Structural Decomposition Analysis of water uses in Spain

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Abstract

The structural decomposition analysis (SDA), which was defined by Rose and Chen (1991) as "the analysis of economic change through a set of (static and comparable) changes in key parameters of an input-output table", has been used to study variations in impacts and resource use (see Rose and Casler, 1996, Hoekstra and Van der Berg, 2002, for a review). Behind the variation of water uses in a country, there are components such as intensities, technology, and levels and composition of the demand changes, and thus those are the factors examined. In the application for Spain, a relatively homogenous series of water uses for 1997-2006 (constructed from the Satellite Water Accounts of the National Statistic Institute) is extended backwards with historical agrarian and water use information, and linked to a time series of input-output tables in constant prices (complying with the EUKLEMS aggregates). The rebound effect in agriculture is tested, i.e. if improvements in water use lead to increasing the surface of crop cultivation, or if they lead to put in production more water intensive crops. In the results, the most important effects are the "final use level", and then the "eco-technological" ones, resulting the "final demand structure" (variations in the composition in demand) negligible in the latter period. The decrease in the participation of the agrarian sector in the economy is well known, and hence decreases in water uses of that activity, the one generating more direct water abstractions could be expected. But interestingly, after 2001 the direct reductions in water abstractions would not only be explained by the decrease in the participation of the sector in the economy (as % of Added Value), but also by reductions in industrial water withdrawals per euro of Added Value take place.

Abstract Category: Environmental input-output modeling.

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Introduction

The growth and technological transformation over the last four decades that has taken place in Spain has modified the patterns of resources use, particularly of water use, having to do both with the direct and embodied contents. This means changes in the water used per euro of production, but also technological, substitution, and demand variations, both in the main direct users, but also in sectors that demand highly water intense products directly and indirectly.

To examine those issues, paying attention to the influence of those effects, such as the influence of technological change and the increase in demand in Spain from 1980 to 2007, we use yearly input-output tables of the period, and apply a differential structural decomposition analysis (SDA). We based our SDA on the developments of Van der Linden and Dietzenbacher (2000) and Dietzenbacher and Hoekstra (2001).

Our starting point therefore is the Leontief demand model where production can be obtained as a product of the Leontief inverse (representative of technology) and a vector that summarizes the net final demands.

In previous works we concluded that growth in the Spanish economy was driven by a mix of technological modernization and scale growth.

In the results, we observe that the average annual increase of 1,599 hm^3 was driven by a 130% and 177% average yearly importance in the increase of the substitution effect and demand effect, despite the reduction via the technology effect of a 220%. The average yearly water change comes from the agrarian sector, with a 97%, driven by a 25% of an embodied intensity effect annual average change, and 75% of demand effect annual average change.

Given the particular importance of the agrarian sector in explaining not only the high water volumes, but also the direct and embodied annual changes, we look in detail to the productivity, area harvested, and water consumed by crop along the period. The highest average contribution to the total water consumption of the crops comes from olives, grapes, barley, wheat and almonds, which had relevant increases during the period. Also via crops with average water consumption higher than 1% of the total, were those of Pulses, Chiles, pim. pic., pim. (Green) and Oranges (and with less variation Grasses, Sugar beet, Rye, etc.). Increases less driven by increases in productivity but raises in the area harvested were those of Poppy seeds, Linseed, Flax fiber and tow, Hemp fiber, Soybean, Sorghum, Citrus, or the aforementioned Graminea and leguminous crops.

Methodology

The structural decomposition analysis (SDA), which was defined by Rose and Chen (1991) as "the analysis of economic change through a set of (static and comparable) changes in key parameters of an input-output table", has been used to study variations in impacts and resource use (see Rose and Casler, 1996, Hoekstra and Van der Berg, 2002, for a review).

Dietzenbacher and Hoekstra (2001) show an interpretation of technological change as one that represents a reduction of inputs for the same structure of inputs by sector, existing another type of change of scale, identified with 2 types of innovation, of a process and of a product. There is uniformity in rows and columns, and that is very close to the "r" and "s" of the rAs method (having still a cellSpecific effect). This analysis performed for production, lead us when analyzing water, to break the changes into the intensities, technology, substitution, cellSpecific and demand effects, but only of the direct uses. Since for this case the point of view of the producer and of the seller are quite different, we look also at the embodied contents to observe not only what occurs if the water efficiency is improved in the sector of oneself, but also how the sector is affected by the improvements in the water management of others.

Hence if the interpretation of the SDA is done both looking at the rows, which lead us to break the effects of the direct water uses, we also look at the columns, to examine the different effects of the embodied water, ie, the water contents incorporated through the demand of the products.

The treatment of the final demand is done with net exports, and hence the assumption of water intensities of imports in this preliminary version is that of the domestic country (we examine the water volumes that do not need to be used to produce the goods that indeed are imported).

Data

The starting point for the procedure consisted of the input-output tables provided by the Spanish Statistical Institute (INE) for the year 1980 and from 1985 to the last year. From them we construct a time series of input-output tables complying with the EUKLEMS aggregates.

We distinguish among the periods 1980-1986, 1986-1992, 1992-1999 and 1999-2007, given the similarity of the periods (6,6,7 and 8 years respectively), given the clear changes among them observed in the production data.

The data of (blue and green[1]) water consumption in the agricultural sector is obtained from the assumption of constant water intensities (in m^3 per ton of production) per crop, obtained from Chapagain and Hoekstra (2004), which are multiplied by the production (in tones) of crops (FAO, 2011).

Regarding the industrial and services water, which represent much lower numbers, is obtained from 1997 to 2007 from the Satellite Water Accounts for Spain, of the Environmental Statistics from the National Statistic Institute (SWA, 2011). Before that year, constant intensities (per euro of production) are assumed from the year 1997. Hence the intensity effect of the first two periods is only relevant for agriculture

We thought of performing a correction with the relative proportion of the irrigation and dryland surface[2], however the number of hectares of the two types is relatively constant along the long period, and furthermore the correction can only be interesting if the irrigation and dryland surface of each type of crop is known, something for which we cannot obtain homogeneous data.

Results

Importance of the sectors in the use of direct and embodied water contents

Table 1 shows the importance of each sector as a direct water user, and Table 2 the embodied water role by sector of the final demand of water (includes net exports).

Table 1: Direct water use (% with respect to the total of the period**)**

	80-86	**86-92**	**92-99**	**99-07**
Agriculture, hunting and forestry	92%	93%	79%	89%
Mining and quarrying	0%	0%	-1%	-2%
Electricity, gas and water	7%	6%	21%	12%
Rest of Activities	1%	1%	1%	1%
Total	100%	100%	100%	100%

Source: Own elaboration

[1] The concept of green water refers to the part of water received as rain or snow that does not come to form part of the flow in watercourses. It consists, then, of the flow of precipitation that is not run-off. Blue water is associated with what hydrologists call contributions in the natural river regimen, hence with what traditionally has been called abstraction and ulterior use.

[2] Also it is possible to scale the numbers to the results of agrarian water consumption obtained with specific provincial detail by Garrido et al. (2010), however in our work probably the importance is given to the yearly changes.

Table 2: Embodied water content (% with respect to the total) of the final demand (includes net exports *).

Classification /Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Agriculture, hunting and forestry	-16%	-26%	-25%	-23%	-18%	-14%	-5%	1%	2%	-2%	-9%	-8%	-3%	1%	3%	20%	25%	25%	25%	28%	30%	30%	30%	32%	25%	25%	34%	35%
Mining and quarrying	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-2%	-1%	-1%	-1%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%
Electricity,gas and water	1%	3%	4%	2%	1%	1%	2%	2%	1%	2%	2%	1%	1%	1%	1%	6%	4%	4%	5%	5%	5%	6%	6%	6%	6%	6%	4%	4%
Electrical, optical, office & computing	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chemical products	-1%	-1%	-1%	-1%	-1%	-1%	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Machinery	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Motor vehicles	1%	1%	1%	1%	2%	1%	1%	1%	2%	2%	1%	2%	2%	1%	2%	2%	1%	1%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Coke, refined petroleum & nuclear fuels	-1%	-1%	-1%	-1%	-1%	-1%	0%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	1%	1%	1%	1%	1%	1%	0%	1%	0%	1%	0%	1%	1%
Rubber and plastic	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other non metallic minerals	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	0%	-1%	-1%	-1%	-1%	0%	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Basic metals & fabricated metal products	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Food industry	61%	66%	63%	67%	63%	64%	57%	53%	53%	54%	59%	60%	57%	55%	51%	29%	29%	30%	28%	27%	28%	30%	30%	29%	31%	29%	26%	26%
Textile and footwear	9%	8%	8%	7%	7%	7%	6%	6%	5%	5%	5%	4%	4%	4%	4%	2%	2%	2%	2%	2%	2%	2%	1%	1%	1%	1%	1%	1%
Wood and wood products	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	1%	1%	1%	1%	0%	0%	0%	0%	-1%	-1%	0%	0%	0%	0%	0%	0%	0%
Pulp and paper	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	0%	1%	1%	1%
Manufacturing	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Construction	6%	6%	6%	5%	5%	4%	4%	4%	4%	5%	5%	6%	5%	5%	5%	6%	5%	4%	5%	5%	5%	4%	4%	4%	4%	3%	3%	3%
Communications	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%
Business activities	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Wholesale, retail trade & recovery	4%	4%	4%	4%	4%	4%	3%	3%	3%	3%	3%	4%	4%	4%	4%	5%	5%	5%	5%	4%	4%	5%	5%	5%	5%	6%	5%	5%
Hotels and restaurants	20%	23%	24%	23%	21%	21%	19%	18%	18%	20%	21%	20%	19%	19%	19%	19%	19%	19%	18%	18%	17%	14%	13%	13%	15%	14%	13%	13%
Transport	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%
Financial intermediation	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Real estate activities	0%	0%	1%	0%	1%	0%	1%	1%	0%	1%	0%	1%	1%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Other services	12%	13%	13%	12%	12%	11%	9%	9%	8%	9%	9%	9%	9%	9%	9%	8%	7%	7%	7%	6%	6%	6%	7%	7%	10%	12%	11%	11%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

* The negatives, which we mainly find in the agrarian contents from the year 1980 to 1986, are mainly explained by net water imports.

Source: Own elaboration

Average Water Changes

For the reasons explained in the methodology, we will look at both direct and embodied water contents.

The averages by period of the yearly variations of direct water use are presented in Table 3, where we may observe that a reduction in non-agriarian water use has taken place in the last period, of 1999 to 2007, while the only period of decrease of the direct agrarian water consumption is the 1986-1992. As explained in the data, this occurs under the strong assumption of constant water intensities by crop per ton of production.

This is likely to be largely driven by a reduction of the total production in the period, but as we will see in the last subsection of results, also issues of crop production substitution may have an important effect.

Table 3: Average of the yearly variations of direct water use (hm^3).

Classification in the IO Table	80-86	86-92	92-99	99-07
Agriculture, hunting and forestry	780	-419	3,343	1,631
Mining and quarrying	1	4	5	-14
Electricity, gas and water	314	278	-113	244
Electrical, optical, office, accounting and computing	0	0	0	0
Chemical products	6	11	8	-29
Machinery	0	0	0	0
Motor vehicles	0	0	0	-1
Coke, refined petroleum and nuclear fuels	-1	0	1	-2
Rubber and plastic	2	3	3	-11
Other non metallic minerals	0	2	2	-1
Basic metals and fabricated metal products	-3	-3	0	-5
Food industry	2	6	-1	12
Textile and footwear	-1	0	1	-9
Wood and wood products	0	1	3	-4
Pulp and paper	1	7	5	-12
Manufacturing	0	0	0	0
Construction	0	0	0	0
Communications	0	0	0	0
Business activities	0	2	0	-1
Wholesale, retail trade and recovery	0	0	0	0
Hotels and restaurants	0	1	0	-1
Transport	0	0	0	0
Financial intermediation	0	0	0	0
Real estate activities	0	0	0	0
Other services	1	2	5	-2
TOTAL	**1,101**	**-105**	**3,263**	**1,795**

Source: Own elaboration

Table 4 shows the average of the yearly variations of embodied water use, where we find notable water reductions via the demand of Food industry, Textile and footwear, and even in the Construction in the first and last periods.

Table 4: Average of the yearly variations of embodied water use (hm^3)

Classification	80-86	86-92	92-99	99-07
Agriculture, hunting and forestry	1,155	174	3,329	1,300
Mining and quarrying	2	14	-230	-76
Electricity, gas and water	146	-99	348	-86
Electrical, optical, office, accounting and computing	13	5	14	-9
Chemical products	-13	58	28	-1
Machinery	-18	0	3	15
Motor vehicles	25	7	5	5
Coke, refined petroleum and nuclear fuels	51	-32	152	-8
Rubber and plastic	-12	-28	22	9
Other non metallic minerals	4	-13	61	37
Basic metals and fabricated metal products	-22	-27	9	-14
Food industry	258	-29	-1,109	336
Textile and footwear	-176	-267	-73	-104
Wood and wood products	28	-41	-138	36
Pulp and paper	9	-29	3	11
Manufacturing	-52	-7	118	-51
Construction	-145	169	40	-174
Communications	5	-1	14	35
Business activities	-45	14	21	1
Wholesale, retail trade and recovery	-1	64	73	190
Hotels and restaurants	62	54	563	-269
Transport	3	-6	14	-23
Financial intermediation	-1	-1	3	29
Real estate activities	23	-11	38	-9
Other services	-196	-72	-47	612
TOTAL	**1,101**	**-105**	**3,263**	**1,795**

Source: Own elaboration

Average effects of the water changes in the period

The average yearly total change in the water use from 1980 to 2007 was of 1,599 hm^3. Looking in Table 5 at the importance of each sector in the direct changes we observe as expected that it can be explained in almost a 90% by the agrarian sector, in an 11% by the Electricity, gas and water sector; and only Mining and quarrying, and the Chemical products sector have changes that reach the 1% in any effect, in this case with a reduction of the intensities and increase of demand.

Table 5: Average yearly direct water changes along the period 1980-2007 (%).

Mean yearly Changes along the period 1980-2007	Intensities	Technological	Substitution	CellSpecific	Demand	DeltaW
Agriculture, hunting and forestry	31%	-224%	127%	0%	156%	89%
Mining and quarrying	0%	1%	0%	0%	-1%	0%
Electricity, gas and water	-15%	4%	1%	0%	21%	11%
Chemical products	-1%	0%	0%	0%	1%	0%
Rest of activities	-1%	0%	0%	0%	1%	0%
TOTAL	14%	-220%	130%	0%	177%	100%

Source: Own elaboration

The average annual increase of 1,599 hm^3 was driven by a 130% and 177% average yearly importance in the increase of the substitution effect and demand effect, despite the reduction via the technology effect of a 220%. Interestingly, looking at the embodied contents in
Table **6**, the average yearly water change comes from the agrarian sector, with a 97% (this should not necessary happen given that although the direct water use is mainly explained by this sector, its participation as final demand, driving the embodied water contents, is very different, see Table 2), driven by a 25% of an embodied intensity effect annual average change, and 75% of demand effect annual average change. The intensity effect was on average in the period participating in a 14%.

Table 6: Average yearly embodied water changes along the period 1980-2007 (%).

Classification	Intensities	Technological	Substitution	CellSpecific	Demand	DeltaW
Agriculture, hunting and forestry	25%	-3%	0%	0%	75%	97%
Mining and quarrying	2%	0%	0%	0%	-7%	-5%
Electricity ,gas and water	-6%	1%	0%	1%	9%	5%
Electrical, optical, office & computing	0%	0%	0%	0%	0%	0%
Chemical products	0%	0%	0%	0%	1%	1%
Machinery	0%	0%	0%	0%	0%	0%
Motor vehicles	-1%	-1%	1%	0%	2%	1%
Coke, refined petroleum & nuclear fuels	0%	3%	-3%	0%	4%	3%
Rubber and plastic	0%	0%	0%	0%	0%	0%
Other non metallic minerals	0%	0%	0%	0%	1%	2%
Basic metals & fabricated metal products	0%	0%	0%	0%	-1%	-1%
Food industry	-3%	-116%	73%	-3%	41%	-9%
Textile and footwear	-1%	-8%	3%	0%	-3%	-9%
Wood and wood products	-1%	-1%	0%	0%	-1%	-2%
Pulp and paper	0%	-1%	0%	0%	1%	0%
Manufacturing	0%	-1%	0%	0%	1%	0%
Construction	-1%	-6%	1%	-1%	5%	-2%
Communications	0%	0%	0%	0%	1%	1%
Business activities	0%	0%	0%	0%	0%	0%
Wholesale, retail trade and recovery	0%	-6%	0%	6%	5%	6%
Hotels and restaurants	3%	-60%	41%	-5%	27%	6%
Transport	0%	-2%	1%	0%	0%	0%
Financial intermediation	0%	0%	0%	0%	1%	1%
Real estate activities	0%	0%	0%	0%	1%	1%
Other services	-3%	-17%	11%	1%	15%	7%
TOTAL	14%	-220%	130%	0%	177%	100%

Source: Own elaboration

By period, for example the demand effect let us observe the reduction of the Mining and quarrying (and also at a smaller scale of the Textile and footwear sector) demand in the last two periods, as we observe in Table 7, which explains the reductions in the volume used in the last period. Regarding the embodied water use of the sector however, we see in Table 8 that a strong reduction takes place only in the first period of the two (92-99).

Table 7: Demand effect of the % change of the direct water uses by period.

Classification	80-86	86-92	92-99	99-07
Agriculture, hunting and forestry	4	6	4	3
Mining and quarrying	5	6	-24	-30
Electricity, gas and water	4	3	6	3
Electrical, optical, office, accounting and computing	3	5	5	1
Chemical products	0	6	4	2
Machinery	-2	3	3	4
Motor vehicles	3	3	5	2
Coke, refined petroleum and nuclear fuels	32	0	37	2
Rubber and plastic	0	2	4	3
Other non metallic minerals	1	8	7	5
Basic metals and fabricated metal products	0	3	3	1
Food industry	3	6	-2	3
Textile and footwear	1	0	-2	-3
Wood and wood products	4	3	-7	3
Pulp and paper	1	4	2	3
Manufacturing	-5	3	13	-1
Construction	-	-	-	-
Services	5	32	31	33
TOTAL	**4**	**5**	**4**	**3**

Source: Own elaboration

Table 8: Demand effect of the % change of embodied water uses by period.

Classification	80-86	86-92	92-99	99-07
Agriculture, hunting and forestry	-8	56	132	5
Mining and quarrying	0	20	-132	13
Electricity, gas and water	46	-6	39	2
Electrical, optical, office, accounting and computing	465	8	17	-2
Chemical products	7	-4	6	13
Machinery	-5	2	5	10
Motor vehicles	4	4	6	2
Coke, refined petroleum and nuclear fuels	-7	6	-18	14
Rubber and plastic	135	35	-7	-112
Other non metallic minerals	-1	5	130	103
Basic metals and fabricated metal products	18	159	66	32
Food industry	3	6	-3	3
Textile and footwear	1	-1	-2	-7
Wood and wood products	9	0	-5	0
Pulp and paper	6	1	4	5
Manufacturing	-11	0	185	-1
Construction	0	8	0	2
Services	-8	-29	44	90
TOTAL	**4**	**5**	**4**	**3**

Source: Own elaboration

Inspection of the Agrarian production and water use Changes

As we have seen above, the importance of the agrarian sector is marked in explaining the direct water uses and changes, and also very high as the main factor of embodied water yearly variations. In this sense a further inspection of the factors behind the water use increases (assuming constant blue and green consumption of the crops, i.e., satisfaction of the needs) is presented in Table 9 the average yearly productivity (production per area), area harvested and water consumption yearly increase of the crops during the period 1980-2007.

As shown from the highest to the lowest importance of the changes (from red, yellow, orange, lighter oranges to white), the highest average contribution to the total water consumption of the crops comes from olives, grapes, barley, wheat and almonds. In the case of olives, clearly an average increase of the 16% in the water use has taken place given the increase in area harvested and especially of productivity, and similarly for barley and almonds, but with an average increase of a 8-9%. Grapes and wheat had average increases of water consumption of a 3 and 4%, with improvements in productivity along the period. Other crops with an average water consumption higher than 1% of the total, which had high increases along the period, and hence, help explaining the total water change are Sunflower, and Graminea and leguminous crops. Also relevant increases in water consumption of crops with average water consumption higher than 1% of the total, were those of Pulses, Chiles, pim. pic., pim. (Green) and Oranges (and with less variation Grasses, Sugar beet, Rye, etc.). Increases less driven by increases in productivity but raises in the area harvested were those of Poppy seeds, Linseed, Flax fiber and tow, Hemp fiber, Soybean, Sorghum, Citrus, or the aforementioned Graminea and leguminous crops.

Discussion

The SDA analyzed allows decomposing the yearly variations of direct and embodied water use into an intensity, technological, substitution, cell specific and demand effect. The rAs decomposition allowed us to make those interpretations of technological changes that represents a reduction of inputs for the same structure of inputs by sector, and of other changes that are questions of substitution or scale. The first treatment of imports proposed, with the assumption of autonomous economy, with the same import water coefficients than the domestic. However, this let us isolate the effect of intensity outside the country, and see how the variation of water contents from the foreign countries entering Spain depends on the changes in the volumes of imports, and more importantly to examine based on the same intensities what are the effects of key changes in the country such as the technological. In the end the real reductions of efficiency are not strictly considered (intensities are assumed constant, since total green and blue water consumption of the crops is assumed to be relatively constant over time). But indeed, the analysis of the agrarian sector lead us to a specific SDA of the interactions among productivity or area harvested, which are another way to decompose production, and hence the water needs for production.

Table 9: Average yearly productivity (P), area harvested (A) and water (W) variation (Δ) by crops.

Crop	Average Yearly P Δ	Average Yearly A Δ	Average Yearly W Δ	Average % in the total W	Crop	Average Yearly P Δ	Average Yearly A Δ	Average Yearly W Δ	Average % in the total W	Crop	Average Yearly P Δ	Average Yearly A Δ	Average Yearly W Δ	Average % in the total W
Olives, olives	8%	2%	16%	16.10%	Dried beans	3%	-7%	-4%	0.63%	Mint	0%	1%	2%	0.00%
Avocados	-1%	15%	14%	0.05%	Trop Fruit Sc	0%	0%	11%	0.00%	Cereal Mix	10%	19%	27%	0.13%
Garlic	1%	0%	1%	0.13%	Fruit Harin	0%	0%	0%	0.00%	Millet	1%	11%	20%	0.01%
Dry apricot	0%	0%	6%	0.00%	Dried Fruit	0%	0%	0%	0.00%	Forage Turnips	0%	-10%	-6%	0.33%
Apricots	6%	1%	7%	0.38%	Trop Fruit	-1%	7%	11%	0.03%	Orange Juice	0%	0%	15%	0.02%
Artichokes	2%	2%	4%	0.27%	NCP citrus	3%	32%	19%	0.00%	Oranges	2%	1%	4%	1.33%
Alfalfa	-1%	-1%	2%	0.51%	Chickpeas	7%	-3%	3%	0.44%	Nuts in shell	-7%	14%	0%	0.05%
Locust beans	0%	-2%	-3%	2.44%	Gramin & Legum	2%	141%	327%	3.09%	NCP Nuts	-3%	-2%	1%	0.04%
Seed cotton	3%	2%	3%	0.48%	Grasses	-2%	0%	2%	2.26%	Red Grapes	0%	0%	3%	0.39%
Cotton Fib	0%	0%	3%	0.16%	Dried peas	2%	15%	15%	0.19%	Other Berries	-1%	0%	3%	0.00%
Almonds in shell	5%	3%	8%	7.40%	Green peas	1%	2%	3%	0.04%	Other Fruits	0%	0%	2%	0.14%
Birdseed	6%	-1%	12%	0.02%	Haba com. and horse	4%	-2%	1%	0.52%	Other melons (incl.	0%	-2%	2%	0.21%
Lupin	4%	7%	14%	0.05%	Figs	-3%	-2%	-3%	0.33%	Potatoes, potatoes	0%	0%	-1%	1.56%
Anise, Badian, fennel, cilantro	-1%	-3%	4%	0.01%	Dried Figs	0%	0%	2%	0.02%	Raisins	4%	-3%	3%	0.00%
Paddy	1%	4%	4%	1.24%	Mushrooms and	0%	6%	0%	0.00%	Cucumbers and	3%	2%	5%	0.03%
Hazelnuts	10%	-1%	11%	0.47%	For Hort + Tub	-1%	16%	23%	0.04%	Pears	3%	3%	7%	0.39%
Oats	6%	0%	8%	1.66%	Nep Hortal	-1%	0%	1%	0.06%	Prepare Frut	0%	0%	0%	0.00%
Bananas	1%	0%	1%	0.18%	NCP leguminous	0%	0%	0%	0.02%	Forage Prod	0%	0%	8%	0.03%
Sweet potatoes,	-1%	-2%	-1%	0.03%	French beans	1%	0%	2%	0.05%	Leeks and other	1%	4%	5%	0.00%
Eggplant	2%	1%	3%	0.03%	JugCítri with	0%	0%	0%	0.00%	Chicory roots	1%	-8%	-5%	0.01%
Green coffee	0%	0%	-7%	0.00%	JugLimonConc	0%	0%	0%	0.00%	Root and tuber starch,	0%	2%	5%	0.00%
Pumpkins, zapayos &Calabar	2%	1%	3%	0.02%	JugLimonNCon	0%	0%	0%	0.00%	Ryegrass	0%	1%	3%	0.42%
Sugar cane	-1%	-9%	-6%	0.06%	NOCN JugManz	0%	0%	0%	0.00%	Sugar beet	3%	-1%	2%	1.23%
Hemp Fiber	13%	57%	70%	0.01%	Citrus Juice	0%	0%	0%	0.00%	Mangold	-2%	-8%	-6%	0.05%
Hemp Seed	8%	21%	28%	0.00%	Grape Juice	0%	0%	0%	0.00%	Watermelons	3%	0%	3%	0.09%
Chestnuts	-3%	1%	2%	0.48%	Fruit Juice	0%	0%	0%	0.00%	Poppy seeds	-3%	220%	224%	0.01%
Barley	6%	2%	9%	11.42%	Grapefruit Juice	0%	0%	0%	0.00%	Cottonseed	0%	0%	2%	0.26%
Onions (incl. shallots), green	2%	1%	2%	0.00%	Conc Jugon	0%	0%	0%	0.00%	Safflower seed,	5%	10%	35%	0.03%
Dry onions	2%	-1%	1%	0.14%	JugoToronCon	0%	0%	0%	0.00%	Sunflower seeds	5%	20%	31%	1.28%
Rye	5%	-3%	2%	1.42%	JuManzanaCon	0%	0%	0%	0.00%	Soybean	0%	42%	37%	0.03%
Cherries	-1%	6%	3%	0.35%	Kiwis	8%	11%	26%	0.00%	Sorghum	6%	35%	88%	0.11%
Chilies and peppers, dry	0%	-4%	0%	0.00%	Lettuce and chicory	0%	2%	2%	0.04%	Sorghum for Fodder	-1%	5%	15%	0.07%
Chiles, pim, pic., pim. (Green)	2%	0%	3%	4.15%	Forage Legum	-2%	-2%	0%	2.99%	Gross Snuff	2%	0%	1%	0.06%
Plums and sloes	0%	5%	5%	0.23%	NCP pulses	11%	-2%	4%	1.01%	Tangerines, mandarins,	2%	6%	8%	0.70%
Coles Forage	-2%	-5%	-3%	0.04%	Lentils	13%	0%	11%	0.57%	Tomatoes	3%	1%	3%	0.22%
Cabbages and other brassicas	-2%	-3%	-2%	0.15%	Lemons and limes	3%	4%	8%	0.25%	Grapefruits (including	1%	5%	8%	0.01%
Cauliflower and broccoli	-1%	2%	2%	0.03%	Linseed	-4%	425%	777%	0.04%	Clover	0%	-6%	-7%	0.43%
Rape	3%	136%	131%	0.09%	Flax fiber and tow	10%	118%	177%	0.03%	Wheat	6%	-2%	4%	10.23%
Dates	-4%	2%	-1%	0.01%	Hops	4%	-1%	2%	0.01%	Triticale	7%	21%	38%	0.04%
Asparagus	1%	3%	3%	0.19%	Corn	3%	0%	4%	2.70%	Gooseberries	0%	0%	-3%	0.00%
NCP Spices	0%	-3%	5%	0.02%	ForageMaize	-1%	0%	3%	0.70%	Grapes	4%	-1%	3%	11.52%
Spinach	2%	1%	2%	0.00%	Peanut (groundnut) in	1%	-1%	-5%	0.01%	Vetch	6%	3%	4%	0.62%
Similar to Jute Fibres	3%	-5%	-3%	0.00%	Apples	3%	2%	5%	0.64%	Fodder carrot	0%	-6%	-3%	0.01%
Raspberries	-2%	3%	6%	0.00%	Peach, (Peach), nectar,	3%	5%	8%	0.62%	Carrots and turnips	4%	6%	10%	0.03%
Strawberries	6%	3%	10%	0.04%	Quinces	-3%	4%	2%	0.02%	**TOTAL**	**1%**	**0%**	**2%**	**100%**

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