is a tendency to think that the highest levels of water demand in cities correspond to industrial and domestic uses, instead of services, but this is really an accounting issue[1]. At this point, we move on to assess the weight that cities have on the whole of water consumption, once the "Virtual Water" has been incorporated, using as a base the set of Spanish central cities, in terms of environmental indicators, according to the data offered by the publication
"The Spanish Water Footprint in the Context of Climate Change" (Sotelo Navalpotro, J.A., 2010), as well as the own elaboration of the data bases.

Table 1. "Water Footprint per capita" in Spanish cities (2015).

	Population	hm^3	m^3/per capita	Spain/municipality
SPAIN	46,438,422		2611.31	
Madrid	3,099,834	8125.05	2621.1	1.13
Barcelona	1,578,546	4108.54	2602.7	1.12
Valencia	785,732	1806.57	2299.2	0.99
Sevilla	704,203	1684.34	2391.8	1.03
Zaragoza	638,799	1372.43	2148.5	0.92
Málaga	547,731	1335.42	2438.1	1.05
Murcia	398,815	1020.02	2557.6	1.1
Las palmas	376,953	798.91	2119.4	0.91
Valladolid	321,713	740.87	2302.9	0.99
Palma de Mallorca	368,974	863.53	2340.4	1.01
Santiago	92,298	217.43	2355.7	1.01
Vitoria	223,702	586.16	2620.3	1.13
Oviedo	209,495	472.72	2256.5	0.97
Pamplona	191,865	515.03	2684.3	1.15
Santander	183,799	429.35	2336	1
Toledo	73,485	180.67	2458.6	1.06
Badajoz	139,135	336.82	2420.8	1.04
Logroño	141,568	329	2324	1
Bilbao	352,317	914.01	2594.3	1.12
Córdoba	314.178	768.22	2445.2	1.05
Alicante	310,330	724.35	2334.1	1
Vigo	292,059	687.32	2353.4	1.01
Gijón	271,039	610.32	2251.8	0.97
Hospitalet de Llobregat	250,536	652.19	2603.2	1.12
Santa cruz de Tenerife	219,446	471.51	2148.6	0.92
SUM or AVERAGE	12086552	29750.78	2400.3	1

Source: Own Elaboration

The study of the relationship between the domestic water supplied and the "Virtual Water" used in the production and consumption of both goods and services in Spanish cities, shows that in the selected cities, only seven of them are below the national "Water Footprint per capita". Although its values are close to the country's average, we can say that cities demand a very important part of the "Water Footprint" of the total of Spain (see Table 1).

[1] For example, garden irrigation and urban police waters are not accounted for; like the water used in the construction sector, the so-called "construction" water, which also leaves out of accounting many cubic meters, which are not invoiced, or at least not on the same scale as domestic or industrial water, or the one used in service companies.

Table 2. Correlation coefficient: Water and City.

Virtual Water- Domestic Water	0.188	
Domestic Water- Urban hierarchy		0.05
Virtual Water – Urban hierarchy	0.673	
m^2 housing -Virtual Water		0.405
m^2 housing - Domestic Water		0.075
m^2 housing - Hierarchy		0.405
Inhab. / Km^2- Hierarchy	0.535	
		-
Inhab. / Km^2-Domestic Water	0.435	
		-
Price - Hierarchy	0.139	
Population - Hierarchy	0.658	
Km2 - Virtual Water		0.199
Consumption – precipitation in mm		0.251
Population / “Water Footprint” per capita		0.306

Source: Own Elaboration

As for drinking water, it is observed that with the value of the "Water Footprint" in the urban hierarchy and taking into account the average size of the housing, they have a relatively weak correlation coefficient, so it does not seem that the inhabitant of a large city consumes significantly more water resources than that of a medium or small city.

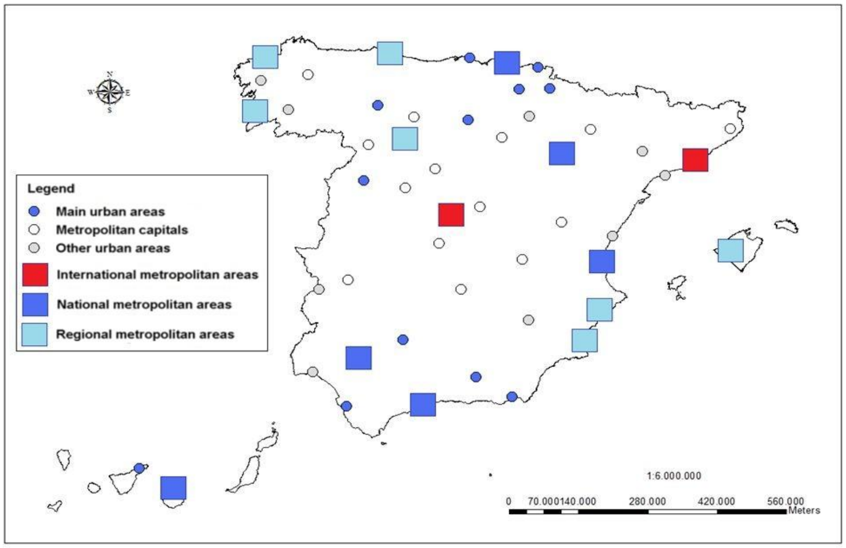
On the other hand, the correlation between population density and "per capita" consumption is inverse, which could suggest a fact, which is that denser agglomerations are more efficient in the use of drinking water. However, the average housing size does not seem to have much relation to the consumption of "supply" water, although it does relate to two of the aspects considered: urban hierarchy and virtual water.

In the first case, the relation is inverse, the higher the urban hierarchy, the smaller the average housing area size. This makes sense, because larger cities have a greater pressure on the ground than those of lower status. On the other hand, the greater the average ground surface area, the greater the virtual water consumption. The negative value in the cases in which the hierarchy is correlated, is due to the fact that the range has been tabulated from 1 to 5 (being 1 the highest in the scale and 5 the lowest). Whereas, the value "per capita" of urban consumption shows a very small correlation with the volume of average annual rainfall (INM series 1971-2000) (no doubt this consumption can be influenced by other climatic variables, but it does not seem to be significantly related to the volume of rainfall) (see Table 2).

Similarly, the average "Water Footprint" per capita in the urban sample demands a total of 2,400 m3 / inhabitant / year for 480,000 inhabitants, and it follows that this demographic pattern does not have a full relationship with the "Water Footprint" expressed in its "per capita" form. An example of this is found in the specific case of Madrid, where the population is 6.5 times the average, so the "Water Footprint" should be 17,036 m3 / inhabitant / year, compared to 2,621 m3 obtained after the calculations.

It happens similarly in Barcelona, where its "Water Footprint" should be 8,499 m3 / inhabitant / year and yet barely exceeds 2,600 m3 / inhabitant / year. It is thus shown that the nature of a large city does not entail a greater waste of water resources, in fact, in many cases, it happens otherwise and a more efficient use of them is carried out (although, the levels of "Water Footprint" vary or change if we carry out a detailed study of the so-called "Water Footprint " colors, although this does not significantly affect the obtained results).

Figure 1. Urban hierarchy in Spain and "Water Footprint"



Source: Own elaboration

On the other hand, if we stop at the urban hierarchy itself (see Figure 1), we can differentiate three types of levels. In the first of them there appear cities like Madrid and Barcelona with positioning and functions that allow them to be considered as national metropolis of international standing. These are the cities that have a greater consumption of "Water Footprint". In both cases, these are central municipalities of urban metropolitan areas whose size exceeds one million people and whose profile corresponds to consolidated urban spaces, in economic, social, and territorial terms, whose recent expansion obeys the model of the post-industrial , meta-industrial or services city. In addition, both Madrid and Barcelona account for more than thirty percent of the Gross Domestic Product of Spain (so that each hm3 / year generates 16.4 euros in Madrid and 19.6 euros in Barcelona, of the total GDP).

A second level consists of the cities that hold a regional centrality, but with nationwide functions. This means that they have a very important weight in the bordering areas. These are the cities of Valencia, Seville, Zaragoza, Malaga, Las Palmas and Bilbao, which have a demographic range that ranges between 360,000 and 800,000 inhabitants. It is true that at this level there are important size differences, since the variability of its dimension ranges from 1 to almost 3. It is well known by urban geography that neither the characteristics nor the so-called "urban pathologies" of a city of 1,000,000 inhabitants are the simple sum of three cities of 300,000 inhabitants. Will the same thing happen with the "Water Footprint"?

From this perspective in relation to the previous group there is a significant decrease in the "Water Footprint". The value of the "Water Footprint" of these cities is very far from those of Madrid or Barcelona, but this is only an effect of the difference in population. If we look at the per capita value, there is a decrease in the footprint, but not in the same proportion as in population (note that Bilbao has a footprint almost as similar to that of Barcelona, and that it is also significant the case of Zaragoza and Las Palmas, but especially the first two, that with very unequal populations have very similar footprints).

In the other categories, there is a decrease in the "Water Footprint" in a certain consonance with the decrease in urban category. In this sense, the case of Murcia, which has a fairly high value in relation to the set of cities in its range, is particularly striking.

The cities are the main protagonists of the water overstepping of Spain, something that the calculation of the "Water Footprint" reveals. It should not be forgotten that the calculation of transferred virtual water is currently a very difficult calculation to perform, due to the scarcity of available data sources and the large number of involved variables. This is especially relevant in the economic sector of services, which is predominant in urban spaces.

The cities studied are only part of the Spanish cities, whose selection threshold has not been strictly population size. There are cities of more than 100,000 inhabitants that do not appear in the present study, and other smaller ones that do because they have the character of administrative capital.

Table 3. "Water Footprint" and Economic Activity in Spain (2015).

	Inhabitants	EAI	W.F.	E.E.H.H.
ESPAÑA	**46,438,422**	**100,000**	**101,434**	**1.00**
Barcelona	1578546	9,196	4108.54	2.24
Pamplona	191865	1,121	515.03	2.18
Valencia	785732	3,629	1806.57	2.01
Oviedo	209495	872	472.72	1.84
Santiago de Compostela	92298	401	217.43	1.84
Las palmas	376953	1,326	798.91	1.66
Palma de Mallorca	368974	1,430	863.53	1.66
Bilbao	352317	1,478	914.01	1.62
Santa Cruz de Tenerife	219446	758	471.51	1.61
Sevilla	704203	2,632	1684.34	1.56
Santander	183799	661	429.35	1.54
Madrid	3099834	12,020	8125.05	1.48
Zaragoza	638799	1,953	1372.43	1.42
Alicante	310330	1,021	724.35	1.41
Toledo	73485	253	180.67	1.4
Logroño	141568	440	329	1.34
Valladolid	321713	960	740.87	1.3
Córdoba	314178	897	768.22	1.17
Badajoz	139135	392	336.82	1.16
Málaga	547731	1,509	1335.42	1.13
Vigo	292059	775	687.32	1.13
Murcia	398815	1,099	1020.02	1.08
Gijón	271039	638	610.32	1.05
Vitoria	223702	496	586.16	0.85
Average or Sum		46,231	29750.8	1.4272
Correlation Index	**EAI-Water F.**		**0.972**	

(E.A.I.: Economic Activity Index; W.F.: Water Footprint)
Source: Own elaboration

Given the lack of disaggregated macroeconomic data at the municipal level, we have opted to use the indicator called "Economic Activity Index", hereinafter (EAI). This is established based on the tax corresponding to the total economic business activities (industrial, commercial and services) and professional activities, except for agricultural, which are not subject to economic activity tax. Our study shows that there is an important correlation between the value of the EAI and the annual "Water Footprint" per capita ($r2 = 0.944$, $r = 0.972$), in the series of cities considered (see Table 3).

The number of studied cities provides more than 46% of the economic activity that reflects the total index of the country, so although some of these cities far exceed the average of the national per capita "Water Footprint", most of them are well below this value.

One question is whether that consumption of virtual water has a fair correspondence with the intensity of economic life, a term which we might call "economic efficiency" of the different consumptions of virtual water (i.e., which are the water costs for obtaining the different values of the economic activity index).

To achieve a value of 46% of the activity, the "Water Footprint" is 29,750.8 hm3 / year; or what is the same thing that each hm3 generates in the set of cities 1.55 points, against the 1 of the whole of the country. In that sense, the most efficient cities in the balance of economic activity according to their "Water Footprint" would be Barcelona, Pamplona and Valencia, which would double the water efficiency of the national average.

In this way, with the objective of achieving sustainable development and the mitigation of the urban ecological footprint, objectives should be set to increase the value of the activity with the decrease in the value of the footprint. This would mean achieving a greater efficiency of the urban productive system in terms of water resources, both own and imported from areas outside the cities.

As it is evident, there is no uniform behavior among the cities. It can specifically be seen how that similar behavior of the two large Spanish cities of Barcelona and Madrid is undone when including this new variable. Indeed, Barcelona shows a greater productive efficiency in terms of consumption compared to Madrid, which is 0.48 points above the average value. Also remarkable is the value of 1.48 of Madrid, belonging to the group of more efficient cities when compared to the larger ones. In this sense, it is revealed that the largest agglomerations, although responsible in proportion to the greater expenditure of water resources regarding the "Water Footprint", are those of greater economic efficiency.

4. Conclusions

The current processes of change in the model of development and urban growth of Spanish cities during the last decades have been marked by the continuous growth of their demands for water resources, with the purpose of carrying out the set of economic, social, and political activities whose main objective has been to increase the economic benefit. In this way, following the foregoing, the following conclusions are drawn:

1. The "Water Footprint" has to become a key indicator to optimize the management policies and planning of water resources that would allow an efficient use of these in the urban field in particular and in sustainable development in general.
2. Cities generate a more intensive and diversified form of occupation than other territories, in terms of land uses and activities, and this is why they are the main centers of production and generation of goods and services. This generates a huge and continuous consumption of water resources thus increasing their demands for "Water Footprint".
3. The raw materials necessary for the production of goods and services consumed and transferred in the cities, are not produced in their entirety in the same territory of the city, and in most cases not even in in their immediate environment. Consequently, it seems that the cities are the largest generators of "Water Footprint" for themselves and for third regions.
4. Water resources, conceived as part of the natural capital, are fundamental for survival and for the development of any region, so they must be preserved through good urban practices.
5. The "per capita" domestic consumption of water seems to be unrelated (at least statistically) to most of the basic urban indicators (population density, territorial extent, average size of housing, and unemployment rates do not seem to directly affect this consumption. In all of them, and in the set of cities offered by the source, we have obtained very weak correlation coefficients).
6. The "Water Footprint" of production is the higher the higher the position of the city in the urban hierarchy in our territorial model at a total level, and with a not very clear relation as to the rank in the national urban system. This is almost direct consequence of the size and importance of the population, since if urban hierarchy is related to "Water Footprint" per capita, the relation is not as fitted.

References

Biggs, E.M., Bruce, E., Boruff, B., Duncan, J.M.A., Horsley, J., Pauli, N., McNeill, K., Neef, A., Van Ogtrop, F., Curnow, J., Haworth, B., Duce, S., Imanari, Y., 2015. Sustainable development and the water–energy–food nexus: a perspective on livelihoods. Environ. Sci. Policy 54, 389–397.

Box & Harrison (1992), Citado por Miracle, MR en «La Construcción de la ciudad sostenible». Consideraciones y casos en torno al ciclo del agua.

Cabrera, E. (2008). «El suministro urbano de en España». Fundación Nueva Cultura del Agua. Panel Científico-Técnico de seguimiento de la Política de Aguas, Convenio Universidad de Sevilla-Ministerio de Medio Ambiente.

Carta de las Ciudades Europeas hacia la Sostenibilidad. Aalborg (1994).

Chapagain, A.K. y Hoekstra, A.Y. (2004). «Water footprints of nations», Value of Water Research Report Series No. 16, UNESCO-IHE, Delft, the Netherlands.

Chapagain, A.K. y Orr, S. (2009). «An improved water footprint methodology linking global consumption to local water resources», Journal of Environmental Management 90: 1219-1228.

Chapagain, A.K. y Orr, S. (2009). «UK Water Footprint: The impact of the UK's food and fibre consumption on global water resources», WWF-UK, Godalming, UK.

Chouchane, H., Krol, M. S., & Hoekstra, A. Y. (2018). Virtual water trade patterns in relation to environmental and socioeconomic factors: A case study for Tunisia. *Science of the total environment*, *613*, 287-297.

De Miguel García, A. (2007) «Estimación del flujo de agua virtual entre las comunidades de CastillaLa Mancha y Murcia», MSc thesis, Univ. de Alcalá – Univ. Rey Juan Carlos.

EUROSTAT. «Urban Indicator for Core Cities».

García Alvarado, J.M. (2000). «El modelo metropolitano madrileño: enjuiciamiento desde la perspectiva del V Programa de Acción de la C.E. en materia de Medioambiente. Apuntes metodológicos». Observatorio Medioambiental, Nº 3.

Hoekstra, A.Y. et alii. (2009). «Water footprint accounting, impact assessment, and life-cycle assessment». Proceedings of the National Academy of Sciences 106(40): E114.

Hoekstra, A.Y. et alii. (2011). «The water footprint assessment manual: setting the global standard», Earthscan, London.

Institutos Nacionales de Estadística (INE, 2016).

Jerez Mir, C. (2011). «¿Qué es el urbanismo?», Granada, Universidad de Granada., 166pp.

Lynch, K. (1965). «The City as Environment». in *Cities*, Scientific American. New York: Alfred A. Knopf, Inc., 1965, pp. 192-202.

Madrid, C. (2007) «Hidratar el Metabolismo Socioeconómico: Los Flujos de Agua Virtual y el Metabolismo Hídrico. Una aproximación al sector hortofrutícola Andaluz», MSc thesis, Universidad Autónoma de Barcelona.

Ministerio de Agricultura, Alimentación y Medio Ambiente. (2011). «Programa A.G.U.A.»

Rueda Palenzuela Salvador (1999). «Modelos e Indicadores Para Ciudades Más Sostenible. Taller sobre Indicadores de Huella y Calidad Ambiental Urbana». Departament de Medi Ambient de la Generalitat de Catalunya.

Sotelo Navalpotro, J. A., Olcina Cantos, J., García Quiroga, F. y Sotelo Pérez, M. (2012, B). «Huella Hídrica de España y su diversidad territorial». Estudios Geográficos, volumen 73, pp. 239-272

Sotelo Navalpotro, J. A., Olcina Cantos, J., Tolón Becerra, A., García Alvarado, J. Mª., Lastras Bravo, X., García Quiroga, F, Sotelo Pérez, Mª., Sotelo Pérez, I. (2011). «Huella hídrica, desarrollo y sostenibilidad en España», pp. 425. Fundación Mapfre

Sotelo Navalpotro, J. A., Olcina Cantos, J., Tolón Becerra, A., Lastras Bravo, X., García Quiroga, F, Sotelo Pérez, Mª. (2010). «Huella Hídrica española en el contexto del cambio ambiental global», pp. 218. Fundación Mapfre.

Sotelo Navalpotro, J. A., Sotelo Pérez, M. y García Quiroga, F. (2011). «Análisis «coste-beneficio» y «coste-eficiencia» de la Huella Hídrica en España». Observatorio Medioambiental. Pp. 225-254.

Sotelo Navalpotro, J.A. (2009). «Las lógicas ilógicas del agua». Tribuna Complutense.

Sotelo Navalpotro, J.A. (2012). «Tras las «Huellas» del agua en España». Apuntes de Medio Ambiente, Boletín del Ilustre Colegio de Doctores y Licenciados, número 12.

Sotelo Navalpotro, J.A., Tolón Becerra, A. y Lastras Bravo, X. (2011). «Indicadores por y para el desarrollo sostenible, un estudio de caso». Estudios Geográficos. Volumen 72, nº 271. pp. 611-65

Sotelo Pérez, M. (2012). «Economía y Huella Hídrica en España (I) ». Apuntes de Medio Ambiente, Boletín del Ilustre Colegio de Doctores y Licenciados, número 12.

Sotelo Pérez, M. (2013). «Economía y Huella Hídrica en España (II) » Apuntes de Medio Ambiente, Boletín del Ilustre Colegio de Doctores y Licenciados, número 13.

Sotelo Pérez, M. (2015). «Cuestiones de escala en el ámbito de la Huella Hídrica». Observatorio Medioambiental, vol. 18, pp. 9-37. ISSN: 1139-1987

William E. Rees (1992). «Ecological footprints and appropriated carrying capacity: what urban economics leaves out». Environment and Urbanization October 1992 vol. 4 no. 2 121-130.

WWF. 2014. Informe Planeta Vivo 2014: Personas y lugares, especies y espacios. [McLellan, R., Iyengar, L., Jeffries, B. and N. Oerlemans (Eds)]. WWF Internacional, Gland, Suiza.