Water use and the Verdoorn's law: an input-output framework to assess water productivity dynamics. An application to Castile and León Region (Spain)

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Abstract

Water is a scarce input necessary for the production of many goods and services and should be managed accordingly. However, water policy has failed to consider water as an economic good and has focused instead in guaranteeing the provision of this resource at subsidized prices. Under this paradigm population growth and the improvement of living standards brought about by development have driven water demand up and the pressures over water resources have escalated. The resulting ever growing water dependency requires a comprehensive assessment of water productivity to establish priorities in the design of strategic actions such as river basin or drought management plans. This paper develops a methodology based on the Hypothetical Extraction Method (HEM) to estimate inter-temporal direct and indirect water productivity values. The method is applied in the Spanish region of Castile and León for the period 2000-2006. The low water productivity found for irrigation water confirms that agriculture has to play a key role in any water saving policy. However, the relevant linkages between agriculture and the rest of the economy, which acts as an indirect water consumer, makes difficult the finding of a permanent and effective solution. The results also show the existence of increasing returns to scale in the manufacturing industry and the service sector which can be regarded as an evidence of the existence of a Verdoorn's Law for water.

1. Introduction

Water is a scarce input necessary for the production of many goods and services and should be managed accordingly. However, water policy has failed to consider water as an economic good and has focused instead in guaranteeing the provision of this resource at subsidized prices. Under this paradigm population growth and the improvement of living standards brought about by development have driven water demand up and the pressures over water resources have escalated. Consequently water is now overexploited in many areas. As water became scarcer, policy making has become reactive and incremental and command and control policies, instead of replaced, have been reinforced. Surprise and crisis are now regular occurrences (Anderies, 2006). As a result there is an increasing need worldwide to manage water resources better (Molden, 1997; Molden and Sakthivadivel, 1999). Demand oriented policies such as water markets or water tariffs are gaining importance as a means to improve water allocation among competing uses (EC, 2000 and 2007). However, for these and other policies to succeed in attaining a socially desirable water allocation, a comprehensive and in-depth understanding of *water productivity* is required.

Water productivity (WP) has been assessed in depth using different techniques and methodologies and as a result there is a vast array of definitions available. However, we can safely define WP as the output of a given activity (in economic terms, if possible) divided by some expression of water input (Playan and Mateos, 2006).

As irrigation is by large the main water consumer worldwide, most of the studies available refer to WP in agriculture either from an agronomic, economic or hydrologic perspective (or a combination of them). A very fruitful research field relies on the water balance concept considering different spatial boundaries; this can be found for example in Owen-Joyce and Raymond (1996), Hassan and Bhutta (1966), Perry (1996), Kijne (1996), Helal et al. (1984), Mishra et al. (1995), Rathore et al. (1996), Bhuyian et al. (1995), Tuong et al. (1996) and Molden (1997). More recently the rise of georreferenced systems and remote sensing has permitted the development of a new series of studies based on spatial models as in Van Dam et al. (2006), Wesseling and Feddes (2006), Zwart and Bastiaanssen (2007), Vazifedoust et al. (2008) and Cai et al. (2011), among others. Although scarcer, there is also research on WP in the secondary and tertiary sectors (see for example Pérez et al., 2010 and Maestu et al., 2008). All this body of literature allows a better understanding of the intra-sectorial distribution of water, but it only offers a partial equilibrium assessment of WP that excludes other relevant water uses and does not assess the potential of inter sectorial water reassignments.

Increasing structural scarcity, decreasing drought resiliency and growing demand have awakened environmental concerns as well as worries on the security of household supply. Authorities have reacted ordering new laws to guarantee water supply for these priority uses[1]. This new institutional framework may result in a reduction of water allocation for productive uses in certain regions. This problem requires a comprehensive and integrated assessment of WP in order to optimally assign scant water resources among different sectors. General equilibrium models (GEM) have the potential to address this issue. There are many examples of GEM for the study of water use and WP. Duarte et al. (2002), Velázquez (2006) and Pérez et al. (2011) assessed direct and indirect water flows and WP in different regions from an input-output (IO) perspective. Dietzenbacher and

[1] This is for example the case of the European Union after the implementation of the Water Framework Directive (EC, 2000).

Velázquez (2007), Guan and Hubacek (2007) and Zhang et al. (2011) opened the economy for trading and studied trans-boundary water flows. González (2011) used IO modeling to estimate monetary losses stemming from hypothetic water supply restrictions scenarios. The expected outcome after the implementation of different hypothetic water policy scenarios was assessed in Tirado et al. (2006) (for water markets) and Llop (2008) (tax rise and efficiency improvements in irrigation). Feng et al. (2011) and Yu et al. (2010) also used IO approach to calculate sustainable indicators for water consumption. All this body of literature offers an insightful approach to WP assessment for every sector in the economy under different economic structures. Additionally, it also makes possible the estimation and comparison of apparent/direct WP (measured in the partial equilibrium models above) and indirect WP. While direct WP only considers water directly consumed by the sector, indirect WP takes into account also the water consumption induced by the sector in other areas of the economy. That is to say, the latter includes the water that the sector consumes as well as the water that would not be used in the remaining sectors if that sector was to be removed from the economy.

The main drawback of available GEM models is that they are static and do not assess WP dynamics. This is mostly owed to the lack of continuous data series. Nonetheless, this has changed recently as environmental satellite accounts (including water accounting) and IO tables have become regularly available in several regions. New statistical data now makes possible an inter-sectorial as well as an inter-temporal assessment of WP.

This paper aims to shed light over the inter-temporal problem of how to better assign scarce water resources among sectors. We use the Hypothetical Extraction Method (HEM) (Strasser, 1968; Cella, 1984) to obtain annual indirect and direct WP in the region of Castile and León (CL) for a medium term period (2000-2006). Results confirm the existence of a relevant gap between WP in agriculture (the main water consumer) and that of the other sectors. Additionally, there is a significant difference between the results obtained with the WP method and those obtained with the preferred indirect WP method, with important implications over water policy design. Results also show the existence of a positive relationship between GDP growth and WP growth in the manufacturing industry as well as in the service sector. This relationship can be regarded as a *Verdoorn's Law for water* and illustrates the significant potential water savings stemming from industrial and tertiary development.

The paper is structured as follows: in Section 2 we introduce the area where the case study is applied, the Castile and León Region in Spain; Section 3 presents the HEM for water; Section 4 presents and discusses the results obtained according to the methodology shown in 2; Section 5 concludes the paper.

2. Background to the case study: The Castile and León Region (Spain).

In this paper, we apply the GEM's WP concept from a dynamic perspective to the Castile and León (CL) Region in Spain. CL is at the same time the largest region of Spain (94,223 km^2, 18.7% of the Spanish territory) and one of the most depopulated regions of Europe (26.6 inhab/km^2) (Eurostat, 2011). The structure of the CL's economy is similar to that of the Spanish economy as a whole. Industry, construction and the tertiary sector have a similar composition and weight in the national and regional GDP and have showed also a similar evolution during the last decade. However, CL has been traditionally and is still today an agrarian region with classical agrarian periphery socio-economic problems, namely, depopulation and low income.

Agriculture represents 6.6% of the GDP and 10.2% of total employment in CL, more than doubling the Spanish shares (2.7% of the GDP and 4.4% of the employment). More than a half (52%) of CL surface is devoted to agricultural uses. Prevailing agroecosystems in CL are cereal landscapes and irrigated areas, where maize plays the central role, resulting in relatively low agrarian incomes. Yet irrigation is the main water user and represents 92% of total consumption (DRBA, 2008).

Approximately 82% of the CL Region is located inside the Duero River Basin (DRB) boundaries. Since the 90s the DRB has experienced its more intense, spread and lasting droughts in a century (DRBA, 2007). Average water availability has fallen and this trend is expected to continue (EEA, 2005; IPCC, 2007), thus threatening all water uses including priority environmental and household supply. Authorities have reacted regulating drought response and decreasing water availability for productive uses under drought events (DRBA, 2007). As droughts are nowadays basically unpredictable, the new climate dynamics and institutional framework can affect every economic sector and may have a significant impact over regional GDP (Freire, 2011) that demands a reassessment of water resources allocation.

3. Materials and methods

For the assessment of WP we use the Water Satellite Accounts (WSA) and the IO symmetric tables for CL. WSA are a high quality statistical source yearly available in Spain since 1997 that provide information on the amount of water used by every economic sector (INE, 2012b). On the other hand, symmetric tables are offered intermittently by national and regional institutes of statistics; however, CL Institute of Statistics has been yearly supplying symmetric IO tables since 2000 (JCYL, 2012). As a result, both symmetric tables and WSA have been available simultaneously for every single year during the period 2000-2006. In this paper we use the Hypothetical Extraction Method (HEM) to combine WSA with IO symmetric tables in order to estimate inter-sectorial water flows and from there the corresponding WPs. Then we repeat this process for each one of the seven years of the period considered. A more exhaustive description of the HEM methodology for water can be found for example in Duarte et al. (2002) or Sánchez Chóliz and Duarte (2002) from a static perspective.

We start from an IO model where the production of an economy comprising *n* sectors is described as follows:

$$x = Ax + y = \begin{pmatrix} A_{s,s} & A_{s,-s} \\ A_{-s,s} & A_{-s,-s} \end{pmatrix} \begin{pmatrix} x_s \\ x_{-s} \end{pmatrix} + \begin{pmatrix} y_s \\ y_{-s} \end{pmatrix} \quad [1]$$

Being $x = x_i$ the production vector, $y = y_i$ the vector of final demands and $A = A_{ij}$ the matrix of technical coefficients. The economy can be split into blocks comprising one or more sectors. The subscript *s* refers to a specific block, and the subscript –*s* to the remaining blocks of the economy. Alternatively, [1] can be formulated as follows:

$$x = (I - A)^{-1} y = \begin{pmatrix} \Delta_{s,s} & \Delta_{s,-s} \\ \Delta_{-s,s} & \Delta_{-s,-s} \end{pmatrix} \begin{pmatrix} y_s \\ y_{-s} \end{pmatrix}$$

Where: $\begin{pmatrix} \Delta_{s,s} & \Delta_{s,-s} \\ \Delta_{-s,s} & \Delta_{-s,-s} \end{pmatrix} = \begin{pmatrix} (I - A_{s,s})^{-1} & (I - A_{s,-s})^{-1} \\ (I - A_{-s,s})^{-1} & (I - A_{-s,-s})^{-1} \end{pmatrix}$ [2]

Being $(I - A)^{-1}$ the Leontief inverse. The HEM measures the impact of every block (namely, *s*) by comparing the production vector of that economy with (x) and without (x^*) that block. The production of the economy in which a given block (*s*) is extracted is described as follows:

$$x^* = (I - A^*)^{-1} y^* = \begin{pmatrix} (I - A_{s,s})^{-1} & 0 \\ 0 & (I - A_{-s,-s})^{-1} \end{pmatrix} \begin{pmatrix} y_s \\ y_{-s} \end{pmatrix} \quad [3]$$

The change in production is obtained as the difference between x and x^* and shows the effect of the block *s* over the remaining blocks of the economy:

$$x - x^* = \begin{pmatrix} C_{s,s} & C_{s,-s} \\ C_{-s,s} & C_{-s,-s} \end{pmatrix} \begin{pmatrix} y_s \\ y_{-s} \end{pmatrix} \quad [4]$$

Every block has four separate effects over the economy: an internal effect, a mixed effect, an external or net backward linkage and an external or net forward linkage. The internal effect of the block *s* (IE_s) represents the effect of the goods produced, sold and purchased inside the sector *s* to obtain y_s. The mixed effect (ME_s) measures the impact of the products sold by the block *s* to other blocks and later re-purchased to produce y_s. The net backward linkage (NBL_s) represents the direct and indirect requirements of the sector *s* from the rest of the economy to obtain y_s, namely the "imports" of the sector *s*. Finally, the net forward linkage (NFL_s) represents the direct and indirect requirements of the rest of the economy from the sector *s* to obtain y_{-s}, namely the "exports" of the sector *s*:

$$IE_s = c'(I - A_{s,s})^{-1} y_s \quad [5]$$

$$ME_s = c'[\Delta_{s,s} - (I - A_{s,s})^{-1}] y_s \quad [6]$$

$$NBL_s = c\, \Delta_{-s,s}\, y_s \quad [7]$$

$$NFL_s = c' \Delta_{s,-s}\, y_{-s} \quad [8]$$

Where c' denotes the vector (1, …, 1). If the vector c' is replaced by a vector of unitary inputs of water (w') obtained from the WSA[2], we obtain again the four effects over the economy of the block *s*, but this time referred to the amount of water embodied in the part of the production process that

[2] The new WSA series (2000-2006) offers data in detail for every sector by type of water at a national level. However, regional data is aggregated by type of water (irrigation, urban water). On the other hand, chosen IO symmetric tables are regional. To disaggregate data on urban water use at a regional level we assume that urban water users in Spain have a homogeneous technology and thus the composition of water demand is a function of the regional and national GDP shares of every block (Pérez et al., 2010).

the different effects represent. Now the internal effect (IEw_s) is the water consumed exclusively inside the block; the mixed effect (MEw_s) is the water consumed in the block *s*, then used as an input in other block/s and again used as an input in the block *s*; the net backward linkage ($NBLw_s$) is the water originally used in other blocks than *s* and then “imported” and used in *s* to generate the final demand; and the net forward linkage ($NFLw_s$) is the water originally used in the block *s* and then “exported” and used in other block/s to generate their final demand:

$$IEw_s = w'\left(I - A_{s,s}\right)^{-1} y_s \qquad [9]$$

$$MEw_s = w'[\Delta_{s,s} - \left(I - A_{s,s}\right)^{-1}] y_s \qquad [10]$$

$$NBLw_s = w\ \Delta_{-s,s}\ y_s \qquad [11]$$

$$NFLw_s = w'\Delta_{s,-s}\ y_{-s} \qquad [12]$$

These effects are subsequently put into two groups in order to obtain the vertically integrated effect and the direct effect. The direct effect (DE_s) stems from direct consumption and is the result of the aggregation of the mixed effect, internal effect and net forward linkages of the block *s*. The ratio between the final demand (y_s) and the direct effect (DE_s) of that block is its direct water productivity (DWP) (namely, the quotient of total production to observed water uses or *apparent productivity*):

$$DE_s = IEw_s + MEw_s + NFLw_s \qquad [13]$$

$$DWP = \frac{y_s}{DE_s} \qquad [14]$$

Vertically integrated effect (VIE_s) stems from indirect consumption and is the result of the aggregation of the internal effect, mixed effect and the net backward linkages. It is used to obtain indirect WP. The ratio between the final demand (y_s) and the vertically integrated effect (VIE_s) of a given block is its indirect water productivity (IWP).

$$VIE_s = IEw_s + MEw_s + NBLw_s \qquad [15]$$

$$IWP = \frac{y_s}{VIE_s} \qquad [16]$$

4. Results.

The data used in this paper comes from the regional IO symmetric tables for CL and the WSA available during the period 2000-2006. WSA offer information on water use disaggregated in 24 productive sectors for different types of water. For the purposes of this research, we will focus on irrigation and the sum of drinkable and non-drinkable water (to which we will refer as *urban water*). The IO symmetric tables for CL offer economic information disaggregated in 58 sectors. In this paper all the different sectors in the WSA and IO tables are put into the seven homogeneous blocks described below:

Block 1 (B1): Agriculture, livestock, hunting, forestry and fishing.

Block 2 (B2): Extraction of energy products, Extraction of other mineral products, Oil refining and nuclear fuels, Water collection, purification and distribution and Energy, gas and water production and distribution.

Block 3 (B3): Food, drinks and tobacco.

Block 4 (B4): Textile and clothing, Leather and footwear, Timber and cork, Paper and publishing and Other non-metallic mineral products industries.

Block 5 (B5): Chemicals, Rubber and plastic materials transformation, Metallurgy and manufacture of metal products, Machinery and mechanical equipment, Electric and electronic material, Transport material and Diverse manufacturing industries.

Block 6 (B6): Construction.

Block 7 (B7): Public sanitation, Public Administration and Other service sector activities.

Finally indirect and direct WP are obtained for every single block and year during the period 2000-2006 for both urban and irrigation water. All WP values are shown in constant prices (real WP). The results obtained using the IWP method are shown in the following tables.

Table 1. Indirect water productivity (IWP) in the Castile and León Region, 2000-2006 (€/m^3, constant prices). Irrigation water.

Block/year	2000	2001	2002	2003	2004	2005	2006
B1	1.81	1.81	1.72	1.58	1.67	1.46	1.92
B2	186.46	193.91	172.6	172.62	179.45	141.38	145.42
B3	4.06	4.27	3.98	3.74	3.99	3.35	3.73
B4	26.84	29.1	26.09	24.97	29.04	22.98	24.32
B5	103.19	104.41	95.38	93.53	99.6	81.11	91.55
B6	77.24	82.07	72.92	67.79	72.21	55.29	57.73
B7	63.72	66.82	60.42	56.34	59.81	50.07	55.79

Source: Own elaboration

Table 2. Indirect water productivity (IWP) in the Castile and León Region, 2000-2006 (€/m^3, constant prices). Urban water.

	2000	2001	2002	2003	2004	2005	2006
B1	169.06	148.15	129.08	112.51	137.32	124.15	168.72
B2	250.75	269.39	272.46	237.76	295.46	292.79	458.47
B3	265.84	252.38	220.72	199.14	243.78	213.27	247.31
B4	557.77	585.93	557.41	471.81	615.26	598.05	802.64
B5	531.68	526.79	501.64	459.93	562.00	570.78	822.52
B6	869.88	869.99	826.12	732.37	878.23	807.52	1088.99

B7	701.30	685.85	671.72	623.25	810.61	788.63	1065.41

Source: Own elaboration

IWP values in the year 2006 are distorted as a result of the extreme drought that suffered Spain and particularly the DRB since mid-2005, the most intense ever recorded in the basin (DRBA, 2008). Resulting water supply restrictions significantly increased water efficiency and IWP. The opposite can be said for the relatively water abundant period 2002-2003. In any case and in spite of these anomalies, a clear trend for IWP in every block can be inferred for the period 2000-2005.

Irrigation water represents 92% of total water demand in the region and is directly consumed by agriculture. The remaining blocks demand irrigation water indirectly through the significant backward linkages that they have with agriculture. Thus, the low and decreasing IWP observed in agriculture has a negative effect over IWP in the other blocks of the economy. The consequence of this vicious circle is that most of the water being used in the economy is employed with a low and decreasing efficiency. This lesson can be extrapolated to most regions worldwide, with only a few exceptions where water availability is very low and agricultural income is very high (Gómez and Pérez, 2012).

In the case of urban water there are two clearly differentiated trends. In the primary sector (B1) and in the food industry (B3) IWP is low and shows a negative trend. IWP poor performance in B3 is a consequence of its dependency on B1, which results in a high indirect demand (high net backward linkage) from low productive B1. The construction sector (B6) shows a constant trend for IWP until the 2005-2006 drought once the effect of inflated household prices is discounted. This is also explained by its backward linkages with less productive sectors. On the other hand, the tertiary sector (B7), manufacturing industry (B4 and B5) and the energy and water block (B2) show a significant and continued increase of IWP along the period. IWP increases by 15.5% in B2, 6.8% in B4, 7.1% in B5 and 11.7% in B7 in the period 2000-2005. This empirical result may be regarded as a *Verdoorn's Law for water*: faster growth in output increases productivity due to increasing returns in certain blocks of the economy prone to technological improvements and efficiency gains (such as manufacturing industry).

Original research by Verdoorn (1949) and Kaldor (1966) estimated that changes in the volume of production, say about 1%, tend to be associated with an average increase in input productivity (in those cases, labor) between 0.45% and 0.484%. Subsequent estimations of the law found figures close to this value. In our case, a 1% increase in the volume of production results in an increase of IWP in selected blocks of 0.49% (B2), 0.38% (B4), 0.39% (B5) and 0.41% (B7) in the period 2000-2005. Longer series are needed to obtain concluding evidence; nonetheless, these results suggest the existence of a Verdoorn's law for water in these economic sectors.

The following tables show the DWP values, also in constant prices:

Table 3. Direct/apparent water productivity (DWP) in the Castile and León Region, 2000-2006 (€/m^3, constant prices). Irrigation water.

Block/year	2000	2001	2002	2003	2004	2005	2006
B1	0.56	0.55	0.52	0.47	0.51	0.40	0.51

Source: Own elaboration

Table 4. Direct/apparent water productivity (DWP) in the Castile and León Region, 2000-2006 (€/m^3, constant prices). Urban water.

Block/year	2000	2001	2002	2003	2004	2005	2006
B1	57.86	55.48	46.20	42.25	54.81	43.21	49.07
B2	144.80	145.56	156.37	142.80	174.41	185.96	338.47
B3	1030.70	921.67	860.56	952.85	982.45	832.67	952.22
B4	1044.29	1506.13	1539.60	843.55	1374.38	1701.20	2727.97
B5	677.72	734.66	695.81	604.52	808.37	855.78	1295.45
B6	3421.15	2635.68	2733.49	3679.54	3846.88	4012.62	6525.80
B7	639.89	650.63	704.48	693.59	955.72	978.06	1418.25

Source: Own elaboration

DWP values largely differ from IWP. In the case of irrigation water, DWP method does not consider the water indirectly demanded by other blocks and consumed in agriculture. As a result, DWP underestimates WP in agriculture as compared to IWP method by 26%-31% and DWP in the rest of the blocks of the economy equals 0 (there are no backward linkages).

In the case of urban water demand, DWP method significantly overestimates WP in the water-importing blocks (B3, B4, B5, B6 and B7) and underestimates it in the water-exporting blocks (B1 and B2) as compared to IWP. DWP method supports the existence of increasing returns in water for blocks B2, B4, B5, B6 and B7. In this case, the construction sector (B6) also shows this positive relationship as the negative effect of its net backward linkages with low WP blocks is replaced by the positive effect of its net forward linkages with high WP blocks.

5. Conclusions

This paper uses the HEM applied for water to estimate WP in the production of goods and services in the CL Region during the period 2000-2006. We have obtained the internal effect, the mixed effect, the net forward linkage and the net backward linkage. Using these results and the concepts of vertically integrated and direct consumption we have assessed direct and indirect WP in the different sectors of the economy for irrigation water and drinkable and non-drinkable water (urban water). It has been shown that apparent/direct WP is not the proper measure to obtain WP, as it misses the relevant links that exists among sectors and that explain actual water demand. Two relevant and insightful conclusions have been obtained as well.

A first key conclusion is that any GEM for WP assessment has to focus on *irrigation water*. Agriculture is the main water consumer worldwide and low and decreasing WP in this sector results in an overall low and decreasing WP in the economy. A huge potential for water saving can be found here and proposals to reconvert this sector or even to limit its activities have been advanced. Nonetheless, it is necessary to keep in mind that most of the water which is directly consumed by agriculture is used to produce goods that supply other sectors of the economy. In the case of CL, where irrigation represents 92% of total water demand, net forward linkages mean between 69% and 73.5% of total water consumption in the period. Thus any attempt to reduce the volume of this sector, even in the less water productive areas, will affect other sectors of the economy, such as the food industry or the service sector, both essential in the CL and Spanish economies. For example, during the 2005-2006 drought in CL, agricultural GDP dropped by 6.2% and as a result production in the food industry fell by more than 3% (INE, 2010a).

There is no doubt that a reduction in the production of the agricultural sector would result in significant water savings and WP gains, but it would have also adverse effects over production in the rest of the economy. In the medium run the dependence of some sectors over agriculture would result in the substitution of national products by imports. The water scarcity problem would be transferred outside, but not solved (and maybe worsened if WP in the exporting area is lower), and replaced by a balance of payments problem. A permanent solution should increase WP and water savings in agriculture at the same time that enhances production in the rest of the economy through increasing water availability and security. This solution may consist of demand side policies that put in place the necessary economic policy instruments that induce an adaptive behavior in agriculture towards a more efficient water use (Gómez and Pérez, 2012). Water thus saved would improve the environmental outcomes of the economy and constitute a pool of resources that can be used as an insurance against drought in agriculture and other blocks.

The weight of agriculture is less relevant in the case of *drinkable and non-drinkable water*, which nonetheless means a minor fraction of total water demand (less than 2% in CL). In this case significant WP gains can be obtained along with GDP growth. Evidence for the existence of a Verdoorn's Law for water has been found in CL for the energy and water block (B2), manufacturing (B4 and B5) and in the service sector (B7), which together represent 76%-78% of CL's GDP and a decreasing share of indirect water consumption (from 66.7% in 2000 to 56.1% in 2006). In developed and developing regions with an ever growing tertiary and secondary sectors, this may represent an important source for water saving. Additionally, there are studies that link higher WP values to quality improvements in water (Pérez et al., 2010).

In summary, it has been shown that the necessary WP gains in the economy in order to preserve water resources and enhance GDP at the same time can be obtained in two different ways. First of all, it is necessary to implement the necessary reforms to increase WP in agriculture, the main water consumer worldwide and the sector with a lowest WP, avoiding a negative effect over production. Here we have exposed that this goal can be attained through the progressive implementation of demand side policies that allow an internalization of the costs of the resource and encourages a higher technical efficiency and WP. Second, relevant WP increases and water savings can be obtained as an economy moves towards a more secondary and tertiary structure, when increasing GDP results in higher WP.

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