WATER FOOTPRINT IN PORTUGAL

Securing water for people and nature

WWF Mediterranean, 2010
Index

Executive Summary .......................................................................................... 3
1. WWF approach to Freshwater ........................................................................ 4
2. Water: a scarce resource in the Mediterranean .............................................. 6
3. The Water Footprint assessment tool ............................................................... 8
   3.1. Background ............................................................................................. 8
   3.2. Objectives ............................................................................................... 9
   3.3. Concepts ................................................................................................. 10
4. Water Resources and Water Footprint in Portugal ..................................... 13
   4.1. Water Resources in Portugal - waste and imbalance .............................. 13
   4.2. The Portuguese Water Footprint components ....................................... 13
   4.3. Case Study - olive trade with Spain ....................................................... 23
5. Conclusions - when Water calls for Stewardship ........................................ 29
   5.1. Sectorial results ...................................................................................... 30
   5.2. Environmental relevance ....................................................................... 31
Acknowledgements .......................................................................................... 34
References ......................................................................................................... 34
Executive Summary

The Water Footprint of a country is the volume of water used globally to produce the goods and services consumed by its inhabitants. It’s a monitoring tool that enables the assessment of the huge virtual water volume embedded in most products traded across the world.

The Living Planet Report published by WWF in 2008 has shown that Portugal has the 6th largest Water Footprint per capita in the world, topping the list with other Mediterranean countries. It also pointed that freshwater biodiversity is declining more rapidly than terrestrial and marine biomes, because of over-abstraction, habitat loss, and poor governance.

The analysis conducted herein provides a framework analysis of water resources in Portugal, presents the Water Footprint tool applying it to the Portuguese reality, and assesses its significance for a sustainable use and management of water resources.

The report highlights the fact that Portugal is the European country with the highest amount of water withdrawn for agricultural uses per capita, a sector that uses most of the overall water demand. These two facts show that water use efficiency is quite low, and agriculture is the key sector for reducing the national Water Footprint.

The report’s major results also show that the most important crops in terms of water consumption are olives, maize and grapes, more than half of the national Water Footprint comes from imported goods, and all trade sectors analysed (crops, livestock, industry) are net virtual water importers. Also there are large internal regional differences, with significant water scarcity problems in the south, and particularly in the Guadiana Basin.

It is proposed that Portugal can reduce its national Water Footprint through increased public participation, stakeholders’ involvement and empowerment of citizens on environmental matters, a long-term key to achieve a sustainable use of water resources. The concept of Water Stewardship is suggested as a policy process of methods and standards, fostering a social and environmentally responsible use of water.
1. **WWF approach to Freshwater**

This Report provides a brief framework analysis of water resources in Portugal, in the context of the Mediterranean region, presents the Water Footprint tool and its application to the Portuguese reality, and assesses its significance for a sustainable use and management of water resources.

The Living Planet Report published in 2008 shows that freshwater biodiversity is declining more rapidly than the terrestrial and marine biomes. The primary causes are clear: massive over-abstraction of water for water intensive crops, sprawling urban areas and growing population, and habitat loss due to infrastructure development and urbanisation. Poor governance models, weak water management institutions, and climate change, are all factors contributing to exacerbate imbalances and to create new challenges.

**Freshwater biodiversity is declining more rapidly than the terrestrial and marine biomes, due to water over-abstraction for thirsty crops and cities and habitat loss for infrastructures**¹.

WWF considers that Water Footprint analysis is a fundamental tool to improve water access, efficiency and allocation for people and the environment. In order to achieve WWF’s Vision on **securing water for people and nature** in priority river basins, three pillars of work have been proposed:

¹ WWF, 2008
1) Promoting Water Stewardship\textsuperscript{2} to Reduce Water Footprint Impacts on WWF’s priority river basins, while meeting the needs for business and agriculture development;

2) Promoting Responsible Water Infrastructure and Securing Sustainable Flows, to safeguard hydrological regimes that freshwater flora and fauna rely on, while meeting water demands for basic needs, social purposes and economic development;

3) Protecting Representative Freshwater Habitats, and where possible, establishing freshwater conservation networks in WWF’s priority river basins, to secure freshwater dependant flora and fauna.

The Living Planet Report also pointed that Portugal has the 6th largest Water Footprint \textit{per capita} in the world. The global causes of freshwater decline are also true for Portugal: over-abstraction, habitat loss, poor governance. There is a clear need to link these issues with the footprint concept, finding ways of reducing it, and finding where, who, and how this reduction should occur.

\begin{quote}
\textbf{In Portugal, WWF works on securing water for people and nature by promoting water stewardship and protecting freshwater habitats.}
\end{quote}

\begin{footnotesize}
\textsuperscript{2} Water stewardship refers to the process of making water users responsible for a socially beneficial and environmentally sustainable use of water resources.
\end{footnotesize}
2. **Water: a scarce resource in the Mediterranean**

Although facing the Atlantic, Portugal lies within the Mediterranean region, subject to a particular climate that occurs in only 3% of the Earth’s surface. The Mediterranean climate is characterised by two major features:

- a strong precipitation variability, with short but intense rainfall events, frequent dry spells, and occasional long-term drought events;

- a dry season coinciding with the warm season (summer).

These two features are dominant across the whole country, albeit the regional differences: the northwest is subject to a strong Atlantic influence, with a short dry season and high average precipitation values, while the southeast is subject to semi-arid conditions, with sub-tropical traces on the south coast.

In summer, when water supplies are strongly reduced, water demand raises substantially, both for crop irrigation and for urban supply needs. Such seasonal imbalance is increased by massive tourism flows to the coastal regions, as is particularly the case for the southern Portuguese Algarve.

This natural and man-made pattern of variability and scarcity is aggravated by:

- continuous **growth in demand** due to unsustainable economic and social development, based on an intensive and inefficient use of energy and natural resources;
- water management practices based on an increasing network of supply infrastructures, favouring consumption and waste;

- climate change, which has reduced water availability due to increased temperature and evapotranspiration, and reduced run-off.

In Portugal, as in the rest of EU Mediterranean countries, these trends are slowly being tackled as water policies become increasingly integrated, and further oriented towards sustainability, demand management, and climate change mitigation. The Water Framework Directive (WFD), in force at EU level since 2000, represents the greatest policy effort in that direction, but major challenges still lay ahead to most countries.

One of these challenges relates to the accountancy used in the economics and management of water resources. So far, accounting has been restricted to the direct abstraction of water (for urban supply, industry, irrigation, etc.) - the challenge now, is to account on the water used for the production of all goods that are traded and consumed all over the world. This will enable the assessment of the huge virtual water volume embedded in most products traded across the world, either based in countries, regions, or river basins. Such volume is particularly high for agricultural crops that use large amounts of rain water that otherwise would be available for other uses.
3. **The Water Footprint assessment tool**

3.1. **Background**

The fact that pushed this report forward came from the Living Planet Report issued by WWF in 2008. In the section “Water footprint of consumption”, Portugal ranked 6th among all 140 countries assessed. Furthermore, there were five Mediterranean countries (Greece, Italy, Spain, Portugal, Cyprus) in the top 10 of the list, suggesting a potential regional pattern. Since then, WWF Mediterranean has developed significant efforts to deepen its knowledge on the reasons for such critical consumption.

Contrarily to other EU and OECD developed countries, Portugal water use keeps rising steadily, following the country’s strong economic growth after EU accession (1986-2000), and its rapid urbanisation and modernisation in the last four decades. Unfortunately, such development has been based on an intensive and inefficient use of energy and natural resources. Households, industries, businesses, and mainly agriculture, have all contributed to such increase. Water use efficiency has only recently become a policy target and a clear environmental goal, namely after the severe 2004-06 drought event.

Furthermore, such amount of water only represents a small portion of the water used on a daily basis. A considerably higher portion is hidden in food, clothes and other products consumed in everyday life - the so called virtual water. In combination with data on water sources and information on the consequences of its abstraction, one may refer to the concept of Water Footprint (WF).

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3 MAOT, 2000; PCM, 2006
Like most of the other Mediterranean countries, a large part of Portugal’s WF is external, which is of great interest and significance in the context of globalisation and European integration. Since Portugal imports a large amount of the water consumed in everyday life, it is important to know which countries are affected by this virtual water trade, and which products represent the greatest water consumption. In fact, conclusions from a number of studies show that the impacts of global trade on regional water systems are at least as severe as the consequences of climate change\(^4\). This external dimension of Portugal WF is the subject of a first approach in the case study “Olive Trade with Spain”, presented in Chapter 4.3 of this report.

### 3.2. Objectives

Based on the available estimations of Portugal WF (such as those used for WWF’s Living Planet Report), WWF’s main goal for this study is to analyse Portugal’s water use and WF more accurately, and to assess its meaning for water management and responsible consumption. The analysis of the vast data sets behind this study is a strong argument for governments, companies and citizens to reduce the ecological, social and economical consequences of their WF. Thus, this study intends to call public attention to the overall use of water in Portugal, based on the concepts of virtual water and WF.

For WWF, the concept of WF is a crucial tool to raise awareness on effective water consumption, and thus to increase its efficiency and mitigate the consequences of water waste, pollution, and scarcity.

\(^4\) WWF, 2007
By telling who, where and what is using more water to support its consumption standards, Water Footprint analysis shall contribute to achieve responsible water management, thus securing water for people and nature.

This report does not aim that citizens, companies or whole countries reduce their consumption per se, but rather that they increase their efficiency in using the water needed for their activities. It is rather important that the reduction, through increased efficiency, takes place where high virtual water consumption has the strongest negative consequences for people and nature.

The aim is to increase efficiency by water users at the national level, and to reduce virtual water import through responsible consumption.

3.3. Concepts

The WF of a country is the total volume of water used globally to produce the goods and services consumed by its inhabitants. It includes water withdrawn from rivers, lakes and aquifers (surface and groundwater), that is used by irrigation agriculture, industry, households and others, as well as rainfall water that is used to grow crops.
“The total WF of a country is made up of two components: the internal WF is the volume of water needed to grow and provide the goods and services which are produced and consumed inside that country; the external WF results from consumption of imported goods, or in other words, water that is used for the production of goods in the exporting country. A country’s exports are not included as part of its WF.

Worldwide, the external WF accounts for 16% of the average person’s water footprint, though this varies enormously within and between countries. 27 countries have an external WF which accounts for more than 50% of their total (including Portugal and several other EU countries). The world average WF is 1.24 million litres per person per year; equivalent to half the volume of an Olympic swimming pool.

The impact of a WF depends entirely on where and when water is extracted. Water use in an area where it is plentiful is unlikely to have an adverse effect on society or the environment, whereas in an area already experiencing water shortages the same level of water use could result in the drying up of rivers and the destruction of ecosystems, with associated loss of biodiversity and livelihoods.

Externalizing the WF can be an effective strategy for a country experiencing internal water shortages but it also means externalizing environmental impacts. The virtual water trade is influenced by global commodity markets and agricultural policies which generally overlook the possible environmental, economic and social costs to exporting countries. This trade in virtual water further underscores the need for international cooperation on water resource management in a context where some 263 of the world’s major rivers and lakes and hundreds of aquifers cross borders.”

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5 WWF, 2008
Figure 1 shows schematically which components make up the WF of Portugal. On one hand, there is the water directly used in households for cooking, cleaning and washing. On the other hand there is an indirect water consumption, which is calculated adding the national water resources used for the production of goods consumed in the country (Internal Water Footprint, IWF), to the water used in other countries for the production of goods which then are exported to and consumed in Portugal (External Water Footprint, EWF). Together, direct and indirect water consumption makes the total WF of Portugal.

Figure 1 - Scheme of the components that are taken into account for the calculation of the national Water Footprint
4. Water Resources and Water Footprint in Portugal

4.1. Water resources in Portugal - waste and imbalance

Portugal has relatively abundant water resources, especially in the context of the Mediterranean region.

With an average annual volume of 6.87 hm$^3$ of renewable water resources per capita, Portugal ranks 2$^{nd}$ among the 6 southern EU countries (Portugal, Spain, Italy, Malta, Greece, Cyprus), only behind Greece$^6$. Nevertheless, this average hides a high dependency on external water resources, and important internal imbalances.

External dependency relates to the fact that transboundary basins include 45% of the Iberian Peninsula territory (64% of Portugal and 42% of Spain), including the river basins of Minho, Lima, Douro, Tejo (Tagus) and Guadiana. For Portugal its significance is even higher, due to its particularly fragile geographic position (downstream), and to the fact that 67% of its surface water resources come from transboundary basins (20.300 out of 30.400 hm$^3$), while that value in Spain is only about 39%$^7$.

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$^6$ Hoekstra & Chapagain, 2004
$^7$ INAG, 2001
Internal imbalances are mainly geographical and sectorial. In geographic terms, the SW-NE mountain ridge system of Sintra-Montejunto-Estrela (slightly north of the Tagus river) broadly splits the country between the humid Atlantic northwest, and the dry Mediterranean southeast (Figure 2). The sectorial imbalance refers to the high importance of agriculture as the main water consumer, responsible for over two thirds of all water withdrawals - a feature shared with its Mediterranean neighbours, where agriculture is dependent on summer irrigation, as a consequence of a warm growing season that coincides with the dry season.


Figure 2 - Hipsometric map of Portugal, highlighting the mountainous system of Sintra-Montejunto-Estrela
In fact, the agricultural sector uses 78% of the overall water demand in Portugal (in Europe it is only surpassed by Greece, with 81%). Furthermore, it is the European country with highest amount of water withdrawn for agricultural uses \textit{per capita} (with 880 m$^3$/p.c.), only surpassed in the Mediterranean region by Syria (1.169), as shown in Figure 3.

Source: Clark & King, 2004

\textbf{Figure 3 - Water withdrawn for agricultural uses \textit{per capita} (m$^3$)}

\textbf{Portugal is the European country with the highest amount of water withdrawn for agricultural uses \textit{per capita}, and the sector uses 78% of the overall water demand. With a quite low level of water use efficiency, agriculture is the key sector for reducing the national Water Footprint.}
Nevertheless, the overall water abundance in the country has fed a management strategy based on a ever-increasing supply from water infrastructures (dams, boreholes, channels), thus supporting inefficient and wasting uses.

The governmental authorities have recently (2008) approved a hydropower development programme, based on the fact that Portugal is only using about 46% of its hydroelectric potential. The target is to reach 70%, closer to the level of its European partners and competitors (Spain is using 85%, Italy, Germany and France about 95%)\(^8\). Although energetically sound, this programme will pose heavy costs to freshwater habitats, and contributes to the “supply increase” strategy previously mentioned, rather than contributing to increase sustainability and water use efficiency.

A National Programme on Water Use Efficiency was drafted in 2000, but never came into practice. It was revised in 2005 following a severe drought period, but according action was never taken. Currently, most effective gains in

\(^8\) [http://pnbeph.inag.pt/np4/sobre](http://pnbeph.inag.pt/np4/sobre)
efficiency relate to the replacement and renewal of old urban supply infrastructures, funded by the European Cohesion Fund, and by several scattered measures foreseen in the Rural Development Programme, with funding granted only to investments oriented towards greater water use efficiency (according to the recent EU principle of environmental cross-compliance).

4.2. The Portuguese Water Footprint components

Table 1 presents the values estimated for blue, green, and grey water (see below for definitions) that can be used to calculate the national Water Footprint (WF) of Portugal.

It is important to acknowledge that these estimation values are based on average values calculated for the whole country, and therefore hide significant differences and variations between regions and river basins. Only a regional analysis could overcome this gap, recalculting virtual water content values based on crop locations, and on regional climatic, hydrologic and agronomic parameters.

<table>
<thead>
<tr>
<th></th>
<th>Blue</th>
<th>Green</th>
<th>Grey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td>6.21</td>
<td>1.09</td>
<td>0.6</td>
</tr>
<tr>
<td>Urban supply</td>
<td>2.03</td>
<td>8.00</td>
<td>10.55</td>
</tr>
</tbody>
</table>

Source: Hoekstra and Chapagain, 2004

It is also crucial to understand that the values presented in Table 1 don’t add up; they simply refer to different types of water use, as explained hereafter.
**- Blue Water:**

These values refer to the direct abstraction of water from internal surface and groundwater sources (mainly reservoirs and aquifers). It is the volume accounted for in traditional water resources management, and is directly dependent on the hydrologic variables that regulate the water cycle (precipitation, runoff, infiltration, evaporation, and others). Agriculture is by far the largest water user, with a great imbalance between northern and southern regions (where the relative share of agriculture is even higher).

**- Green Water:**

These values refer to rainfall water used for crop evapotranspiration. It is directly dependent on precipitation, potential evaporation, and crop requirements. It includes the value of blue water that does not percolate (data not available). The strong external food dependency of Portugal explains why imported products have such a large share on the nation’s WF.

**- Grey Water:**

Refers to the volume of clean water needed to dilute or purify polluted and wastewater. Few analyses have deepened this concept, as it is quite dependent on the numerous chemical parameters of such waters, and its monitoring is quite poor. The value presented is merely informative, and is just an estimation of the overall drainage of wastewater\(^9\). The true grey water value is unknown, but is expected to be significantly higher.

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\(^9\) The national INSAAR Report (INAG, 2008) presents a total national value of 481 hm\(^3\)/yr; considering the same rate of drainage and treatment as in domestic sewage (±80%), the present value is obtained.
Table 2 shows the total WF of Portugal by sector. The green water (in Table 1) corresponds to the WF of agriculture (in Table 2), and the blue water for urban supply corresponds to the WF of households. Part of the blue water in agriculture (the one that doesn’t percolate) is included in the internal green water value for the sector. Thus, the only difference between the two tables is in the industrial sector, because a part of the sector water use (blue water, in Table 1) is exported in industrial products (0.62 km³) - this results in the value of internal WF presented in Table 2.

Table 2 - Total Water Footprint of Portugal by sector (km³/yr)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Internal</th>
<th>External</th>
<th>Total</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>8.00</td>
<td>10.55</td>
<td>18.55</td>
<td>82</td>
</tr>
<tr>
<td>Industry</td>
<td>1.41</td>
<td>1.59</td>
<td>3.00</td>
<td>13</td>
</tr>
<tr>
<td>Households</td>
<td>1.09</td>
<td>-</td>
<td>1.09</td>
<td>5</td>
</tr>
<tr>
<td>Total (km³/yr)</td>
<td>10.50</td>
<td>12.14</td>
<td>22.64</td>
<td>100</td>
</tr>
<tr>
<td>% of total</td>
<td>46</td>
<td>54</td>
<td>100</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Hoekstra and Chapagain, 2004

The total WF of Portugal is 22.64 cubic kilometres (km³) per year, representing a per capita WF of 2264 m³/yr. More than half of this WF comes from imported goods (an external WF of 1214 m³/cap/yr, compared to an internal WF of 1050 m³/cap/yr). This means that most water needed to produce the goods consumed in Portugal comes from external water resources.

More than half of Portugal Water Footprint comes from imported goods.

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10 1.41 (internal industrial WF) = 2.03 (industrial blue water use) - 0.62 (exported industrial WF)
As a total, 18.55 km³ are used each year in agriculture, 3.00 km³ for the production of industrial products and only 1.09 km³ are used in households. Converted to the country’s population, this makes a daily water consumption of 6203 litres per capita, of which only 299 litres are for domestic use.

With the exception of such water used in households, these numbers include the water volume used within Portugal (internal WF), as well as the amount of water that was used in other countries for the production of goods supplying the Portuguese market (external WF).

Based on the virtual water flows, the WF can be analysed in terms of major crop products (Figure 4).

As shown in Figure 4, the most important crops in terms of average annual water consumption are olives, maize and grapes. In fact, olive groves (with

* both for food and forage

Source: Hoekstra and Chapagain, 2004

Figure 4 - Total volume of water used for crop production in Portugal (annual average in hm³ 1997-2001)
2320 hm$^3$) and vineyards (1370 hm$^3$) are traditional Mediterranean permanent crops, highly significant both in terms of land and water use, and in terms of national economy. Together with maize (both for food and forage), olive groves and vineyards account for over half (55.5%) of total water consumption by agricultural production in Portugal, and point a direction on where to put saving and efficiency efforts in the sector.

Albeit the importance of crop production in the overall national WF, Table 3 shows that Portugal is a net virtual water importer in all trade sectors analysed - crops, livestock, and industry.

Table 3 - Virtual water flows of Portugal related to the international trade of crop, livestock and industrial products (average annual volume in hm$^3$, 1997-2001)

<table>
<thead>
<tr>
<th>Virtual water flows</th>
<th>Export</th>
<th>Import</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop trade</td>
<td>2633</td>
<td>9631</td>
<td>-6998</td>
</tr>
<tr>
<td>Livestock trade</td>
<td>780</td>
<td>2856</td>
<td>-2076</td>
</tr>
<tr>
<td>Industrial trade</td>
<td>1320</td>
<td>2287</td>
<td>-967</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4733</strong></td>
<td><strong>14774</strong></td>
<td><strong>-10041</strong></td>
</tr>
</tbody>
</table>

Source: Hoekstra and Chapagain, 2004

When compared to its major Mediterranean partners, Portugal clearly has a higher external WF in relation to its internal one (Table 4). This relation provides a measure of the country’s self sufficiency and virtual water import dependency - which is depicted in Figure 5, and confirms the fragile position of Portugal, mainly dependent on Spain’s water resources.
Table 4 – Renewable water resources and Water Footprint in major EU Mediterranean countries (Gm3/year)

<table>
<thead>
<tr>
<th>Country</th>
<th>Total renewable water resources</th>
<th>Internal water footprint</th>
<th>External water footprint</th>
<th>Total water footprint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portugal</td>
<td>68,70</td>
<td>10,50</td>
<td>12,13</td>
<td>22,63</td>
</tr>
<tr>
<td>Spain</td>
<td>111,50</td>
<td>60,38</td>
<td>33,60</td>
<td>93,98</td>
</tr>
<tr>
<td>Italy</td>
<td>191,30</td>
<td>65,93</td>
<td>68,67</td>
<td>134,59</td>
</tr>
<tr>
<td>Greece</td>
<td>74,25</td>
<td>16,41</td>
<td>8,80</td>
<td>25,21</td>
</tr>
</tbody>
</table>

Source: Hoekstra and Chapagain, 2004

Figure 5 also represents the national water scarcity value of each country, as a measure of the relation between renewable water resources and the national WF. When compared to other Mediterranean countries, Portugal’s water scarcity rate of 33% seems relatively low, but it hides a strong imbalance between northern and southern regions, with acute scarcity problems increasing in importance and severity in the drier South11.

Source: Hoekstra and Chapagain, 2004

Figure 5 - Water scarcity and water import dependency (%) in major EU Mediterranean countries

11 Aldaya & Llamas, 2008
4.3. **Case Study - Olive trade with Spain**

In a country like Portugal, where more than half of its WF is external (54%), it is crucial to understand how imports impact water resources worldwide. This type of analysis has been conducted for several pioneer countries, such as the UK, Belgium and Germany, and is being further prepared by WWF for several other countries, including Portugal. It demands a very extensive and detailed process of calculations, which will take some more time before becoming fully available.

Hereafter, and as a first step on this analysis, a case study is presented based on the virtual water flow between Portugal and Spain for a major Mediterranean crop - olives. As shown in the previous section (Figure 4), **olive groves are the crop that uses more water in absolute terms within Portuguese agriculture.** Still, the country is not self-sufficient and imports a large part of its consumption from Spain, its neighbour and the world’s largest olive oil producer and exporter.

In fact, 95% of the global olive oil production is from the Mediterranean Region, 76% being from EU countries alone (Table 5).

Furthermore, Spain is Portugal’s major trade partner, accounting for 29.5% of its imports, and 26.7% of its exports - although agricultural products represent only 8.8% of Portugal’s imports, and 3.2% of its exports\(^\text{12}\).

\(^\text{12}\) INE, 2003
Table 5 - World’s largest olive oil producers (production estimations data for 2009)

<table>
<thead>
<tr>
<th>Country</th>
<th>Area* (10³ ha)</th>
<th>Production** (10³ tons)</th>
<th>% global production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>2424</td>
<td>1150</td>
<td>40.9</td>
</tr>
<tr>
<td>Italy</td>
<td>1431</td>
<td>560</td>
<td>19.9</td>
</tr>
<tr>
<td>Greece</td>
<td>1026</td>
<td>370</td>
<td>13.2</td>
</tr>
<tr>
<td>Syria</td>
<td>-</td>
<td>155</td>
<td>5.5</td>
</tr>
<tr>
<td>Turkey</td>
<td>-</td>
<td>141</td>
<td>5.0</td>
</tr>
<tr>
<td>Tunis</td>
<td>-</td>
<td>129</td>
<td>4.6</td>
</tr>
<tr>
<td>Morocco</td>
<td>-</td>
<td>79</td>
<td>2.8</td>
</tr>
<tr>
<td>Portugal</td>
<td>529</td>
<td>50</td>
<td>1.8</td>
</tr>
<tr>
<td>Algeria</td>
<td>-</td>
<td>39</td>
<td>1.4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>-</td>
<td>2679</td>
<td>95.3</td>
</tr>
</tbody>
</table>

*Source: Beaufoy (2000)


The world consumption of olive oil has been growing steadily, at an average yearly rate of 3.2% over the last 15 years\(^{13}\). Relating total production with the area occupied by olive groves, Table 5 shows that Portugal presents a particularly low productivity when compared to its European partners. Still, intensive irrigated olive groves have been expanding over marginal lands, wherever water is available (Figure 6). That has been particularly the case for the Portuguese part of the Guadiana shared river basin (in the southern region of Alentejo), and its new Alqueva irrigation perimeter, which aims to irrigate over 110,000ha up to 2013\(^{14}\). Preliminary data estimates that over the last decade, olive groves in the Portuguese Guadiana basin alone have expanded over 30,000ha (i.e. over 6% of the total national production area)\(^{15}\).

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\(^{14}\) [www.edia.pt](http://www.edia.pt)

\(^{15}\) MUSA Research Project (Land Use Changes in Alentejo), e-GEO ([http://e-geo.fesh.unl.pt/00335.asp](http://e-geo.fesh.unl.pt/00335.asp)). Remote sensing data analysis has accounted for 28,675ha of new olive groves, in the municipalities where the Alqueva irrigation perimeter is being implemented and between 2000 and 2006 alone.
The Guadiana River Basin, shared between Portugal and Spain, is a hotspot of biodiversity within the Mediterranean bio-geographic region. It is one of the most water stressed European basins, mostly subject to semi-arid environmental conditions. The lower basin is still in a semi-natural condition, with high conservation values both in terms of species and habitats. The conflict for water use is a key issue within this region. Intensive agriculture growth demands an increasing water supply. Stopping the loss or deterioration of freshwater ecosystems and promoting the recovery of riparian ecosystems of the Guadiana river basin are key goals within WWF programme.
Much of these new investments have been promoted by agro-industrial corporations, many of which based in Spain. This is causing some latent conflict as Portuguese farmers claim that water and land is being taken by the Spanish - an old argument for old disputes over water between the two countries.

These investments are also causing environmental concern, as its intensive farming methods tend to be water-, pesticide- and fertilizer-dependent, natural drainage networks are oversimplified and natural vegetation is ripped-off. This may disrupt the water cycle, increase soil erosion, and seriously affect local biodiversity.

Intensive agriculture is water, pesticide and fertilizer dependent, and oversimplifies the ecosystem by drainage and vegetation rip-off. This may cause water cycle disruption, soil erosion and biodiversity loss.

If we look at trade data between Portugal and Spain on olive oil (Table 6), we can confirm that Portugal is a net importer (60324 tons. in 2007). This represents a net import of virtual water of 851 hm³. For olives alone, the figures are much lower, but still represent a net import of 6993 tons (2007), accounting for a net import of virtual water of 17 hm³.
Virtual water trade on olive products between Portugal and Spain represents over one fifth of the Alqueva dam capacity - that’s how much virtual water Portugal imports from Spain in olive products alone.

Other commercial partners have residual trade values only, when compared to those of Spain, and therefore are not analysed in this report.

Soil erosion is probably the most serious environmental problem associated with olive farming, apart from olive processing, which is by far the most serious problem of olive oil production, due to water pollution caused by residual wastewaters\(^\text{16}\).

Inappropriate weed-control and soil-management practices, combined with the inherently high risk of erosion in many olive farming areas, may lead to desertification on a wide scale in some of the main producing regions (Alentejo and Trás-os-Montes), as well as considerable run-off of soils and agro-chemicals into water bodies.

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\(^{16}\) Beaufoy, 2000
Still, a simplified vision on the sector water use should be avoided, as many other factors should be taken into account when addressing environmental sustainability of specific crops. For instance, **traditional olive groves often represent high value in terms of biodiversity, local employment, landscape and cultural heritage.** On the other hand, **modern intensive olive groves show great production resilience (low risk), and high economic productivity of blue water.** All these factors should be put in balance when assessing options for a more efficient water use.
5. **Conclusions - when Water calls for Stewardship**

This report is a first approach to the concept of Water Footprint (WF) and to its relevance and applicability to Portugal. Its main goal is to apply the WF tool to the current availability and use of water resources in the country, and to highlight its significance for an appropriate water management and stewardship.

Some of the most relevant conclusions that can be withdrawn from this report are summarized hereafter.

1. **The agriculture sector is by far the most significant in terms of Portugal WF, and it presents a very low water use efficiency;**

2. **More than half of Portugal WF is virtual water from imported agricultural goods, depending quite significantly from Spain;**

3. **Portugal has large internal regional differences, with significant water scarcity problems in the south, and particularly in the Guadiana Basin, where a large irrigation scheme is being implemented.**

Other significant aspects highlighted in the report are that:

- the natural seasonal and geographic imbalance between water supply and demand in Portugal, is being aggravated by an ever-rising demand, a pattern of high consumption and waste, and climate change;
- the country strong external water dependency and footprint requires further in-depth studies that allow a better understanding of its Water Footprint;

- in the agricultural sector, three crops (olives, maize, and grapes) represent more than half of total consumption.

It should be acknowledged that most values presented herein are estimations, with a high degree of uncertainty. Such estimations and calculations are based on specific methods that cause results to differ significantly between different authors’ approaches. For example, crop water requirements for the same location may vary up to 100% according to the methodology used; average climatic data used for the whole country hides significant regional variation; the inventory of water users and consumption by irrigation is recognised as inaccurate, and lacking data from a great number of illegal and unregistered users\(^\text{17}\).

To overcome such high level of uncertainty it is very important to act on two sides: one is to further develop the WF tool and related background concepts and methods; the other is to increase metering and monitoring in both direct and indirect water uses.

### 5.1. Sectorial results

Although irrigation agriculture is by far the largest consumer of both blue and green water, its economic productivity is by far higher than that of rainfed agriculture. Also, if the economic productivity of blue water is considered, then urban water supply, industrial and energetic production all have higher values than agriculture. This may help to justify why significant efforts have

\(^\text{17}\) Aldaya & Llamas, 2008
been put into improving water use efficiency in the former sectors, rather than in agriculture.

Nevertheless, while both industrial and urban uses are strictly controlled and concentrated in space, agricultural water use is widespread and diffuse, directly affecting sensitive habitats and putting pressure on local resources. Therefore, it is now time to concentrate the efforts of increasing water use efficiency in for the agricultural sector, thus reducing its WF. Still it’s important to recall that a large part of the agricultural WF is external, which can be reduced through appropriate water stewardship, consumers’ awareness and personal choices of responsible consumption.

With the exception of the growing livestock production, there seems to be a significant trend in the agricultural trade balance towards increasing import of low-value, high water-consuming crops (such as cereals and dairy products), and increasing export of high-value, low virtual-water content crops (such as vegetables and fruits, including grapes and olives for wine and olive oil). This may reduce the pressure on local (green and blue) water resources that can be used to provide ecological services and other more profitable uses\(^\text{18}\) - but ultimately contributes to an increased external WF. That is only a problem if producing regions are water scarce, which calls for a detailed analysis of the external WF.

### 5.2. Environmental relevance

The major causes for the acute decline observed recently in freshwater biomes have been identified, and were presented early in this report: over-abstraction, habitat loss and poor governance.

\(^\text{18}\) Aldaya & Llamas, 2008
In Portugal, over-abstraction is only evident in particular isolated cases of dams (e.g. Roxo, in Alentejo) and aquifers (e.g. Campina de Faro, in Algarve). Unfortunately, most of these cases occur in the semi-arid south, where water scarcity is already a problem and where droughts occur with higher frequency and severity. The hydraulic paradigm that seeks solution to these issues by continuously increasing supply is still dominant among both decision makers and water users - forgetting that annual, usable freshwater resources are finite. Furthermore, water demand hasn’t stopped covering such increases in supply, which are mainly attained at the expenses of fragile ecosystems.

Freshwater habitat loss has been a reality for many centuries, but increased tremendously during last century, mainly because of industrialisation, infrastructure construction, and increasing consumption. Recently it has been recognised that the environmental services provided by such habitats are priceless, and if for no other reason, should be strictly protected. The implementation of the WFD is expected to contribute to reverse the current trend, but little has been achieved since its approval in 2000.

Poor governance may well be the ultimate cause for this situation. The institutional model and architecture were reshaped, funding has been steadily provided, expertise skills and know-how have been fostered - still the management of water resources is inefficient and wasteful. Public participation and awareness, stakeholders’ involvement, and ultimately the empowerment of citizens on environmental matters, may well constitute the key for Portugal to achieve the WFD’s goals, thus protecting its water resources and sustaining its use. This is where and why the concept of Water Stewardship may be of crucial importance, as a policy process based on globally accepted methods and standards, fostering a social and environmentally responsible use of water resources.
Companies and public authorities should develop measures to implement and account water use based on the virtual water concept, in order to increase water use efficiency, reduce water consumption, and reduce the impacts of misuse.

**Water Stewardship** can be seen as the policy framework and Water Footprint as the tool to address the impacts of human activity on global water resources, on a thorough and effective manner, properly balanced between the countries of the world.

At the global scale, the discussion on water use and scarcity also means food availability and production. Both are intimately related and should be jointly discussed.

Based on the Virtual Water concept, **Water Footprint** has broadened the water cycle analysis from a regional scale (such as river basins) to the global scale, through global trade. It is an entire new dimension that will change the way we look into the sustainable use of water.

**Water Stewardship** is the path for water users to take responsibility and receive due credit for improving water management practices, right across their water usage cycle. Specific aims of the Water Stewardship Initiative process are to establish widely endorsed standards for responsible and sustainable water use, define criteria and translate these into verification programs, and establish certification systems.

Establishing such an international initiative calls for the participation of citizens, companies and governments - and the Portuguese situation demands an active participation of its national stakeholders.

This report is a first approach to the concept of Water Footprint and to its relevance and applicability to Portugal. Further development of this analysis will be pursued with the 2010 edition of the Living Planet Report, to be launched in the last quarter of this year.

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**References**


UN - United Nations Comtrade Database, DESA/UNSD. [online]
http://comtrade.un.org/db/

WWF (2007) - More rice with less water. [online]

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WWF’s mission is to stop the degradation of the planet’s natural environment and to build a future in which humans live in harmony with nature, by:

- conserving the world’s biological diversity
- ensuring that the use of renewable natural resources is sustainable
- promoting the reduction of pollution and wasteful consumption.

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