Food and Agriculture Organization
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SDG 6.4 MONITORING SUSTAINABLE
USE OF WATER RESOURCES PAPERS

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Analysis and interpretation of preliminary results in key regions and countries

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2019

Rossi, A., Biancalani, R. & Chocholata, L. 2019. *Change in water-use efficiency over time (SDG indicator 6.4.1): Analysis and interpretation of preliminary results in key regions and countries.* Rome, FAO.

ISBN 978-92-5-131723-5

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1. Introduction

In this working paper, the evolution in water-use and water-use efficiency in selected regions and countries is discussed. Among the regions, the analysis described below focuses on Europe, which includes a large number of developed countries, and on three key developing regions, i.e. Sub-Saharan Africa, Southeast Asia, and Latin America and the Caribbean. Furthermore, particular attention was given to the evolution in water-use, water-use efficiency and related drivers in two groups of countries, i.e. major developing economies (i.e. G7 countries) and newly industrialized countries, i.e. Brazil, China, India, Indonesia, Malaysia, Mexico, South Africa and Turkey[1].

In terms of economic sectors, in line with SDG indicator 6.4.1 (Change in water-use efficiency) and the International Standard Industrial Classification (ISIC) of economic activities, three major sectors were considered, i.e.:

1 The Philippines and Thailand could not be considered, due to limited data.

- Agriculture; forestry; fishing (ISIC A), hereinafter “agriculture”;
- mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply; constructions (ISIC B, C, D and F), hereinafter “MIMEC”; and
- all the service sectors (ISIC E and ISIC G-T), hereinafter “services”.

The evolution in water-use and water-use efficiency in the aforementioned regions, countries and sectors was then put in relation with two key socio-economic variables of relevance to the sustainable development agenda and the related goals, targets and indicators, i.e.: economic growth; and water access, or more specifically access to safe drinking water (i.e. SDG target 6.1 and related indicator 6.1.1). The relationship between water-use, water-use efficiency and economic growth was analyzed and discussed in the context of the literature on the so-called Environmental Kuznets Curve (EKC) applied to water resources, whose main findings are discussed in section three.

In order to illustrate some of the trends and issues discussed above, an example is presented in section five. The example focuses on Spain, which was chosen due its relatively recent and fast economic development process, and in light of the availability of adequate time series data. Finally, a few concluding remarks are provided at the end of the paper.


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2. Water-use and water-use efficiency in selected sectors and regions

Water-use efficiency (WUE), as measured by SDG indicator 6.4.1, tends to be higher in more advanced economies, with 8 countries scoring among the top 20 in terms of both GDP per capita and WUE. On the other hand, in general, the lower the GDP per capita and the higher the contribution of agriculture to GDP and to total water-use, the lower the WUE, even though no linear relationships appear to exist between these variables. As a matter of fact, there are 13 countries ranking among the top 30 in terms of share of agriculture out of total GDP – ranging from 59 percent in Sierra Leone to 22 percent in Mozambique in 2015 - and among the bottom 30 for WUE.

WUE in agriculture tends to be significantly lower – by up to several orders of magnitude – than in the other sectors addressed by indicator 6.4.1 (i.e. MIMEC and services), which explains the high sensitivity of the indicator to changes in the composition of the GDP and especially in the share of water-use accounted for by agriculture vs. the other two sectors.

The differences in WUE across countries/regions and sectors are well illustrated by the results (both aggregated and disaggregated) of indicator 6.4.1 in key four regions, i.e.: Europe, which is comprised of developed economies (including major developed economies, i.e. G7 countries); and three regions - Sub-Saharan Africa (SSA), Southeast Asia (SEA), and Latin America and the Caribbean (LAC) – consisting of developing economies, including a number of least developed countries, especially in SSA.

As shown in Table 1, average WUE is significantly higher among European countries – at 79.66 USD/m^3 – than in the other three regions. However, considerable differences can be found among these three regions, with an average WUE in Southeast Asia (at 4.11 USD/m^3) over four times lower than in Sub-Saharan Africa and Southeast Asia (at 17.44 USD/m^3).

Table 1

Average water-use efficiency (overall and sectoral, including related ratios) in selected regions[a]

REGIONS	WUE (USD/m^3)	WUE-A (USD/m^3)	WUE-M (USD/m^3)	WUE-S (USD/m^3)	WUE-A/-M	WUE-A/-S
Europe[b]	79.66	2.61	136.57	185.69	0.019	0.014
Sub-Saharan Africa[c]	17.4	0.24	104.2	37.38	0.002	0.007
Southeast Asia[d]	4.11	0.37	28.42	26.65	0.013	0.014
Latin America and the Caribbean[e]	17.44	0.66	92.54	47.83	0.007	0.014

[a] Countries with incomplete data or with a WUE at least ten times higher than the average of the other countries in the respective region were not considered for the computation of the average values reported in the table.

[b] Excluding Luxembourg.

[c] Excluding Djibouti and Equatorial Guinea.

[d] Excluding Brunei Darussalam and Singapore.

[e] Excluding Bahamas, Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, and Saint Vincent and the Grenadines.

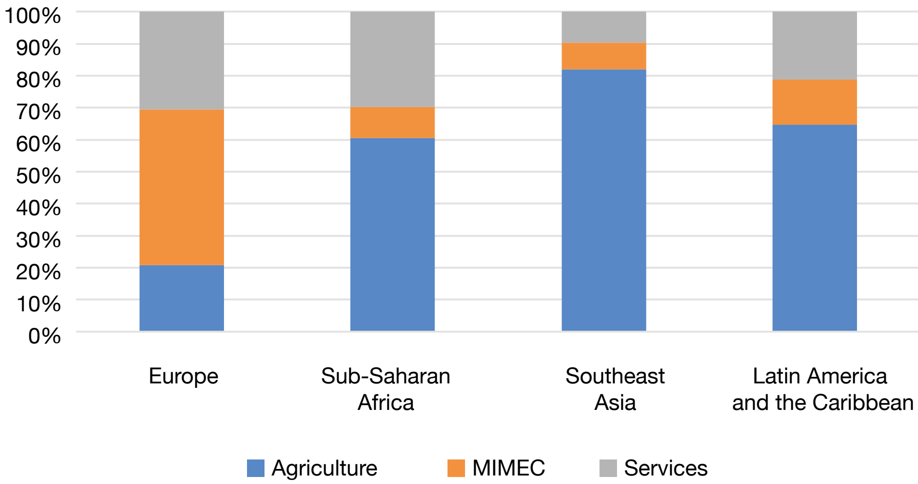
Source: own elaboration based on data from AQUASTAT and World Bank

As a matter of fact, SEA presents the highest average share of agriculture in total water-use, at almost 82 percent (Table 2). Even though SSA displays the lowest water-use efficiency in agriculture (at 0.24 USD/m^3), the contribution of agriculture to water-use (at 60.58 percent) is lower than in SEA. On the contrary, with regard to MIMEC, even though the contribution of the sector to total water-use is relatively similar across the three regions (ranging from 8.41 percent in SEA to 14.28 percent in LAC), SSA displays the highest sectoral WUE, with an average of over 104 USD/m^3, only 24 percent lower than in Europe, followed by LAC with an average of 92.54 USD/m^3. In this case, with 28.42 USD/m^3, SEA presents the lowest water-use efficiency. This region displays the lowest WUE in the services sector as well, i.e. 26.65 USD/m^3, against 37.38 USD/m^3 in SSA and 47.83 USD/m^3 in LAC (in Europe this figure is 185.69 USD/m^3). At the same time, in SEA services account for a very small share (9.67 percent) of total water-use, i.e. less than half than in LAC and less than one third compared to SSA.

Regarding the relationship between water-use efficiencies across the three major economic sectors considered, WUE in agriculture ranges between 0.7 and 1.9 percent of WUE in each of the other two sectors, i.e. MIMEC and services. The only exception to this is represented by agricultural water-use efficiency in Africa, which is particularly low both in comparison with the other regions and the other sectors of the African economy and especially MIMEC, with a value of 0.24 USD/m^3, i.e. 0.2 percent of WUE-M.

However, significant differences exist, in terms of both overall and sectoral WUE, across countries within the aforementioned regions and especially SSA and Europe. In Sub-Saharan Africa, extremely low water-use efficiency levels are found in countries where agriculture accounts for over 80-90 percent of total water-use (e.g. Somalia, Madagascar, Mali), while very high WUE is found in countries with sizeable oil, gas and mining sectors, where MIMEC accounts for an important share of GDP and water-use and presents high sectoral WUE (e.g. Equatorial Guinea, Angola, Congo). In Europe, the highest WUE is found in countries with sizeable MIMEC and especially services sectors presenting high sectoral WUE (e.g. Luxembourg, Denmark, Switzerland), while the lowest WUE is found in countries where MIMEC accounts for a significant share of water-use and presents a very low WUE (e.g. Republic of Moldova, Bulgaria and Serbia).

Figure 1 | Average share of total water-use by sector in selected regions



[a] The same restrictions and related justifications described under Table 1 apply here as well

Source: own elaboration based on data from AQUASTAT.

3. Changes in water-use, water-use efficiency and relationship with economic growth in selected countries

Over the past three to four decades, WUE has increased – in some cases significantly – in all of the major developed economies[2] (i.e. G7 countries) for which sufficient data is available[3] and in most of the newly-industrialized countries (Tables 3, 4). With regard to the latter, the increase in WUE was particularly pronounced in India (+ 240 percent) and especially China (+ 923 percent), while in other countries (e.g. Brazil, Malaysia and South Africa) fluctuations were recorded between the various periods within an overall growth trend. In Indonesia, the few data available show a slight decrease in WUE between the early 1990s and the early 2000s.

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[2] In particular, WUE more than doubled in Germany and Great Britain, while in the USA a 95 percent increase was recorded.

[3] During the 1990/92 - 2010/3 timeframe, data for Italy was available only for 2000. Thus, it is not possible to determine whether WUE increased or decreased during this period. However, according to the available data, WUE doubled in Italy between 1970 (18.3 USD/m^3) and 2000 (36.08 USD/m^3).

Regarding the WUE values recorded in the various countries within this group, it is interesting to note the significant difference between India, where WUE was less than 2 USD/m^3 in 2010-13, and China, where WUE was above 13.5 USD/m^3 in the same period. In line with the explanations provided in the previous section, this is due mainly to the different contributions to total water-use of agriculture (which displays a much lower WUE than the other economic sectors), i.e. 90 percent in India versus 64 percent in China.

Important data gaps may be observed in both groups of countries, e.g. Italy, Great Britain and Canada among major developed economies, and Indonesia, Turkey, Brazil and India among newly-industrialized countries.

Table 2

Water-use efficiency in the major developed economies (USD/m^3), 1990/92 - 2010/13

	1990-92	1995-97	2000-02	2005-08	2010-13	% change
Canada	17.28	21.63		30.73		**+ 78%**
France	38.1	52.67	57.55	65.34	69.49	**+ 82%**
Germany		52.8	66.13		128.9	**+ 144%**
Great Britain			132.9	283.5		**+ 113%**
Italy			36.08			
Japan	38.12	42.59	45.89	51.49		**+ 35%**
USA	17.82		25.06	28.82	34.66	**+ 95%**

Source: own elaboration based on data from AQUASTAT and World Bank.

Table 3

Water-use efficiency in newly industrialized countries[a] (USD/m^3), 1990/92 - 2015/16

	1990-2	1995-96	2000-03	2006-07	2010-13	2015-16	% change
Brazil		17.84		21.22	19.59		**+ 10%**
China	2.04		5.218	9.923	13.57	20.87	**+ 923%**
India	0.5838		0.9591		1.984		**+ 240%**
Indonesia	3.455		3.203				**- 7%**
Malaysia	7.516	23.05	15.59	16.43			**+ 119%**
Mexico			10.98	11.98	12.48	13.62	**+ 24%**
South Africa	10.92	4.004	14.77		21.35		**+ 96%**
Turkey	7.711		12.1				**+ 57%**

[a] Excluding Philippines and Thailand, due to limited data.

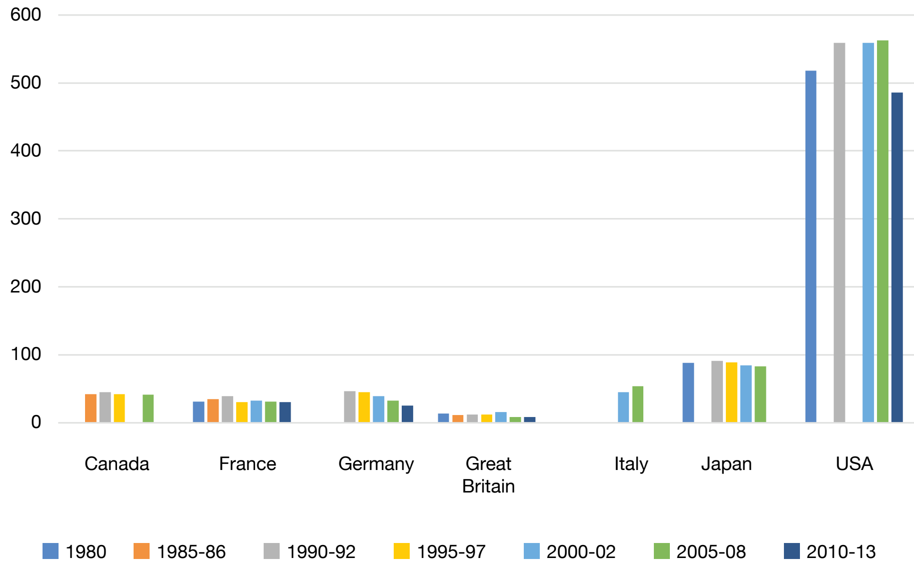
Source: own elaboration based on data from AQUASTAT and World Bank.

The trends in water-use efficiency described above appear to be fairly consistent with the hypothesis of a decoupling of economic growth from water-use, which took different forms in the aforementioned countries.

In the major developed economies, despite the increase in GVA over the past few decades, total water-use has started to decrease after peaking in the early 1990s. In some cases, this decrease has been more pronounced, e.g. in Great Britain and especially Germany (Figure 2). The only exception is represented by Italy, where the limited data available point to an increase in water-use in the early 2000s.

On the contrary, an increase in water-use was recorded in most newly industrialized countries (Table 4). In Malaysia and South Africa, this increase was only slight, with important fluctuations from one period to another in Malaysia, while in the other countries a more substantial increase was recorded. However, as revealed by the data on water-use efficiency discussed above, in newly industrialized countries, GVA increased at a faster pace than water-use over the past few decades, especially in non-

Figure 2 | Total water-use in major developed economies (10^9 m^3/year), 1980-2010/13



Source: AQUASTAT

Table 4

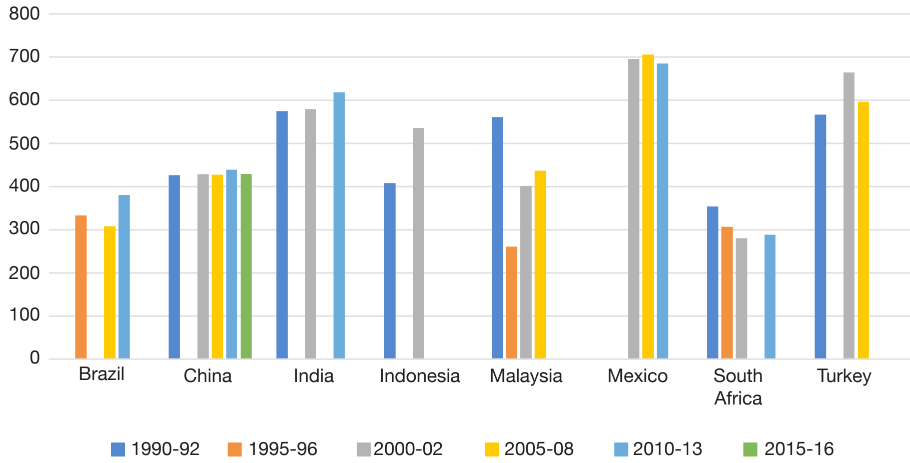
Total water-use in newly industrialized countries[a] (10^9 m^3/year), 1990/92 - 2015/16

	1990-2	1995-6	2000-03	2005-08	2010-13	2015-16	Change (%)
Brazil		54.87		58.07	74.83		**+ 36%**
China	500		549.8	571.3	603.3	598.1	**+ 20%**
India	500		610.4		761		**+ 52%**
Indonesia	74.34		113.3				**+52%**
Malaysia	10.12	5.488	9.305	11.2			**+ 11%**
Mexico			72.6	78.95	82.73	86.58	**+ 19%**
South Africa	13.31	12.9	12.79		15.5		**+ 16%**
Turkey	31.6		42	42.01			**+ 33%**

[a] Only the countries included in Table 4 were considered here. Hence, Philippines and Thailand were excluded.

Source: AQUASTAT.

Figure 3 | Per capita water-use in newly industrialized countries (m^3/year), 1990/92 - 2015/16



Source: own elaboration based on data from AQUASTAT and UNSD.

agricultural sectors, which tend to have a much higher WUE compared to agriculture. Furthermore, as shown in Figure 3, if per capita water-use is considered, a slightly decreasing trend may be observed in recent years in a few newly industrialized countries (e.g. South Africa, Turkey, Mexico).

The results of indicator 6.4.1 and their evolution over time, especially in the major developed economies, appear to be consistent with the main findings of much of the literature on the relationship between economic growth and water-use.

In recent years, a few studies have tested the hypothesis of an inverted U-shape relationship – known as Environmental Kuznets Curve[4] (EKC) - between water-use and economic growth, similar to that described in various previous publications on the relationship between environmental pollution, natural resource use[5] and economic growth. The main assumption behind the EKC is that, at a first stage, the greater the income, the greater the pressure on natural resources; after an income threshold is reached, which varies from country to country, the trend reverses and the pressure on natural resources tends to decrease.

4 Based on the pioneering work by Kuznets (1955) on the relationship between the level of inequality and per capita income.

5 As reported by Miglietta *et al*. (2017), most studies examining the relationship between the use of natural resources and economic growth have focused on land, deforestation and biodiversity, while only a limited number of them have addressed water-use.

For instance, Duarte *et al*. (2013) analyzed the relationship between per capita water-use and per capita income for 65 countries over the period 1962-2008. They concluded that, at the lowest level of per capita income, an increase in average income appears to boost water-use. According to Duarte *et al*. (2013), this is due to a combination of factors, including: development of the industrial sector; growing urbanization; and improvements in standards of living entailing changes in dietary patterns, with increased demand for – and production of - more water-intensive goods such as meat and fruit, enabled by investments in water infrastructure and irrigation.

"As per capita GDP increases, water-use income elasticity turns out to be negative; that is, more affluence means less water-use per capita" (Duarte *et al*., 2013, p. 525). In order to explain this, the study points to a mix of technical, managerial and institutional developments resulting in an increase in water-use efficiency, combined with improvements in irrigation systems and advances in environmental regulation. However, as income continues to grow, the decline in income elasticity tends to become smoother. In other words, as high-income countries become wealthier, "the decrease produced in water-use due to an increase in per capita GDP tends to be smaller" (Duarte *et al*., 2013, p. 525).

Studies examining the relationship between water-use and economic growth using the water footprint approach have reached different conclusions. Under this approach, which was first introduced by Hoekstra and Hung (2002) and then further elaborated under subsequent studies, both direct and indirect (aka 'virtual') water-use is accounted for. At national level, the water footprint can be estimated as the sum of total local water-use plus the gross virtual water import (i.e. the water used in other countries to produced imported goods) minus the gross virtual water export (i.e. the water used in the country considered to produce exported goods) (Sebri, 2016).

The studies that have been conducted using this approach (e.g. Sebri, 2016; Miglietta *et al*., 2017) point to the existence of an N-shaped (as opposed to an inverted U-shaped) relationship between per capita water footprint and per capita income. As Sebri (2016) put it, "this means that water footprint increases first with lower incomes, then temporarily dips at higher income levels to resume rising again with the wealthiest countries" (p. 1951). However, if only internal water resources are considered, a decreasing slope is obtained, indicating that an increase in income levels induces a decrease in the use of internal water resources (Sebri, 2016). This suggests that "developed countries seem not to heavily rely on their domestic water resources, but rather tend to exploit those of developing countries most of which are exposed to water scarcity" (Sebri, 2016, p. 1951).

4. Water-use, water-use efficiency and relationship with access to safe drinking water in selected countries

The Millennium Development Goal 7 ('to ensure environmental sustainability') included a target of halving, by 2015 (compared to 1990 levels), the proportion of people without sustainable access to safe drinking water and basic sanitation. In the 2030 Agenda for Sustainable Development, this objective was picked up under Sustainable Development Goal 6 ('Ensure availability and sustainable management of water and sanitation for all') and, in particular, target 6.1, which commits countries to achieve universal and equitable access to safe and affordable drinking water for all by 2030. Under this target, indicator 6.1.1 measures the 'Proportion of population using safely managed drinking water services'.

Given this framework, data on access to improved drinking sources are relatively abundant, having been collected and reported on a relatively systematic basis from 1990 onwards. This allows us to analyse the relationship between countries' trends in relation to water-use and water-use efficiency on one side and access to safe drinking water on the other side.

Between 1995 and 2012, nine countries have managed to more than halve the proportion of the poorest without access to drinking water (UNICEF & WHO, 2015). The progress made by these countries in access to improved drinking water sources since 1990 is reported in Table 5.

Table 5

Progress in access to improved drinking water sources and changes in water-use in selected countries, 1990 - 2015

	Years	Improved Urban (%)	Improved Rural (%)	Total Improved (%)	Change in water-use (%)
Belize	1990	87	60	73	**n.a.**
	2015	99	100	100	
Egypt	1990	97	91	93	**+ 32%**
	2015	100	99	99	
India	1990	89	64	71	**+ 50%**
	2015	97	93	94	
Jordan	1990	99	90	96	**+ 12%**
	2015	98	92	97	
Mexico	1990	91	59	82	**+ 19%**
	2015	97	92	96	
Pakistan	1990	96	82	86	**+ 18%**
	2015	94	90	91	
Paraguay	1990	85	23	53	**+ 392%**
	2015	100	95	98	
Tunisia	1990	96	64	83	**+ 7%**
	2015	100	93	98	
Uganda	1990	78	36	40	**+ 101%**
	2015	96	76	79	

Sources: UNICEF & WHO (2015); and AQUASTAT.

As shown in Table 5, in the nine countries considered, water-use increased over the past few decades. In seven out of these nine countries (i.e. all excluding Mexico and Paraguay), the municipal sector was one of the main drivers behind this increase, due to the additional water required to ensure access to safe drinking water sources to a growing share of a growing population. As a matter of fact, as shown in Table 6, the share of municipal water-use out of total water-use increased in most of these countries and especially in Pakistan (where it more than tripled), Egypt and Jordan (where it more than doubled), and Tunisia (where it almost doubled).

Table 6

Share of municipal water-use in selected countries, 1990/92 - 2015/17

	1990-92	1995	2000-02	2005-08	2010-12	2015-17
Egypt		6.3	7.8		13.3	13.9
India	5.0		6.9		7.5	
Jordan	21.7		31.0	31.5	41.7	44.5
Mexico			14.1	14.5	14.5	
Pakistan	1.6		3.7	5.3		
Paraguay			20.4		15.0	
Tunisia	8.5	11.0	12.8		15.0	
Uganda				47.7	51.5	

Source: AQUASTAT.

The trends described above had an impact on water-use efficiency. As a matter of fact, the progress made by the nine countries considered in terms of access to safe drinking water sources contributed to lowering WUE in the services sector. However, overall WUE continued to increase in these countries.

Table 7

Water-use efficiency (total, services) in selected countries (USD/m^3), 1990/92 - 2015/16

		1990-2	1995	2000-02	2005-08	2010-12	2015-16	% change
Egypt	WUE		2.389	2.493		4.1	3.027	**26.70573462**
	WUE-S		19.36	17.1		15.59	11.75	**-39.30785124**
India	WUE	0.5838		0.9591		1.984		**239.8424118**
	WUE-S	6.61		8.551		14.28		**116.0363086**
Jordan	WUE	10.79		22.22	29.39	37.52	33.55	**247.7293791**
	WUE-S	34.87		51.43	61.59	60.2	50.69	**72.64123889**
Mexico	WUE			10.98	11.98	12.48	13.62	**24.04371585**
	WUE-S			53.35	53.27	54.46	62.1	**16.40112465**
Pakistan	WUE	0.4681		0.6503	1.185			**153.1510361**
	WUE-S	21.32		12.2	12.53			**-41.22889306**
Tunisia	WUE	4.503	6.196	7.94		10.88		**141.6167**
	WUE-S	34.66	37.7	41.93		47.53		**37.1321408**

Source: own elaboration based on data from AQUASTAT and World Bank.

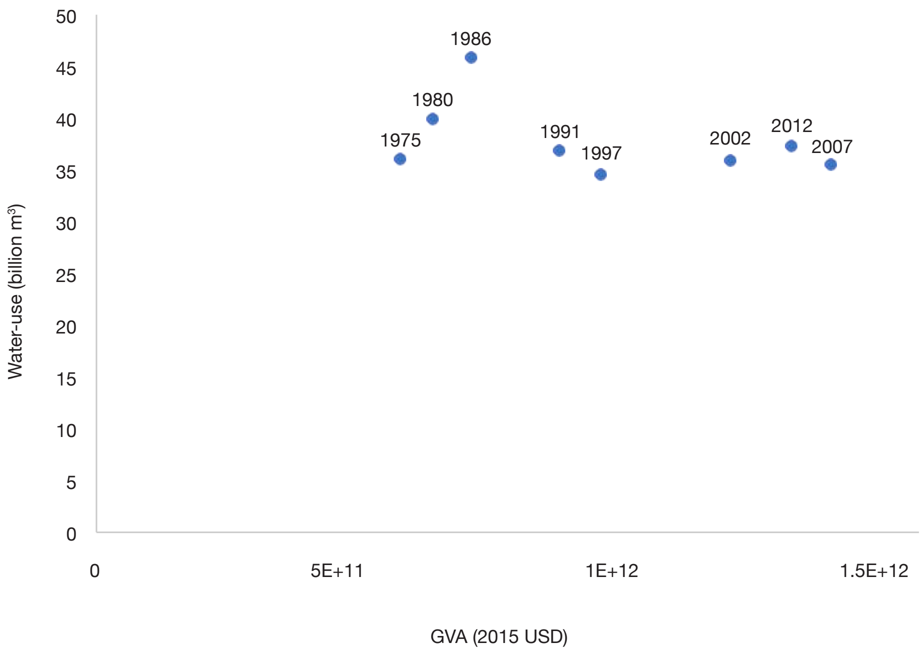
5. Country example: Spain

5.1 Water-use and economic growth in Spain

The decoupling of economic growth from water-use in Spain is obvious when looking at the evolution of GVA and water-use between 1975 and 2012, which appears to be consistent with the main findings of some of the studies discussed above on the Environmental Kuznets Curve applied to water resources.

As shown in Figure 4, between 1975 and 1986, at lower GVA levels, water-use increased in Spain. After reaching a peak/threshold in 1986, water-use rapidly decreased until 1997 and then remained substantially stable until 2007. Following the serious financial crisis that hit most countries around the world, including Spain, in 2008/09 and which negatively affected the national economy during subsequent years as well, a contraction in GVA and an increase in water-use (most likely, both contingent/temporary) were recorded between 2007 and 2012.

Figure 4 | Water-use and GVA in Spain, 1975-2012



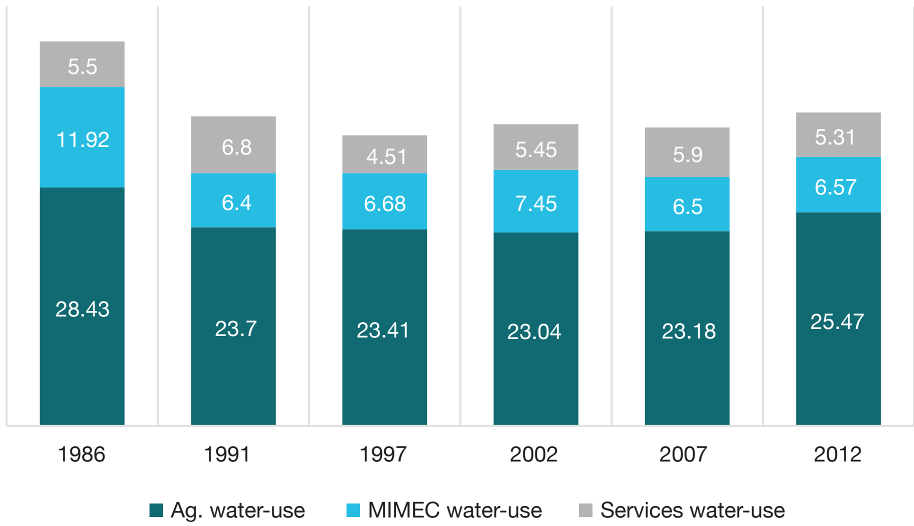
Sources: AQUASTAT; World Bank.

5.2 Gross value added and water-use by sector in Spain

Additional relevant insights into the evolution of water-use and the relationship with economic growth in Spain can be gained by analyzing the data related to water-use and GVA creation by the three major economic sectors addressed under indicator 6.4.1, i.e.: agriculture, MIMEC and services.

The agricultural sector accounts for the majority of water withdrawal in Spain. As shown in Figure 5, in the 1986-2007 period, agricultural water-use decreased (from 28.43 to 23.18 billion m^3 per year), but at a slower pace than total water withdrawals. This resulted in a slight increase in the contribution of the Spanish agricultural sector to total water-use, from 62 percent in 1986 to 65.2 percent in 2007 (Table 8). On the other hand, the MIMEC sector experienced a significant decrease in water-use, with its share of total water-use decreasing from 26 percent in 1986 to 18.3 percent in 2007. Finally, unlike in the other two sectors, water-use for services increased in Spain during the period considered, from 5.5 billion m^3 per year in 1986 (i.e. 12 percent of total water-use) to 5.9 billion m^3 per year in 2007, when it accounted for around 16.6 percent of total use.

Figure 5 | Water-use by sector in Spain (10^9 m^3/year), 1986-2012



Sources: AQUASTAT

Table 8
Share of total water-use by sector in Spain, 1986-2012

	1986	1991	1997	2002	2007	2012
Ag. water withdrawal (%)	62.01	64.23	67.66	64.11	65.15	68.19
MIMEC water withdrawal (%)	26.00	17.34	19.31	20.73	18.27	17.59
Services water withdrawal (%)	12.00	18.43	13.03	15.16	16.58	14.22

Source: AQUASTAT.

In order to understand whether and how water-use efficiency changed across the main economic sectors and for the Spanish economy as a whole during the period considered, and identify the related drivers, the data related to water-use discussed above need to be put in relation with the evolution of GVA and of its composition.

As seen in Figure 4, GVA increased significantly (in real terms, i.e. at constant prices) in Spain between 1986 and 2007. During this period, important changes in the structure of GVA may be observed as well in the country (Figure 6). The contribution of agriculture to GVA decreased by more than half between 1986 and 2007, from 5.5 to 2.5 percent. The share of the MIMEC sector decreased as well, from 34.8 percent in 1996 to 29.4 percent in 2007. On the other hand, the services sector experienced a significant expansion in Spain during the same period. As a matter of fact, the contribution of this sector to GVA increased from 59.7 percent in 1987 to 67.9 percent (i.e. over two thirds of the total) in 2007.

Table 9

Share of gross value added (GVA) by sector in Spain, 1987-2012

	1987	1992	1997	2002	2007	2012
GVA-A (%)	5.51	4.22	4.69	3.79	2.71	2.52
GVA-M (%)	34.76	32.10	30.54	30.51	29.43	23.98
GVA-S (%)	59.73	63.68	64.78	65.69	67.86	73.50

Source: World Bank.

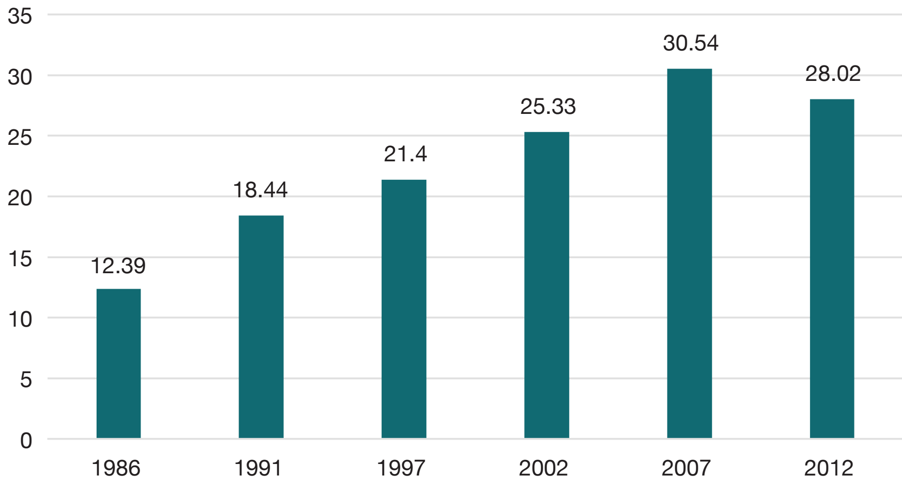
5.3 Water-use efficiency and related changes in Spain

In line with the trends discussed above in relation to economic growth, GVA and water-use, as measured by SDG indicator 6.4.1, in Spain water-use efficiency increased considerably (i.e. by around 2.5 times) in the period considered, and more precisely from 12.4 USD/m^3 in 1986 to 30.8 USD/m^3 in 20076 (Figure 6).

With regard to the specific economic sectors addressed by the indicator, services, which provide the greatest contribution to GVA (i.e. over two thirds of the total in 2007) in Spain, experienced almost a doubling of water-use efficiency, from 65.3 USD/m^3 in 1986 to 128.5 USD/m^3 in 2007 (Table 10). Concerning MIMEC, which contributed over 29 percent to GVA in 2007, the

[6] Following the serious financial and economic crisis in the late 2000s, a contraction in WUE was recorded in the 2007-2012 period. Most likely, this contraction was only temporary and due to contingent factors. For this reason, the analysis presented here focuses on the 1986-2007 period.

Figure 6 | Water-use efficiency in Spain (USD/m^3), 1986-2012



Source: own elaboration based on data from AQUASTAT and World Bank.

increase in water-use efficiency was even more substantial, with almost a tripling during the period considered, i.e. from 17.5 in 1986 to 50.6 in 2007. Finally, as shown in Table 10, WUE in agriculture almost doubled between 1991 and 2002; after 2002, a decrease was recorded.

5.4 Limitations of SDG indicator 6.4.1 in Spain

For the agricultural and MIMEC sectors, only self-supplied water is considered for the computation of SDG indicator 6.4.1. However, according to Eurostat, as of 2013, around one third of the water used for manufacturing came from the public water supply.

Table 10
Water use efficiency by sector in Spain (USD/m^3), 1986-2012

	1986	1991	1997	2002	2007	2012
WUE-A		0.24	0.39	0.45	0.39	0.29
WUE-M	17.53	35.64	35.5	38.77	50.59	38.9
WUE-S	65.28	66.54	111.6	114.1	128.5	147.6

Source: own elaboration based on data from AQUASTAT and World Bank.

Furthermore, according the methodology of indicator 6.4.1, all water-use for public water supply is accounted under ‘Services’. However, in 2014, the services sector accounted only for 22 percent of the public water supply in Spain, followed by industry and construction with 11 percent and manufacturing with almost 10 percent. Non-productive, household uses accounted for around two thirds of total public water supply, according to Eurostat.

Finally, indicator 6.4.1 does not account for changes in population, with water-use efficiency in services being particularly sensitive to such changes. Between 1986 and 2012, the Spanish population grew from less than 39 million to almost 47 million, i.e. by over 20 percent.

6. Conclusions

In this working paper, the evolution in water-use and water-use efficiency in selected regions (Europe, Sub-Saharan Africa, Southeast Asia, Latin America and the Caribbean) and in two key groups of countries (i.e. major developed economies and newly industrialized countries) was discussed, focusing on three major economic sectors, i.e. agriculture, MIMEC and services.

Important data gaps were identified, in both developing and developed countries, especially in relation to the agricultural sector. Filling these data gaps is crucial for an effective monitoring of SDG indicator 6.4.1. Despite these data constraints, a few preliminary conclusions can be drawn from the analysis of the preliminary results of the indicator and of related historical data.

Overall, water-use efficiency, as measured by SDG indicator 6.4.1, tends to be higher in more advanced economies and lower in developing countries with a substantial contribution of agriculture to GDP and to total water use. As explained in section two, this is due mainly to the fact that WUE in agriculture tends to be significantly lower – by up to several orders of magnitude – than in the other sectors addressed by indicator 6.4.1, i.e. MIMEC and services. Agricultural water-use efficiency is particularly low in Sub-Saharan Africa, both in comparison with the other regions and the other sectors of the African economy and especially MIMEC. As discussed above, significant differences exist, in terms of both overall and sectoral WUE, across countries within the aforementioned regions and especially SSA and Europe. In Sub-Saharan Africa, extremely low water-use efficiency levels are found in countries where agriculture accounts for over 80-90 percent of total water-use, while very high WUE is found in countries with sizeable oil, gas and mining sectors, where MIMEC accounts for an important share of GDP and water-use and presents high sectoral WUE. In Europe, the highest WUE is found in countries with sizeable MIMEC and especially services sectors presenting high sectoral WUE, while the lowest WUE is found in countries where MIMEC accounts for a significant share of water-use and presents a very low WUE.

In section three of this paper, the evolution in water-use and water-use efficiency over the past few decades was discussed, focusing on the major developed economies and on the newly industrialized countries. Over the past three to four decades, WUE has increased – in some cases significantly – in all of the major developed economies (i.e. G7 countries) for which sufficient data is available. Regarding newly-industrialized countries, the increase in WUE was particularly pronounced in India and especially China, while in the other countries fluctuations were recorded between the various periods within an overall growth trend.

The evolution in water-use efficiency described in section three appear to be fairly consistent with the hypothesis of a decoupling of economic growth from water-use. As a matter of fact, in the major developed economies (excluding Italy), despite the increase in GVA over the past few decades, total water-use has started to decrease after peaking in the early 1990s. In most newly industrialized countries, an increase in water-use was recorded. However, as revealed by the data on water-use efficiency discussed in this paper, over the past few decades, GVA increased at a faster rate than water-use in these countries, especially in non-agricultural sectors, which tend to have a much higher WUE compared to agriculture. Furthermore, if per capita water-use is considered, in recent years a slightly decreasing trend may be observed in a few newly-industrialized countries as well (e.g. South Africa, Turkey, Mexico).

The results of indicator 6.4.1 and their evolution over time, especially in the major developed economies, appear to be consistent with the main findings of much of the literature on the relationship between economic growth and water-use. As discussed in section three, part of this literature seems to corroborate the hypothesis of an inverted U-shape relationship – known as Environmental Kuznets Curve (EKC) - between water-use and economic growth. In particular, some studies (e.g. Duarte *et al*., 2013) have concluded that, at the lowest level of per capita income, an increase in average income appears to boost water-use. As per capita GDP increases, water-use per capita tends to decrease, thanks to a mix of technical, managerial and institutional developments resulting in an increase in water-use efficiency, combined with improvements in irrigation systems and advances in environmental regulation.

In section four, the evolution in water-use and water-use efficiency in the aforementioned regions, countries and sectors was then put in relation with trends related to water access and, more precisely, access to safe drinking water, which is addressed under SDG target 6.1 and the related indicator 6.1.1 ("Proportion of population using safely managed drinking water services"). The analysis presented in section four focused on the nine countries that managed to more than halve the proportion of the poorest without access to safe drinking water between 1995 and 2012. In these countries, water-use and especially municipal water-use increased during the same period in order to enable the aforementioned progress. Even though, all else equal, this contributed to lowering WUE in services, overall WUE continued to increase in these countries.

In order to illustrate some of the trends and issues discussed above, in section five a country example was presented, focusing on Spain, which underwent an important economic development process in a relatively short period of time, and for which adequate time-series data is available. Overall, the data presented show a decoupling of economic growth from water-use in Spain starting in the 1980s, with significant improvements in water-use efficiency in the services sector and especially in MIMEC.

References

AQUASTAT. [Accessed on 26 June 2019]. http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en

Duarte, R., Pinilla, V. & Serrano, A. 2013. Is there an environmental Kuznets curve for water-use? A panel smooth regression approach. *Economic Modelling*, 31: 518-527.

Eurostat. *Water Statistics*. [Accessed on 26 June 2019]. https://ec.europa.eu/eurostat/statistics-explained/index.php/Water_statistics

Hoekstra, A.Y. & Hung, P.Q. 2002. Virtual water trade. A quantification of virtual water flows between nations in relation to international crop trade. *Value of water research report series No. 11*. UNESCO-IHE [online]. http://www.waterfootprint.org/Reports/Report11.pdf [accessed 2 May 2019].

Miglietta, P.P., De Leo, F. & Toma, P. 2017. Environmental Kuznets curve and the water footprint: an empirical analysis. *Water and Environment Journal*, 31: 20-30.

Kuznets, S. 1955. Economic Growth and Income Inequality. *The American Economic Review*, 45(1): 1-28.

Sebri, M. 2016. Testing the environmental Kuznets curve hypothesis for water footprint indicator: a cross-sectional study. *Journal of Environmental Planning and Management*, 59(11): 1933-1956.

UNICEF & WHO. 2015. *Progress on Sanitation and Drinking Water – 2015 Update and MDG Assessment*. Geneva: World Health Organization (WHO). https://apps.who.int/iris/bitstream/handle/10665/177752/9789241509145_eng.pdf;jsessionid=E6D6BF3715C16ACAE272F67300A5F198?sequence=1

United Nations Statistics Division (UNSD). National Accounts – Analysis of Main Aggregates (AMA). (Accessed on 26 June 2019). https://unstats.un.org/unsd/snaama/

World Bank. DataBank. [Accessed on 26 June 2019]. https://databank.worldbank.org/home.aspx

The purpose of this document is to provide suggestions for the interpretation of the indicator 6.4.1. In particular, it focuses on the concept of economic decoupling from water-use, and its application in policy making.

The evolution in water-use and water-use efficiency in four selected regions: Europe, Latin America and the Caribbean, Southeast Asia and Sub-Saharan Africa, is discussed. Particular attention is given to the evolution in water-use, water-use efficiency and related drivers in two groups of countries, including major developed economies and newly industrialized countries, and in different economic sectors.

The relation of water-use efficiency with economic growth and access to safe drinking water is analyzed and discussed in the context of the literature on the Environmental Kuznets Curve applied to water resources. A country-based example is presented to illustrate some aspects of these issues and a few concluding remarks are provided.

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ISBN 978-92-5-131723-5

CA5400EN/1/08.19