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The water footprint of France

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THE WATER FOOTPRINT OF FRANCE

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Summary

In recent years, it has become increasingly evident that local water depletion and pollution are often closely tied to the structure of the global economy. It has been estimated that twenty per cent of the water consumption and pollution in the world relates to the production of export goods. International trade in commodities implies long-distance transfers of water in virtual form, where virtual water is understood as the volume of water that has been used to produce a commodity and that is thus virtually embedded in it. Knowledge about the virtual-water flows entering and leaving a country can cast a new light on the meaning of water scarcity for a country. For developing a wise national water policy, it is relevant to consider the linkages between consumed goods in a country and impacts on freshwater systems where the goods are produced.

The objective of this study is to carry out a water footprint assessment for France from both a production and consumption perspective. The aim of the assessment from the production perspective is to identify and analyse how French water resources are allocated over various purposes, and to examine where the water footprint of French production violates local environmental flow requirements and ambient water quality standards. Additionally, the aim is to understand how the water resources of France are allocated for making products for export. The assessment from the consumption perspective focuses on the external water footprint of French consumption, so that we obtain a complete picture of how national consumption translates to water use, not only in France, but also abroad, and understand the water dependency of French consumption and the sustainability of imports. We use monthly blue water scarcity values on river basin level for the identification of river basins where the contribution of the water footprint of France can be critical. Per water-scarce river basin, we identify how different commodities contribute to the blue water scarcity in the basin.

The total water footprint of production in France is 90 billion m^3/year in the period 1996-2005. Crops have the largest share (82%) in this footprint, followed by industrial activities (8%), grazing (6%), domestic water supply (3%) and livestock production (1%). The blue water footprint of production in France is dominated by maize production. Other crops with a significant share in the blue water footprint are fodder crops (6%), potato (4%), soybean (3%), rice (3%), and apples (2%). The basins of the Loire, Seine, Garonne, and Escaut have been identified as priority basins regarding the blue water footprint of French production. Maize and industrial production are the dominant factors for the blue water scarcity in these river basins.

The total water footprint of consumption of France is 106 billion m^3/year, which is 1786 m^3/year per citizen. Per capita, the water footprint of French consumption is about 30% more than the world average. The consumption of agricultural products gives by far the largest contribution (87%) to the total consumer water footprint. Consumption of industrial products and domestic water use contribute 10% and 3% respectively. With a contribution of 34%, meat consumption is the largest contributor to the total water footprint. The internal water footprint of France constitutes 53% of its total water footprint and is mainly because of consumption of agricultural products (46%), followed by industrial products (4%) and domestic water supply (3%).

About 47% of the water footprint of French consumption is external, that is outside France, mostly related to imported agricultural products for domestic consumption (41%) and for a smaller fraction related to imported industrial products (6%). Cotton, sugar cane and rice are the three major crops with the largest share in France's external blue water footprint of consumption and identified as critical products in a number of severely water-scarce river basins. The basins of the Aral Sea and the Indus, Ganges, Guadalquivir, Guadiana, Tigris & Euphrates, Ebro, Mississippi and Murray rivers are some of the basins that have been identified as priority basins regarding the external blue water footprint of French consumption.

The study shows that analysis of the external water footprint of a nation is necessary to get a complete picture of the relation between national consumption and the use of water resources. It provides understanding of how national consumption impacts on water resources elsewhere in the world.

1. Introduction

Water plays a key role in life on our planet. It is essential not only for direct uses such as for the provision of drinking water, growing food and the production of energy and other products, but also for ensuring the integrity of ecosystems and the goods and services they provide to humans. Freshwater is a renewable resource; however, its annual availability is limited. Annual freshwater use in many places exceeds the limit of the water available, which has resulted in river flows that are below environmental flow requirements, declining groundwater levels and pollution of water bodies.

In recent years, it has become increasingly evident that local water depletion and pollution are often closely tied to the structure of the global economy (Hoekstra and Chapagain, 2007). It has been estimated that about twenty per cent of the water consumption and pollution in the world relates to the production of export goods (Hoekstra and Mekonnen, 2012). International trade in commodities implies long-distance transfers of water in virtual form, where virtual water is understood as the volume of water that has been used to produce a commodity and that is thus virtually embedded in it (Chapagain and Hoekstra, 2008). Knowledge about the virtual-water flows entering and leaving a country can cast a new light on the actual water scarcity of a country. For developing a wise national water policy, it is also relevant to consider the linkages between consumed goods in a country and impacts on freshwater systems where the goods are produced.

The water footprint is an indicator of freshwater use that looks not only at direct water use of a consumer or producer, but also at the indirect water use. The water footprint can be regarded as a comprehensive indicator of freshwater resources appropriation, next to the traditional and restricted measure of water withdrawal. It is a multi-dimensional indicator, showing water consumption volumes by source and polluted volumes by type of pollution; all components of a total water footprint are specified geographically and temporally (Hoekstra *et al.*, 2011).

The objective of this study is to carry out a water footprint assessment for France from both a production and consumption perspective. The aim of the assessment from the production perspective is to identify and analyse how French water resources are allocated over various purposes, and examine where the water footprint of production within France violates local environmental flow requirements and ambient water quality standards. Additionally, the aim is to quantify which volumes of French water resources are allocated for making products for export and to assess the impact related to this water footprint for export. The assessment from the consumption perspective focuses on the analysis of the external water footprint of French consumption, to get a complete picture of how national consumption translates to water use, not only in France, but also abroad, and to assess French dependency on external water resources and the sustainability of imports.

The study starts with a quantification and mapping of the water footprint of the agricultural and industrial sectors and of domestic water supply within France. Next, virtual water imports into France and virtual water exports leaving France are quantified, by traded commodity. Subsequently, the internal and external water footprint of French consumption is analysed. Finally, it has been analysed which components of the French blue

water footprints of production and consumption contribute to blue water scarcity in specific river basins and which products are responsible herein.

There are several similar water footprint studies in the literature with a focus on a specific country. Studies have been carried out, for example, for Belgium (Vincent *et al.*, 2011), China (Hubacek *et al.*, 2009; Ma *et al.*, 2006; Zhao *et al.*, 2009), Germany (Sonnenberg *et al.*, 2009), India (Kampman *et al.*, 2008), Indonesia (Bulsink *et al.*, 2010), the Netherlands (Van Oel *et al.*, 2009), Spain (Garrido *et al.*, 2010); and the UK (Chapagain and Orr, 2008). These studies mainly focussed on the quantification of the water footprints, were not based on a high-resolution spatial analysis and excluded an assessment of the sustainability of the water footprint. Impacts of water footprints on a national scale are partially addressed in Van Oel *et al.* (2009) for the Netherlands, Kampman *et al.* (2008) for India and Chapagain and Orr (2009) for Spanish tomatoes. However, these studies lack spatial detail as will employed in the current study, which will incorporate data on monthly blue water scarcity at the level of river basins to assess how blue water footprints of production and consumption contribute to water scarcity at river basin level.

From a methodological point of view, this study improves upon the previous country-specific water footprint studies in three ways, following the global study by Mekonnen and Hoekstra (2011b). First, the water footprints of production and consumption are mapped at a high level of spatial detail. Second, the analysis explicitly includes green, blue and grey water footprints. Finally, we make a substantial step beyond quantifying and mapping the country's water footprint of production and consumption by analysing how different components in the water footprint may contribute to blue water scarcity in different river basins and identifying which products are behind those contributions.

2. Method and data

2.1 Water footprint accounting

This study follows the methodology and terminology of water footprint assessment as described in the Water Footprint Assessment Manual (Hoekstra *et al*., 2011). The water footprint is an indicator of water use that looks at both direct and indirect water use of a consumer or producer. The water footprint of an individual or community is defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual or community. Water use is measured in terms of water volumes consumed (evaporated or incorporated into the product) and polluted per unit of time. A water footprint has three components: green, blue and grey. The blue water footprint refers to consumption of blue water resources (surface and ground water). The green water footprint is the volume of green water (rainwater) consumed, which is particularly relevant in crop production. The grey water footprint is an indicator of the degree of freshwater pollution and is defined as the volume of freshwater that is required to assimilate the load of pollutants based on existing ambient water quality standards. The water footprint of production and consumption in France is quantified according to the national water footprint accounting scheme as shown in Figure 1.

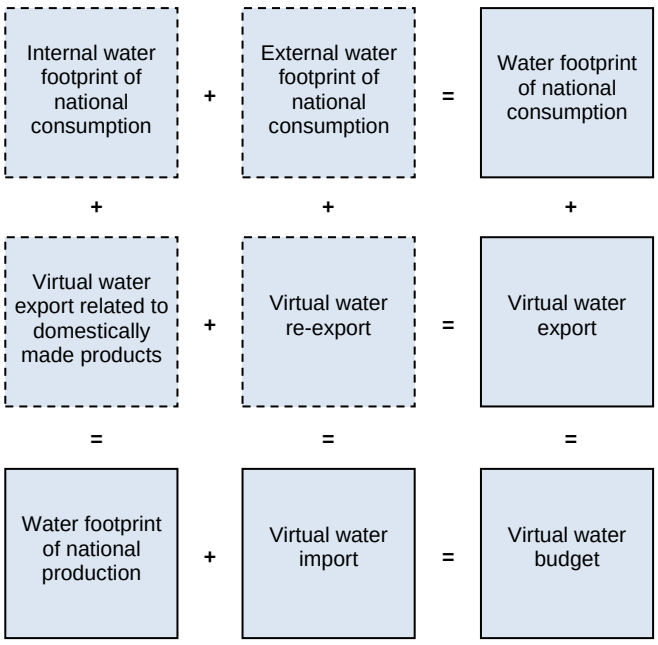

Figure 1. The national water footprint accounting scheme (Hoekstra et al., 2011).

The ‘water footprint of national production’ refers to the total freshwater volume consumed or polluted within the territory of the nation. This includes water use for making products consumed domestically but also water use for making export products. It is different from the ‘water footprint of national consumption’, which refers to the total amount of water that is used to produce the goods and services consumed by the inhabitants of the nation. This refers to both water use within the nation and water use outside the territory of the nation, but is restricted to the water use behind the products consumed within the nation. The water footprint of national

consumption thus includes an internal and external component. The internal water footprint of national consumption is defined as the use of domestic water resources to produce goods and services consumed by the national population. It is the sum of the water footprint within the nation minus the volume of virtual-water export to other nations insofar as related to the export of products produced with domestic water resources. The external water footprint of national consumption is defined as the volume of water resources used in other nations to produce goods and services consumed by the population in the nation considered. It is equal to the virtual-water import into the nation minus the volume of virtual-water export to other nations because of re-export of imported products.

The water footprint of crops and derived crop products produced in France or elsewhere were obtained from Mekonnen and Hoekstra (2010a, 2011a), who estimated the global water footprint of crop production with a crop water use model at a 5 by 5 arc minute spatial resolution. The water footprint of animal products that are produced in France were taken from Mekonnen and Hoekstra (2010b, 2012). The data related to the water footprint of production and consumption in France and the virtual water flows to and from France were taken from Mekonnen and Hoekstra (2011b). In all cases, data refer to the period 1996-2005.

2.2 Identifying priority basins and products

For the blue water footprint of French production and consumption, some additional analysis was carried out in order to identify river basins of concern. After we quantified and mapped the blue water footprints of French production and consumption, we estimated which parts of both water footprints are situated in river basins with moderate to severe water scarcity during part of the year. Monthly blue water scarcity values for the major river basins around the world were taken from a recent global water scarcity study (Hoekstra and Mekonnen, 2011; Hoekstra et al., 2012). The blue water scarcity values in that study were calculated by taking the aggregated blue water footprint per basin and per month over the blue water availability in that basin and month. The latter was taken as natural runoff in the basin minus a presumptive standard for the environmental flow requirement in the basin. They classified blue water scarcity values into four levels:

- low blue water scarcity (<100%): the blue water footprint is lower than 20% of natural runoff and does not exceed blue water availability; river runoff is unmodified or slightly modified; environmental flow requirements are not violated.
- moderate blue water scarcity (100-150%): the blue water footprint is between 20 and 30% of natural runoff; runoff is moderately modified; environmental flow requirements are not met.
- significant blue water scarcity (150-200%): the blue water footprint is between 30 and 40% of natural runoff; runoff is significantly modified; environmental flow requirements are not met.
- severe water scarcity (>200%): the monthly blue water footprint exceeds 40% of natural runoff, so runoff is seriously modified; environmental flow requirements are not met.

The following three criteria have been used to identify priority basins regarding the various components of the blue water footprint of French production or consumption: level of water scarcity over the year in the basin

where the water footprint component is located, the size of the blue water footprint of French production or consumption located in the basin (agricultural and industrial products separately), and the significance of the contribution of a specific product to the total blue water footprint in the basin in the scarce month.

A specific river basin is identified as a 'priority basin' related to France's water footprint of production or consumption of agricultural products if three conditions are fulfilled: (a) the river basin experiences *moderate, significant or severe* water scarcity in any specified period of the year; (b) the French blue water footprint of production or consumption of agricultural products located in that basin is *at least 1%* of total blue water footprint of production or consumption of agricultural products; and (c) the contribution of any specific agricultural commodity to the total blue water footprint in that specific basin in the period of scarcity is significant (*more than 5%*). In addition, a river basin is also identified as a priority basin if the following two conditions are met: (a) the water scarcity in the river basin is *severe* during part of the year; and (b) the contribution of any specific agricultural commodity produced or consumed in France to the total blue water footprint in that specific basin in the period of scarcity is very significant (*more than 20%*).

A river basin is identified as a priority basin related to France's water footprint of production or consumption of industrial products if three conditions are fulfilled: (a) the river basin experiences *moderate, significant or severe* water scarcity in any specified period of the year; (b) the French blue water footprint of production or consumption of industrial products located in that specific basin is *at least 1%* of the total water footprint of production or consumption of industrial products; and (c) the contribution of industrial activities to the total blue water footprint in that specific basin in the period of scarcity is significant (*more than 5%*). In addition, a river basin is also identified as a priority basin if the following two conditions are met: (a) the water scarcity in the river basin is *severe* during part of the year; and (b) the contribution of industrial activities to the total blue water footprint in that specific basin in the period of scarcity is very significant (*more than 20%*).

In addition to the quantitative analysis to identify priority basins and products regarding the blue water footprint of French production and consumption, we assessed the impacts of the grey water footprint of French production and consumption on a qualitative basis.

3. Results

3.1 Water footprint of production

The total water footprint of national production in France is 90 Gm^3/year for the period 1996-2005, which is 1% of the total water footprint of production in the world (Hoekstra and Mekonnen, 2012). The largest part of this water footprint is green (76%), followed by grey (18%) and blue (6%) (Table 1). Crop production constitutes the largest share (82%) in the water footprint of national production in France, followed by industrial activities (8%), grazing (6%), domestic water supply (3%) and livestock production (1%). Among the crops, cereals contribute 47% to the total water footprint. Fodder crops (15%), oil seed crops (9%) and fruits and nuts (6%) are the other major crop groups with a significant share in the total water footprint (Figure 2). Crop production contributes 50% to the total *blue* water footprint within France. The shares of industrial production, animal water supply and domestic water supply in the blue water footprint are 26, 14 and 11% respectively. In France, the grey water footprint is largely due to crop and industrial production.

Table 1. The water footprint of national production in France (Mm^3/year) by major category.

Water footprint of crop production			Water footprint of grazing	Water footprint of animal water supply	Water footprint of industrial production		Water footprint of domestic water supply		Total water footprint		
Green	Blue	Grey	Green	Blue	Blue	Grey	Blue	Grey	Green	Blue	Grey
62700	2849	8018	5672	778	1488	5654	628	2221	68372	5743	15894

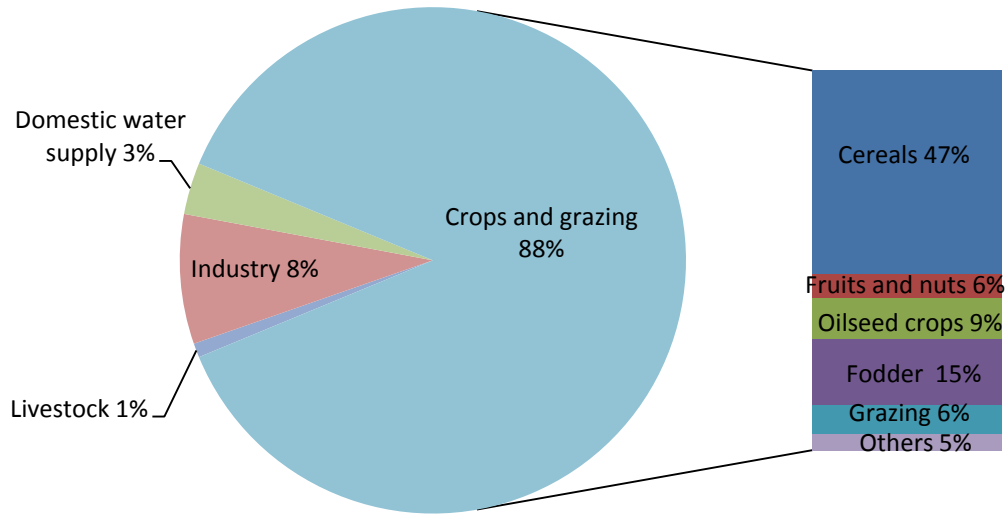

Figure 2. The water footprint of national production in France by sector.

The spatial distributions of the green, blue and grey water footprint of national production in France are shown in Figure 3. The water footprint per region is presented in Figure 4 (with extended data tabulated in Appendix I). Centre region has the largest water footprint with 9.6 Gm^3/year (12% of the total). Other regions with a

significant share are Midi-Pyrenees (7.6 Gm^3/year), Poitou-Charentes (6.7 Gm^3/year), Champagne-Ardenne (5.5 Gm^3/year), Aquitaine (5.4 Gm^3/year), Pays de la Loire (5.3 Gm^3/year), Picardie (5 Gm^3/year), Bourgogne (4.7 Gm^3/year), and Rhone-Alpes (4.2 Gm^3/year). The largest *blue* water footprint in France is in Midi-Pyrenees (where 14% of the blue water footprint within France is located). Aquitaine, Ile-de-France, Centre, Poitou-Charentes, Pays de la Loire, Rhone-Alpes, Provence-Alpes-Cote d'Azur, Languedoc-Roussillon are other regions with a large blue water footprint. The largest *grey* water footprint in France is in Ile-de-France (where 10% of the grey water footprint within France is located), followed by Centre (8%), Midi-Pyrenees (7.8%), Rhone-Alpes (7.3%), Aquitaine (6.6%), Poitou-Charentes (6.4%), and Pays de la Loire (6%). The large grey water footprint in Ile-de-France is due to the high population and industrial activity in the region, especially near Paris metropolitan area.

The distribution of the water footprint in France over its major river basins is given in Table 2. Nearly 60% of the water footprint of production in France is located in just four river basins: the Loire, Seine, Garonne and Rhone. About 45% of the blue water footprint in France lies in three basins (15% in each): the Loire, Seine and Garonne. The grey water footprint in France is largest in the Seine basin (which has 23% of the grey water footprint in France), followed by the Loire basin (18%) and the Rhone basin (12%).

Table 2. The water footprint of national production in France (Mm^3/year) in its major river basins.

River basin	Total related to agricultural production			Related to industrial production		Related to domestic water supply		Total water footprint*			
	Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total
Loire	13868	606	1754	195	741	82	291	13868	884	2787	17538
Seine	12919	305	1531	389	1478	164	581	12919	858	3590	17367
Garonne	7113	746	1117	82	313	35	123	7113	863	1553	9530
Rhone	6325	329	729	221	836	94	332	6325	645	1896	8866
Rhine	3222	24	454	113	417	47	166	3222	184	1037	4444
Escaut	1256	24	161	58	221	24	86	1256	106	467	1829
Ebro	19	1	2	0	1	0	1	19	1	4	24
Po	5	0	0	0	2	0	1	5	1	3	9

* The water footprints within these major river basins sum up to 66 % of the total water footprint of production in France.

The water footprint of agricultural production (crop production, grazing, and livestock water supply) in the period 1996-2005 was 80 Gm^3/year, which is 89% of the total water footprint in France. Wheat (29%), fodder crops (18%), maize (14%), barley (9%), rapeseed (7%), grapes (5%), sunflower (4%) and sugar beet (2%) are together responsible for 88% of the total agricultural water footprint. Cauliflower, artichokes, carrots, lettuce, asparagus, onions, cabbages and tomatoes are the major vegetables with large water footprints. Among the fruits, the water footprint of grapes is the largest, followed by apples, peaches and plumes. The green, blue and grey water footprint of crops produced in France is given in Appendix II.

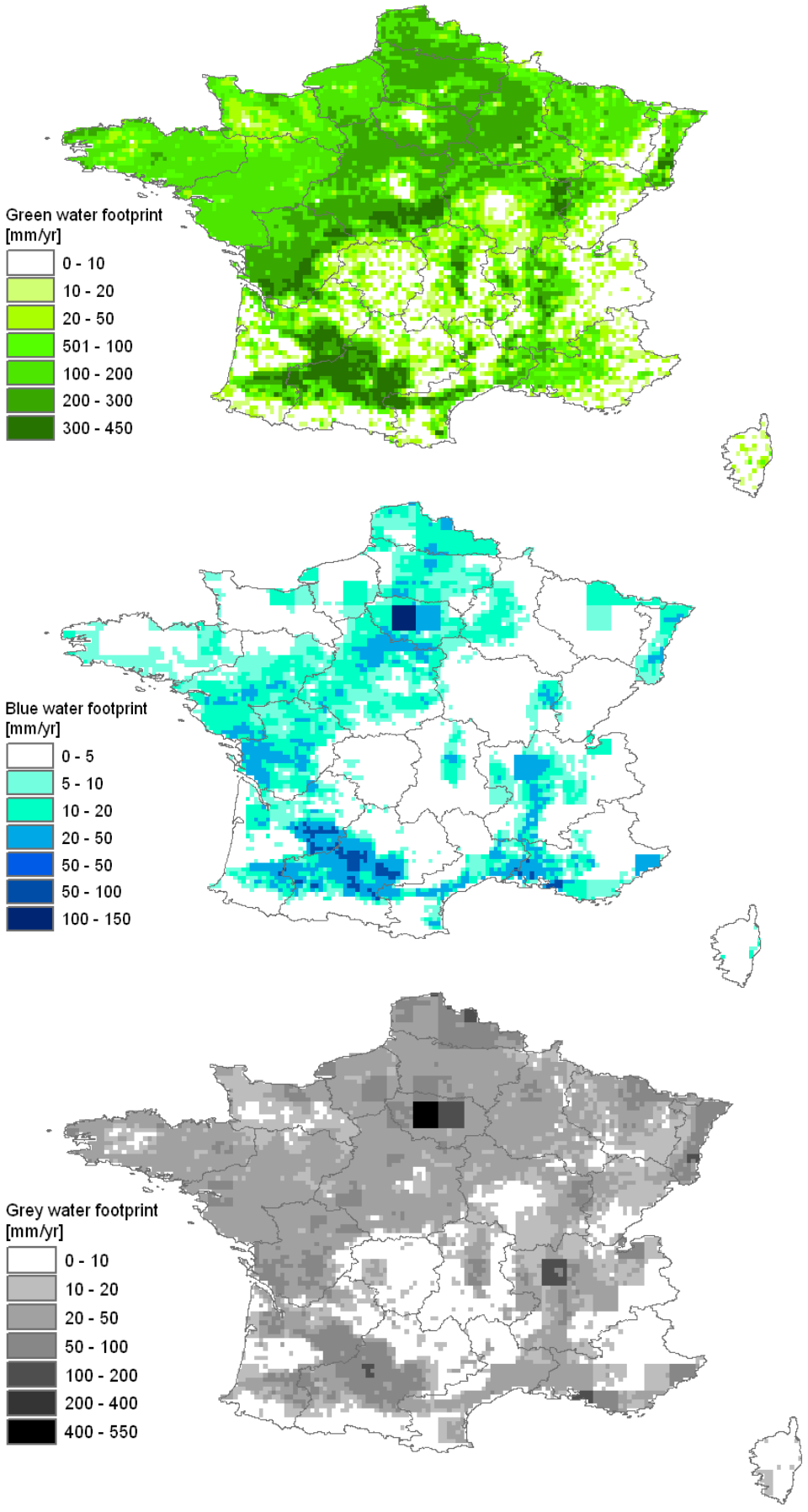

Figure 3. Spatial distribution of the green, blue and grey water footprint of production in France.

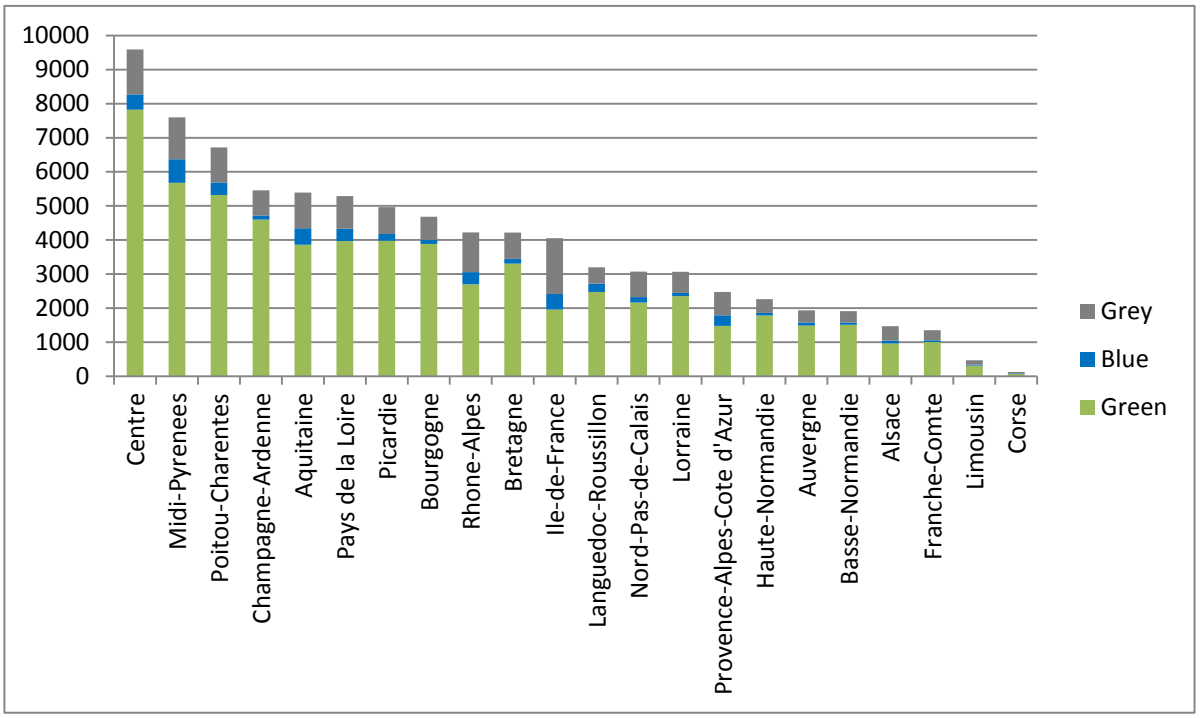

Figure 4. The green, blue and grey water footprint of national production per region in France (Mm^3/year).

Figure 5 shows the contribution of different crops to the green, blue and grey water footprint of total crop production in France. Maize production has the largest blue water footprint in France, and equals to the 50% of the total. Other crops with a significant share in the blue water footprint are fodder crops (6%), potato (4%), soybean (3%), rice (3%), and apples (2%). The green water footprint is mainly due to wheat production (34%), followed by fodder crops (19%), maize (10%), barley (9%), rapeseed (7%), grapes (6%), and sunflower (3%). The largest contribution to the grey water footprint comes from maize production (30%), followed by barley (18%), fodder crops (14%), sunflower (11%), rapeseed (9%), potato (4%) and sugar beet (3%).

The regional distribution of the water footprint related to agricultural production is shown in Figure 6. The largest agricultural water footprint (12.4% of the total) is in Centre region. Other regions with a relatively large agricultural water footprint are Midi-Pyrenees, Poitou-Charentes, Champagne-Ardenne, Aquitaine, Pays de la Loire, Picardie, Bourgogne and Bretagne. The largest blue water footprints related to crop production are located in Midi-Pyrenees, Aquitaine, Centre, Poitou-Charentes, Pays de la Loire, Languedoc-Roussillon, Provence-Alpes-Cote d'Azur and Rhone-Alpes. The largest part of the crop-related blue water footprint in France is due to maize production, which is located mainly in Midi-Pyrenees (23%), Aquitaine (19%), Poitou-Charentes (12%) and Centre (12%). The grey water footprint distribution among the regions is as follows: Centre (12%), Midi-Pyrenees (11%), Poitou-Charentes (10%), Aquitaine (9%), Champagne-Ardenne (7%), Pays de la Loire (6%), Picardi (6%) and Bourgogne (5%). The green water footprint distribution among the regions is similar to blue.

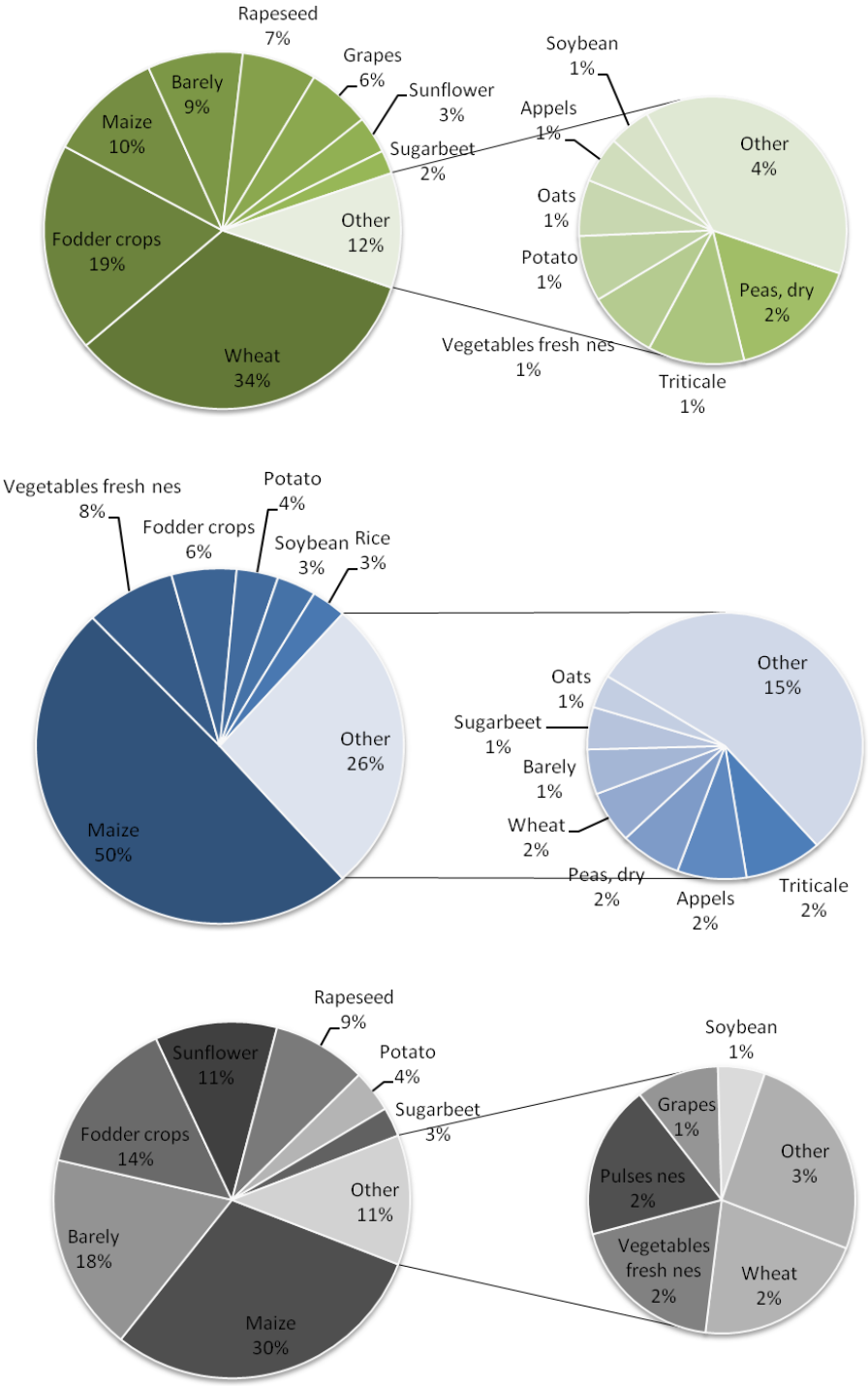

Figure 5. The contribution of different crops to the green, blue and grey water footprint of total crop production in France.

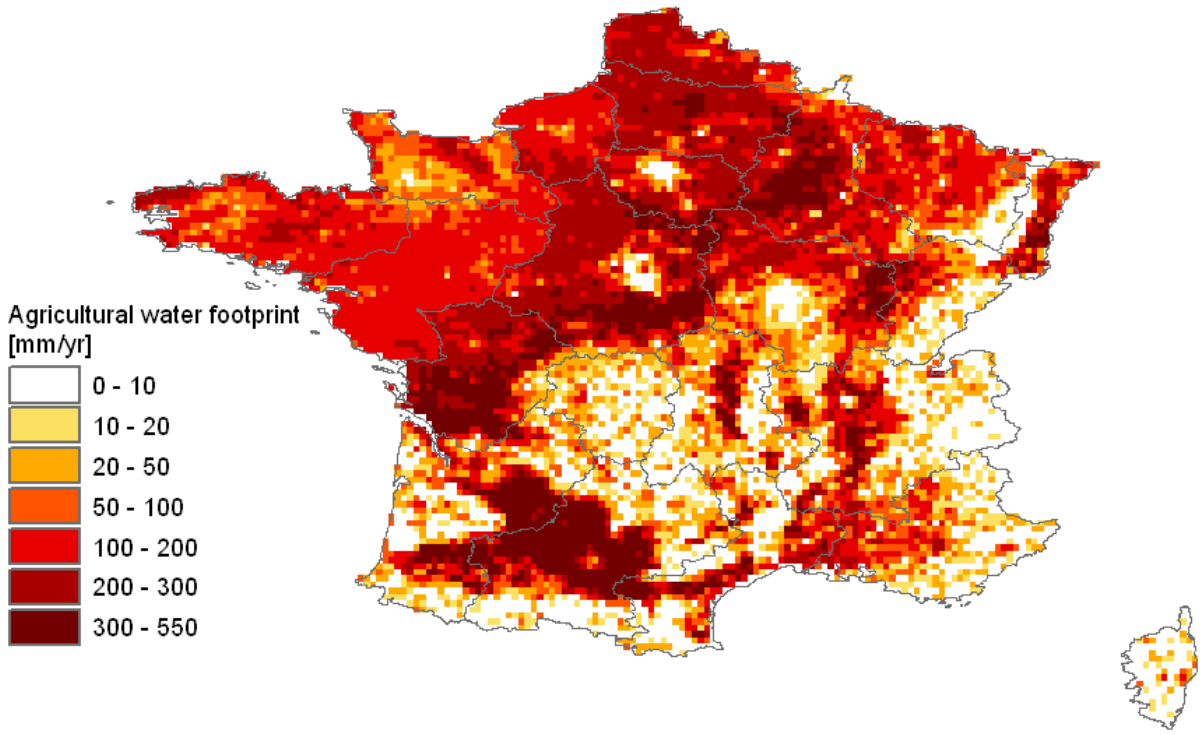

Figure 6. Spatial distribution of the water footprint of agricultural production in France.

The water footprint of industrial production in France in the period 1996-2005 was 7.1 Gm^3/year. This footprint is dominated by the grey component (5.6 Gm^3/year), which represents the pollution due to industrial production. The water footprint of industrial production is concentrated in the Seine (26%), Rhone (15%), Loire (13%), Rhine (7%) and Garonne (6%) basins. Ile-de-France, Rhone-Alpes, Provence-Alpes-Cote d'Azur and Nord-Pas-de-Calais are the regions where water footprint of industrial production is relatively large (Figure 7).

The water footprint of domestic water supply in France in the period 1996-2005 was 2.8 Gm^3/year. The majority of it is grey water footprint (78%). This water footprint is large where population concentrations are high and located mainly in Ile-de-France, Rhone-Alpes and Provence-Alpes-Cote d'Azurb. From a river basin point of view: the Seine, Rhone, Loire and Rhine basins, where most of the French population lives, have the largest water footprint related to domestic water supply.

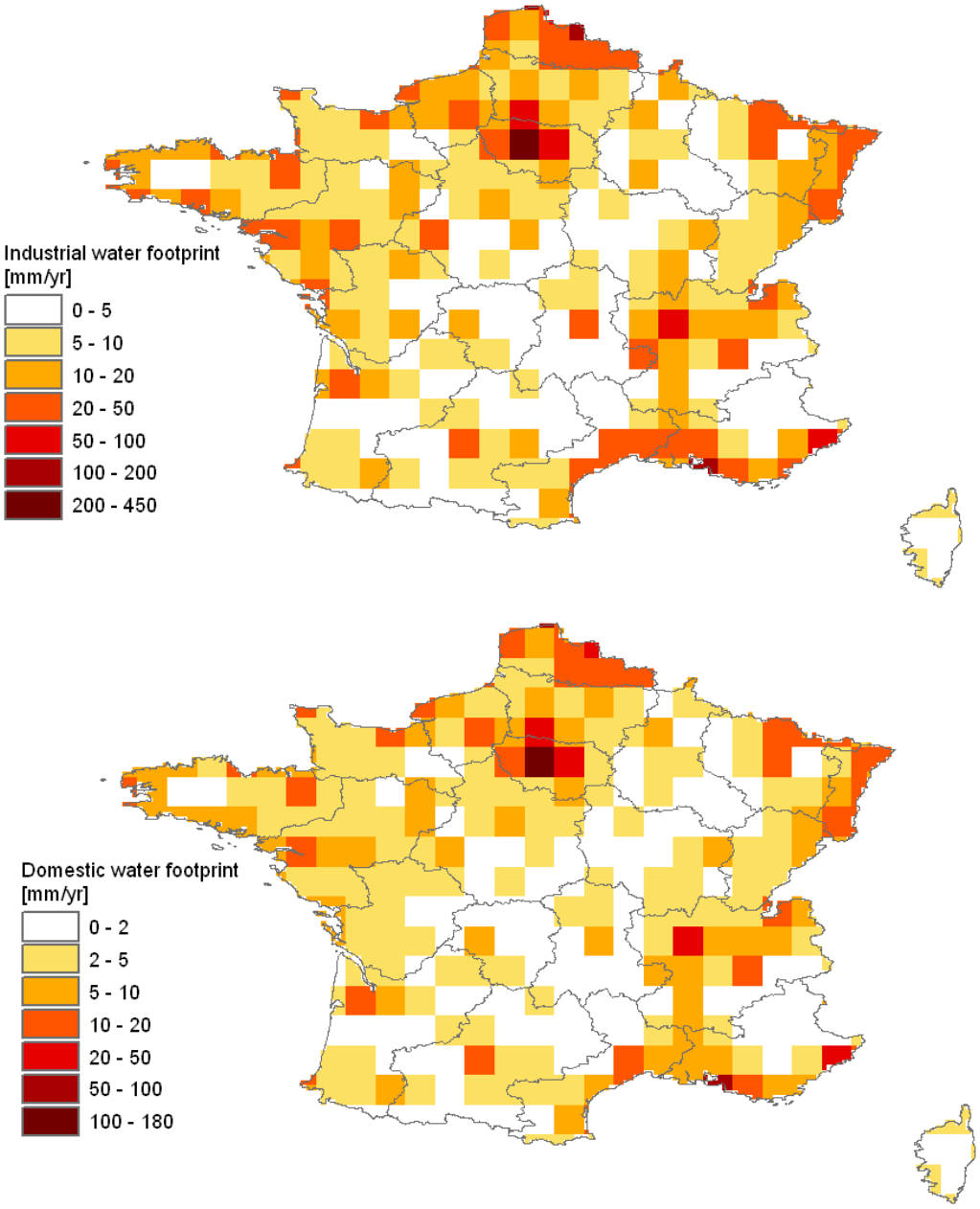

Figure 7. Spatial distribution of the water footprint of industrial production and domestic water supply in France.

3.2 Virtual water flows

The total virtual water import to France in the period 1996-2005 was 78.3 Gm^3/year. About 73% of the virtual water imports relates to imported crops and crop products, 15% to imported industrial products and 12% to imported animal products (Table 3). The largest share (22%) of the total virtual water import relates to the import of cotton and its derived products. Figure 8 shows the contribution of different products to the virtual water import, distinguishing between green, blue and grey virtual water imports.

The green water footprint of imported products is 52.7 Gm^3/year and is 67% of total virtual water import. Cotton products have the largest green water footprint among the imported products, accountable for 18% of the total green virtual water import. Soybean products (17%), animal products (14%), cocoa products (13%) and coffee products (11%) are other products with a significant share in the green virtual water import. The blue water footprint of imported products in France is 10.5 Gm^3/year. Approximately 56% of this footprint is due to cotton products. Animal and industrial products also have significant shares in blue virtual water imports (9% each). The grey water footprint of imported products is 15.1 Gm^3/year. Industrial products give the largest contribution to this grey water footprint (71%), followed by cotton products (13%) and animal products (4%).

The majority of the virtual water imports to France originate from Brazil (10%), Belgium (9%), Spain (7%), Germany (7%), Italy (6%) and India (5%). Spain, Belgium, Morocco, Italy, India, Uzbekistan, and Turkey are the largest blue virtual water exporters to France, accounting for 55% of the blue virtual water import. The grey component of virtual water import is mainly from China (10%), Germany (10%), Russia (10%), Italy (7%), Belgium (7%), the USA (7%), Spain (5%) and India (4%). The green, blue and grey water footprints of virtual water imports to France are shown in Figure 9.

The blue water footprint related to the total of imported cotton products is mainly located in Uzbekistan, Turkey, India, Tajikistan, Turkmenistan and China. The blue water footprint related to imported animal products mainly lies in Spain, Belgium, the Netherlands, Germany and Italy. For industrial products, this ranking is: Germany (15%), the USA (11%), China (9%), Italy (8%) and Russia (8%). Most of the grey water footprint related to the import of industrial products lies in Russia (14%), China (11%), Germany (10%) and the USA (7%).

Table 3. Virtual water import to France by product category (Gm^3/year).

Crop products			Animal products			Industrial products		Total		
Green	Blue	Grey	Green	Blue	Grey	Blue	Grey	Green	Blue	Grey
45.1	8.6	3.8	7.6	0.9	0.6	1.0	10.7	52.7	10.5	15.1

Table 4. Virtual water export from France by product category (Gm^3/year).

Crop products			Animal products			Industrial products		Total		
Green	Blue	Grey	Green	Blue	Grey	Blue	Grey	Green	Blue	Grey
35.9	4.9	4.4	10.1	1.5	0.8	1.0	6.7	46.0	7.4	12.0

The total virtual water export from France in the period 1996-2005 was 65.5 Gm^3/year (Table 4). Since virtual water imports were larger than virtual water exports, France is a net virtual water importer. The virtual water export is dominated by export of crop products (69%) and followed by animal products (19%) and industrial products (12%). The largest part of the virtual water export concerns green water (70%). The blue and grey virtual water exports contribute 11 and 18% of total virtual water exports respectively.

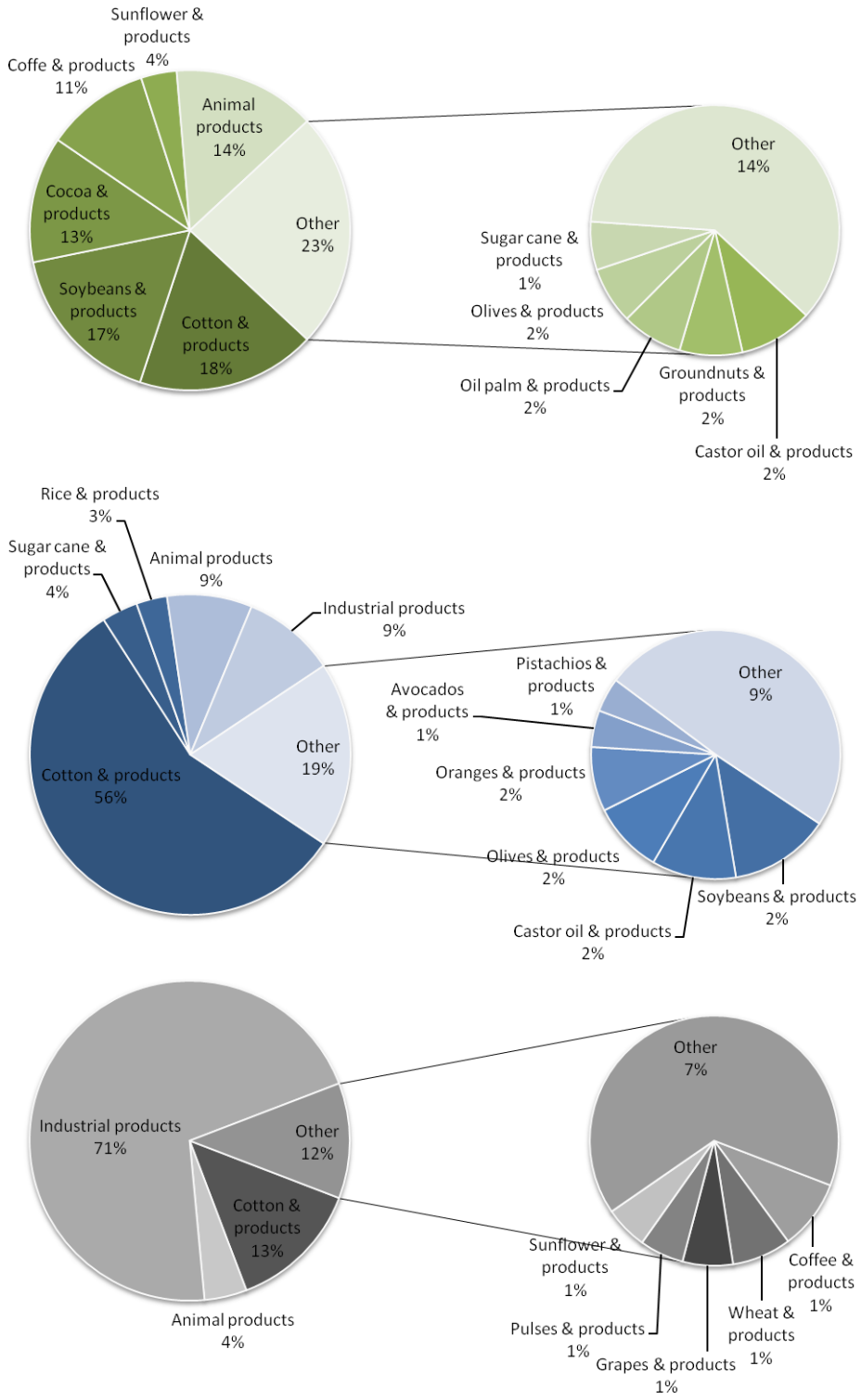

Figure 8. The green, blue and grey virtual water import to France by product group.

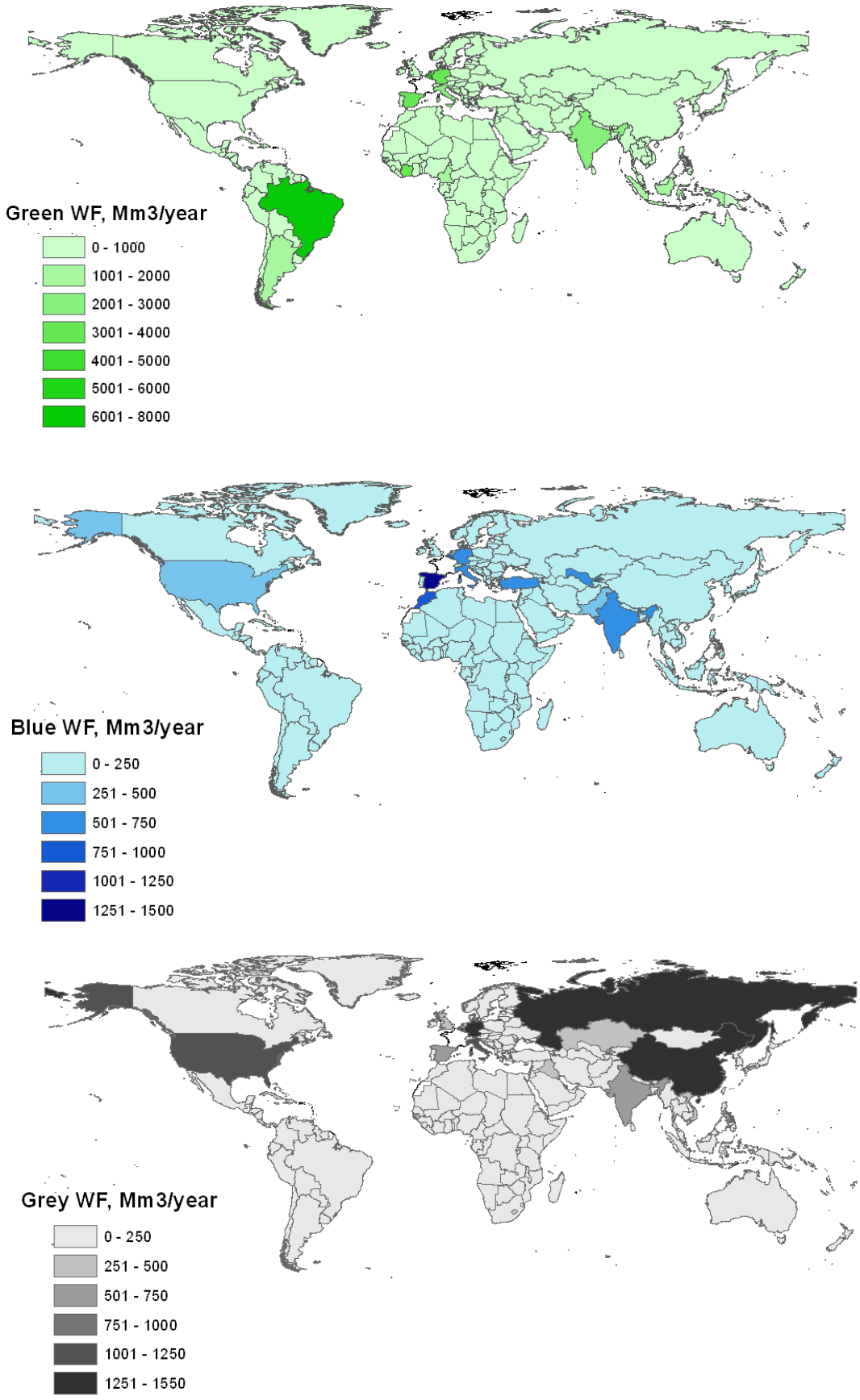

Figure 9. Spatial distribution of the green, blue and grey water footprint of total virtual water import to France.

The largest virtual water flows leaving France go to Belgium (16%), Italy (13%), Germany (11%), Spain (8%), the United Kingdom (7%), the Netherlands (7%), Algeria (3%) and Libya (3%). Figure 10 shows the virtual water exports by product category. This figure only shows virtual water exports related to domestically made products. Animal and wheat products together are responsible for 54% of the green virtual water flows from France. Barley, maize, rapeseed, sunflower and grape products are other major commodities with a large share in green virtual water exports. Blue virtual water exports from France are mainly due to the export of animal products (39%), industrial products (26%) and maize products (17%). The largest grey virtual water export is due to the export of industrial products (61% of the total) and is followed by maize, animal and barley products.

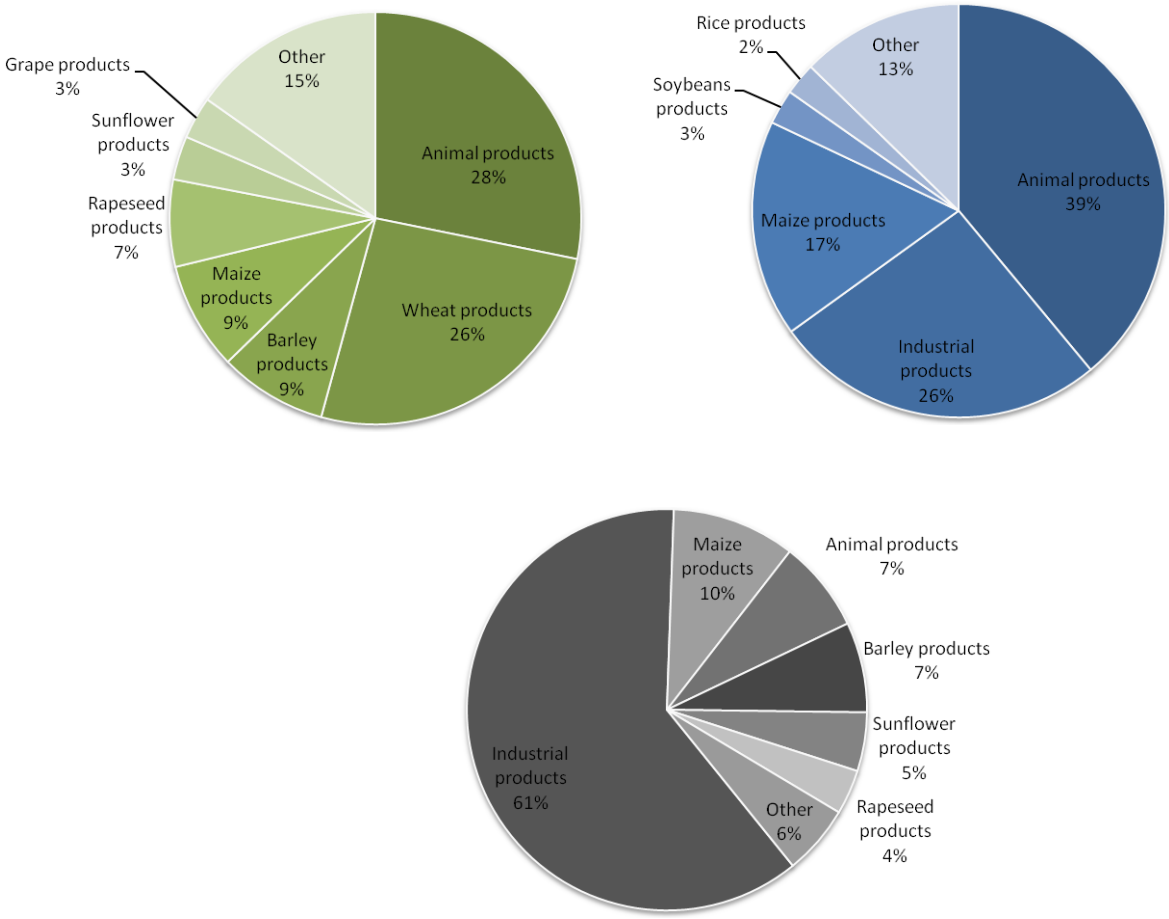

Figure 10. Green, blue and grey virtual water export from France by product group.

3.3 Water footprint of consumption

The total water footprint of consumption in France is 106 Gm^3/year over the period 1996-2005. The green component is the largest and is equal to 76% of total water footprint of consumption. Blue and grey water footprints of national consumption are 8 and 17% of the total. About 53% of the water footprint of French national consumption is internal and 47% is external (Table 5). This means that nearly half of the water resources consumed or polluted to make all products consumed by French citizens are water resources outside the country.

The largest fraction (87%) in the total water footprint of French consumers relates to the consumption of agricultural products. Consumption of industrial products and domestic water supply contribute 10% and 3% to the total water footprint of consumption, respectively (Table 6). The internal water footprint of French consumption is mainly because of the consumption of agricultural products, followed by industrial products and domestic water supply (Figure 11). The external water footprint is largely due to the import of agricultural products for domestic consumption, and for a smaller part due to the import of industrial products. The ratio of external to total water footprint of consumption is higher for industrial products (62%) than for agricultural products (47%). Furthermore, the ratio of external to total water footprint is significantly higher for the blue water footprint (64%) than for the green water footprint (46%) or the grey water footprint (47%). For agricultural products, even 77% of the total blue water footprint of consumption is external.

Table 5. The internal and external water footprint of French consumption (Mm^3/year).

Internal water footprint			External water footprint			Total water footprint			Ratio of external to total water footprint (%)
Green	Blue	Grey	Green	Blue	Grey	Green	Blue	Grey	
43704	2879	9295	36739	5156	8355	80443	8036	17649	47

Table 6. The water footprint of French consumption per major consumption category (Mm^3/year).

Water footprint of consumption of agricultural products						Water footprint of consumption of industrial products				Water footprint of domestic water supply	
Internal			External			Internal		External			
Green	Blue	Grey	Green	Blue	Grey	Blue	Grey	Blue	Grey	Blue	Grey
43704	1375	3753	36739	4577	2078	876	3320	579	6277	628	2221

With a contribution of 34%, meat consumption is the largest contributor to the total water footprint of French consumption (Figure 12). Industrial products (10%), coffee, tea and cocoa (9%), and milk (9%) are other large contributors. The consumption of cereals and sugar contribute 5% and 4% to the total water footprint of consumption, respectively. Rubber, fruits, wine & beer, and domestic water supply each have a 3% share in the total water footprint of consumption. The precise water footprint of consumption per agricultural product is presented in Appendix III. As can be seen from Figure 13, meat, coffee-tea-cocoa, milk, vegetable oils and cereals have the largest shares in the total *green* water footprint of French national consumption (40, 12, 10, 7 and 6% respectively). The *blue* water footprint is also dominated by meat consumption (23%). Consumption of industrial products (18%), fruits (8%), milk (8%) and domestic water supply (8%) are other sectors with a large share in the total blue water footprint. The *grey* water footprint of consumption is mainly due to the

consumption of industrial products (54%), followed by domestic water supply (13%), meat (12%) and milk (5%).

When we compare the external water footprint of France to virtual water imports (Section 3.2), we see that some part of the virtual water imports to France are not consumed domestically. Around 35% of the virtual water import is re-exported again. Part of the re-export of virtual-water is done after having processed imported raw materials. A typical example of such processing is related to cotton and cocoa products. Crops are imported from Asia and Latin America to be used as an input to textile and cocoa industries. When we compare the internal water footprint of French consumption to the water footprint of production within France, we see that the latter is much bigger. About 60% of the total water footprint of production in France is for domestic consumption. The rest of the water footprint in the country is for the production of export commodities.

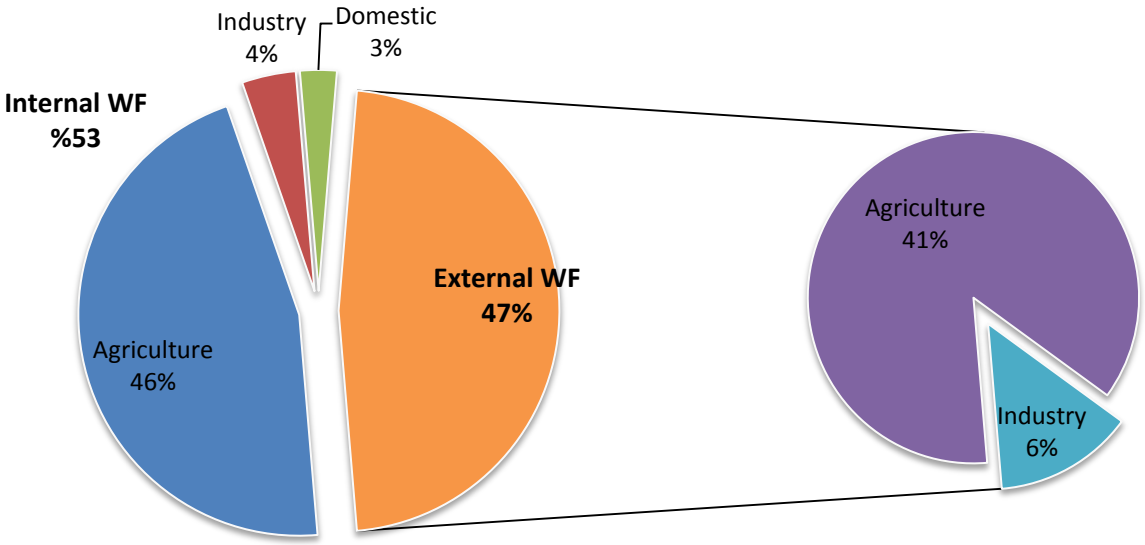

Figure 11. The total water footprint of French consumption shown by internal and external component.

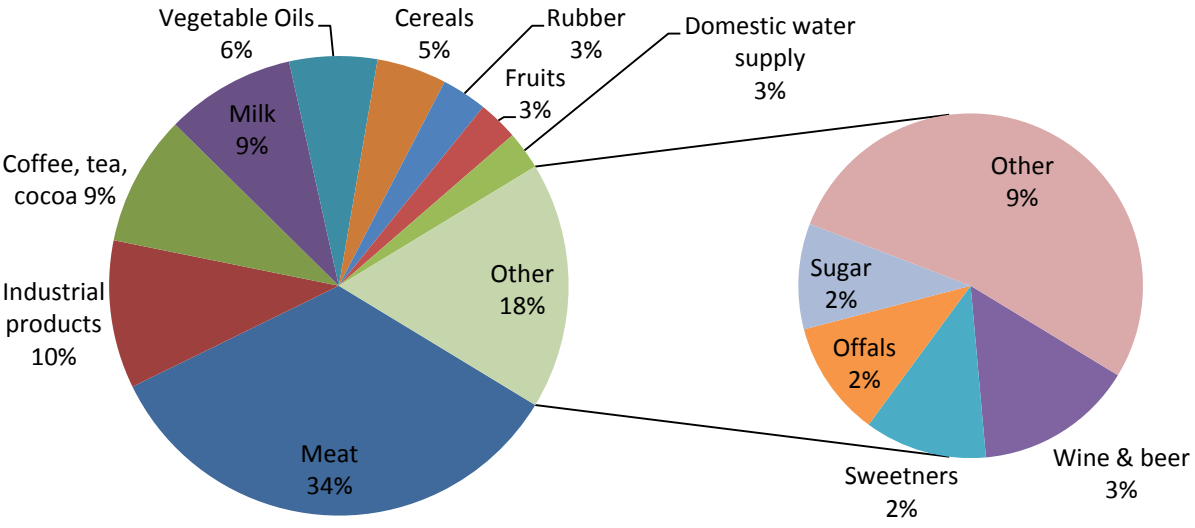

Figure 12. The total water footprint of French consumption shown by consumption category.

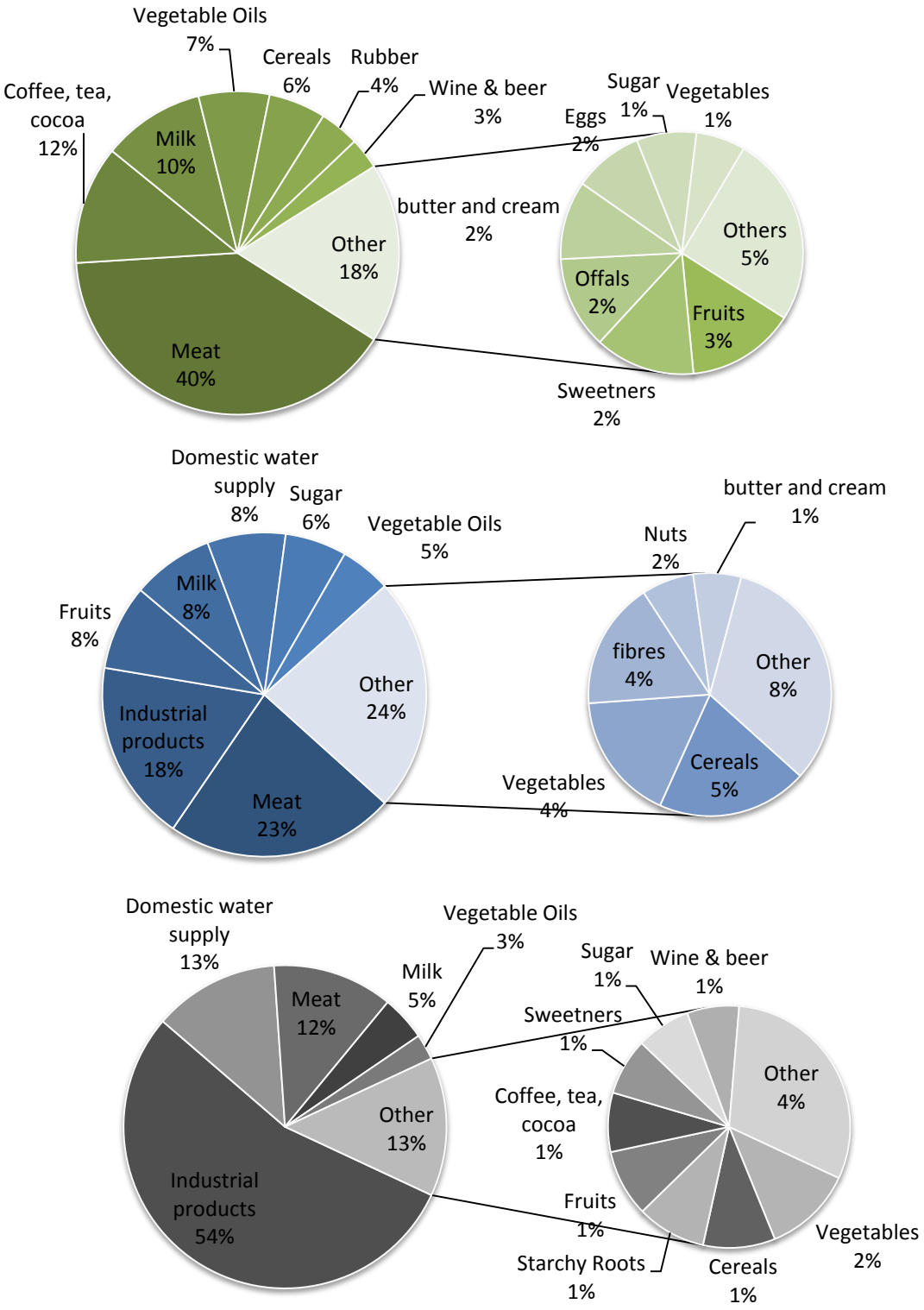

Figure 13. The green, blue and grey water footprint of French consumption per consumption category.

Figure 14 shows the ratio of external to total water footprint for the EU countries. For most countries, this ratio is larger than the world average, which is 22% (Hoekstra and Mekonnen, 2012). Some European countries, such as the Netherlands, Belgium, Malta and Switzerland have a relatively very large external water footprint, contributing 80% to 95% to the total water footprint. Some other countries, such as Romania, Bulgaria and Hungary have a relatively small external footprint, less than 20% of the total. The ratio of external to total water footprint in France (47%) is smaller than the average European ratio, but larger than the world average.

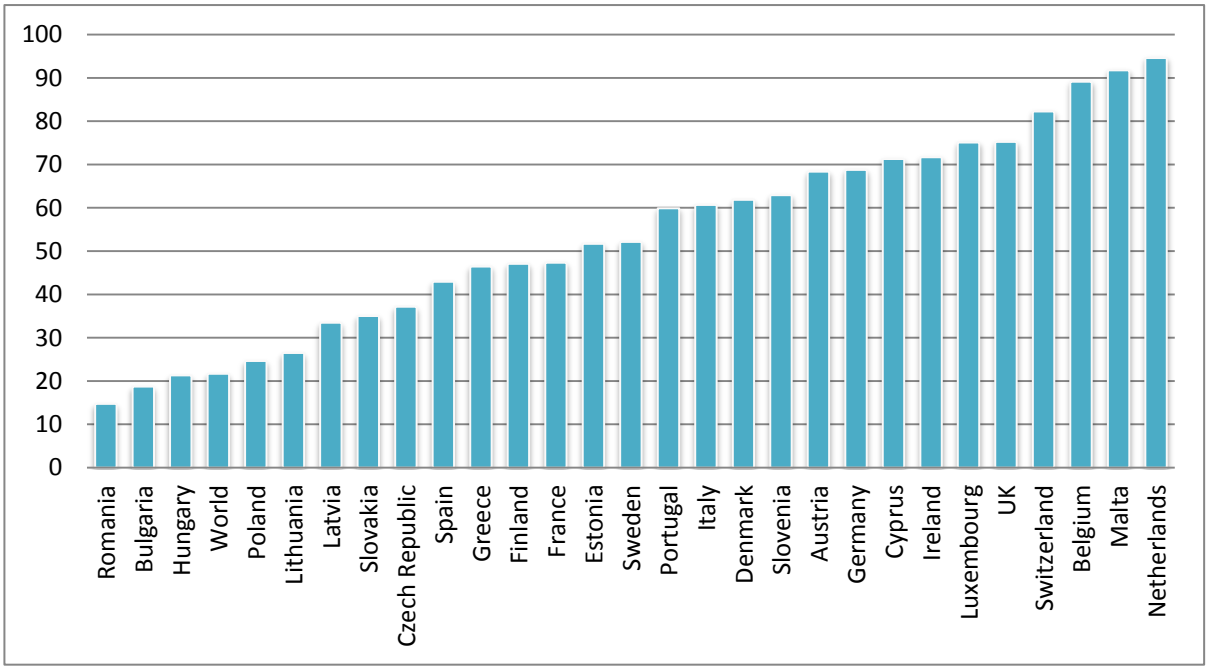

Figure 14. The ratio of the external to the total water footprint of consumption for the EU countries and the world average (%).

The geographic distribution of the water footprint of consumption by French citizens is shown in Figure 15. More than 50% of the external water footprint of French consumption comes from Brazil, Belgium, Spain, Germany, Italy, India and the Netherlands. The geographic spreading of the external water footprint related to the consumption of agricultural and industrial products are different from each other. The external agricultural water footprint is mainly from Brazil, Belgium, India, Spain, and Germany, while the external industrial water footprint is more concentrated in China, Russia, Germany and the USA.

The water footprint of a consumer in France in the period 1996-2005 was, on average, 1786 m^3/year (Table 7). Compared to other EU countries, the water footprint of consumption per capita in France is below the average. However, it is more than the world average, which is 1385 m^3/year (Figure 16). Countries like Portugal, Spain, Cyprus and Greece have very large water footprints per capita, whereas the UK and Ireland have the smallest water footprints per capita in Europe. As can be seen from Figure 17, the water footprint of consumers in Europe is dominated by agricultural products. The share of industrial products is especially high in countries like Belgium, Luxembourg and Switzerland.

Table 7. The water footprint of French consumption per capita (m^3/year/cap).

Population (thousands)	Internal water footprint			External water footprint			Total water footprint			
	Green	Blue	Grey	Green	Blue	Grey	Green	Blue	Grey	Total
59436	735	48	156	618	87	141	1353	135	297	1786

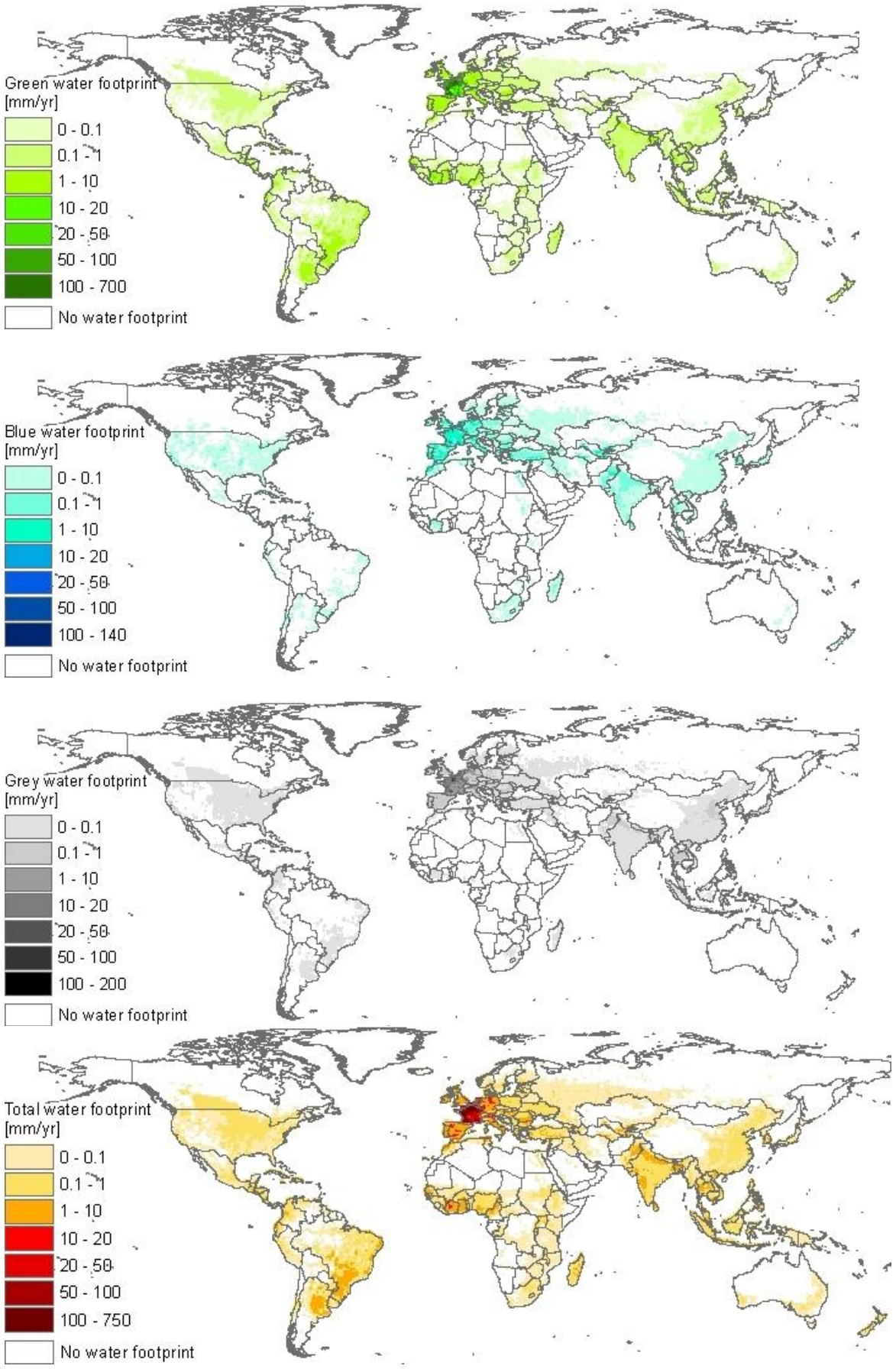

Figure 15. The global water footprint of consumption by the inhabitants of France (period 1996-2005).

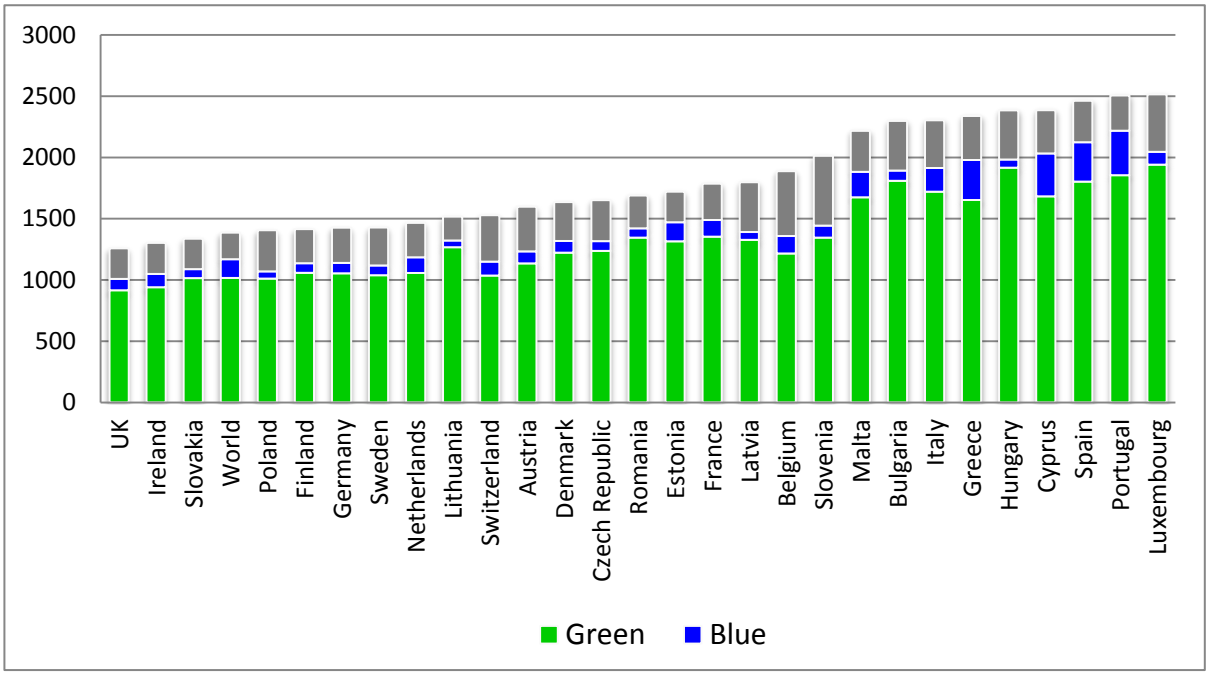

Figure 16. The green, blue and grey water footprint of consumption per capita in EU countries and the world average (m^3/year/cap).

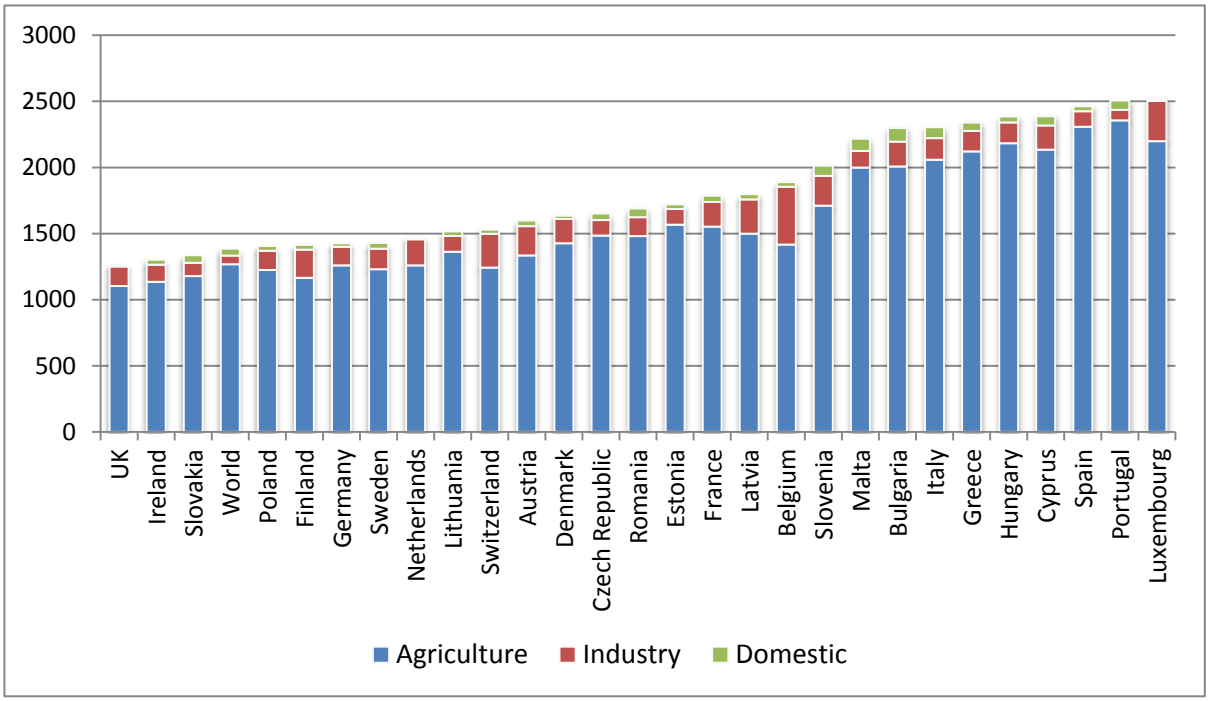

Figure 17. The water footprint of consumption per capita per consumption category in EU countries and the world average (m^3/year/cap).

4. Priority basins and products

4.1 Water footprint of production

As described in Section 3.1, the blue water footprint of France is dominated by crop production and followed by industry and domestic water supply. The blue water footprint is mainly located in the Loire, Seine, Garonne, Rhone, Rhine and Escaut river basins (Table 2). Four of these basins – the Loire, Seine, Garonne and Escaut – experience moderate to severe water scarcity at least one month a year. Table 8 shows, for each of these four basins, the months in which the moderate to severe water scarcity occurs and the products that dominate the water footprint in these months. The Loire, Seine and Garonne basins have the largest shares in the blue water footprint of production in France, 15% each. The blue water footprint in the Escaut basin is much smaller, but the area of this basin is also much smaller than for the other three basins (Figure 18).

The Loire river basin experiences significant water scarcity in August and September. The main activities contributing to the blue water footprint in this basin are maize and industrial production. The Loire basin is considered an important farming area, producing two thirds of the livestock and half of the cereal produced in France. The banks of the river offer a habitat for a rich biodiversity. The river is a refuge for European beavers, otters, and crested newts, and a migration route for fish such as Atlantic salmon. The decrease in water levels in the river during the summer period has a negative effect on the biodiversity located in the banks of the river (UNEP, 2004).

The Seine and Escaut river basins experience water scarcity from July to October. The blue water footprint during this period in these basins is mainly because of industrial production, domestic water supply, and maize and potato production. The Seine river passes through Paris; the high level of urbanization and industrialization has a major impact on the water quality in the basin. Pollution is due to industrial and domestic wastewater, but also intensive agriculture. Agricultural production has a big impact on water quality because it favours intensive farming techniques and spring crops, which leave the soil bare for long periods of the year and increase the chemical load in the rivers by leaching and draining. This has a harmful effect on both the environment and other water uses. Improving water quality is still the major concern of the basin, where non-point source pollution from farming and urban areas is still a major problem, as nitrate, pesticide and heavy metal concentrations continue to increase (UNEP, 2004).

The Garonne faces moderate to severe water scarcity in the period from July to September. The production of maize is the dominant factor behind the blue water scarcity in this basin. Soybean and fodder are two other products that contribute significantly to the blue water footprint in the basin. The Garonne is the most important river of south-western France and main water source for five major cities, including Bordeaux. The Bordeaux region is known for its industrial activities and is well known for the quality of its vineyards. The region especially experiences water shortages during summertime (UNESCO, 2006; AEAG, 2011). The Garonne is an important breeding area for sturgeon and for the migration of Atlantic salmon. Its estuary, in particular, is a very important site for fish and bird migrations. The water quality is worsening with wastewater from the city of

Bordeaux, causing high levels of nitrogen and phosphorous concentrations downstream of Bordeaux. One tributary of the Garonne, the Dropt, is particularly sensitive to eutrophication (Devault et al., 2007; UNEP, 2004). The pollution of a few heavy metals is observed in the Garonne due to industrial activities, especially mining in the basin. This contamination is considered as critical because of the sensitivity of the marine ecosystems located at the downstream (Grousset et al., 1999) .

Table 8. Priority basins regarding the blue water footprint of production in France.

River basin	Month	Level of scarcity	Products with significant contribution to the blue water footprint in the basin (% of contribution)
Loire	August	Significant	Maize (58%), industrial production (6%)
	September	Significant	Maize (45%), industrial production (10%)
Seine	July	Moderate	Industrial production (28%), maize (18%), domestic water supply (12%), potato (11%)
	August	Severe	Maize (38%), industrial production (21%), domestic water supply (9%), potato (%7), sugar beet (%6)
	September	Severe	Industrial production (28%), maize (27%), domestic water supply (12%)
	October	Moderate	Industrial production (5 %), domestic (24%)
Garonne	July	Moderate	Maize (54%), soybean (1 %), fodder (5%)
	August	Significant	Maize (59%), soybean (7%)
	September	Severe	Maize (69%), soybean (8%)
Escaut	July	Significant	Industrial production (61%), domestic water supply (17%), potato (10%)
	August	Severe	Industrial production (57%), domestic water supply (16%), maize (10%), potato (8%)
	September	Severe	Industrial production (70%), domestic water supply (20%)
	October	Severe	Industrial production (77%), domestic water supply (22%)

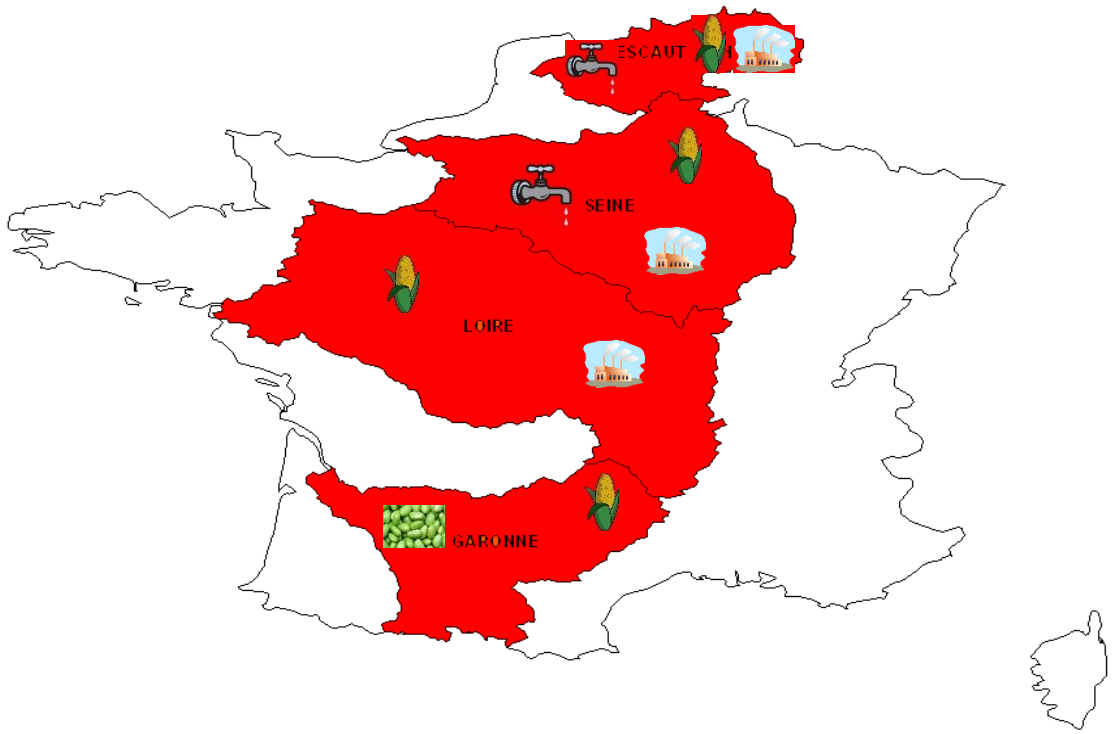

Figure 18. Priority basins and products regarding the blue water footprint of production in France.

A significant portion of the blue water footprint of production in France is for production of export commodities. Around 60% of the agricultural blue water footprint and 40% of the industrial blue water footprint of production are not for producing commodities for internal consumption but for production of export goods. Therefore, some of the impacts of the water footprint of production in French river basins are due to consumption happening elsewhere in the world but not in France.

4.2 Water footprint of consumption

The blue water footprint of French consumption is partly within France and partly outside. In many of the basins where part of the water footprint of French consumption is located, water scarcity is beyond hundred per cent during part of the year. All those basins are shown in Appendix IV, which also shows, per basin, the size of the water footprint of French consumers in the basin and the number of months that the basin experiences different levels of water scarcity.

Agricultural products. We will focus first on the water footprint of French consumption of agricultural products. Table 9 presents the river basins across the globe where there is a significant blue water footprint related to French consumption of agricultural products and where there is moderate, significant or severe water scarcity during part of the year. A 'significant' blue water footprint in a basin means here that at least 1% of the blue water footprint of French consumption of agricultural products is located in this basin. The table also shows a list of river basins where less than 1% of the blue water footprint of French consumption of agricultural products is located. In these basins, water scarcity is severe during part of the year (or even the full year) and the contribution of one or more specific agricultural commodities to the total blue water footprint in the basin in the period of severe scarcity is very significant (more than 20%). Although France imports this or these products in relative small amounts (less than 1% of the blue water footprint of French consumption of agricultural products is located in those basins), these products are obviously contributing to very unsustainable conditions. Table 9 shows, per basin, the number of months per year that the basin faces moderate, significant or severe water scarcity, and priority products per basin. These priority products are the products that contribute significantly to the basin's blue water scarcity and are imported by France. The basins listed in Table 9 are shown on the world map in Figure 19.

The Aral Sea basin is identified as one of the most important priority basins, since 6% of the blue water footprint of French consumption of agricultural products is located there. The basin experiences one month of moderate water scarcity (June) and four months of severe water scarcity (July to October). Cotton production is the dominant factor in the blue water scarcity of the basin (more than 50%). Next in line of the priority basins are the four French river basins that were already identified in the previous section as well: the Garonne, Loire, Escaut and Seine basins. The blue water footprints within those basins lead to moderate to severe water scarcity during parts of the year. For an important part, the blue water footprints of production in these basins relate to producing for the domestic market. A sixth priority basin is the Indus basin, in which 4% of the blue water footprint of French consumption of agricultural products is located. The basin faces severe water scarcity during eight months of the year. The blue water footprint in the Indus basin is mainly due to wheat, cotton, rice and

sugar cane production. However, wheat is not one of the products that France imports from Pakistan, thus it is not a product of major concern for French consumers.

The Ganges, Krishna, Godavari, Cauvery, Tapti and Penner basins are river basins in India that are identified as priority basins. All these basins experience severe water scarcity during most of the year. Rice and sugar cane production are the major reasons of blue water scarcity in these basins. The Guadalquivir, Guadiana, Douro and Tejo are Spanish-Portuguese river basins in which the blue water footprint of French consumption is significant. Sugar beet, maize, grapes, citrus and sunflower are the products that are imported by France and contribute largely to the blue water footprint in these basins.

As can be seen from Table 9, mainly eight agricultural products of concern are identified in 36 different priority basins: cotton, rice, sugar cane, sugar beet, soybean, maize and grape. Among them, cotton, sugar cane and rice are the three major crops. They have the largest share in the external blue water footprint of French consumption and are identified as products of concern in most of the priority basins. Therefore, we examined impacts of these three products in some of the identified priority basins in detail.

Cotton. Cotton is probably the most important product if it comes to the contribution of French consumers to blue water scarcity. French cotton consumption relates to blue water scarcity in a number of basins throughout the world: the Aral Sea basin (Uzbekistan), the Indus (Pakistan), the Guadalquivir (Spain and Portugal), the Tigris & Euphrates (originating in Turkey and ending in Iraq), the Mississippi (USA), the Yongding He (China), the Limpopo (South Africa), the San Joaquin (USA), the Tapti (India), and the Murray (Australia). The Aral Sea ecosystem has been experiencing sudden and severe ecosystem damage due to excessive water abstractions from the inflowing rivers to irrigate cotton fields and other export crops. This unsustainable use of water has environmental consequences, including fisheries loss, water and soil contamination, and dangerous levels of polluted airborne sediments. The impacts of extensive irrigation in the Aral Sea basin has extended far beyond the decline of the sea water level: millions of people lost access to the lake's water, fish, reed beds, and transport functions. Additionally, environmental and ecological problems associated with extensive water use for irrigation negatively affected human health and economic development in the region (Cai et al., 2003; Glantz, 1999; Micklin, 1988). Another well-documented case is the Murray basin in Australia, where water levels have declined significantly, particularly due to water abstractions for irrigation. Much of its aquatic life, including native fish, are now declining, rare or endangered (Chartres and Williams, 2006).

Table 9. Priority basins regarding the blue water footprint of French consumption of agricultural products.

River basin	Percentage of the blue water footprint of French consumption of agricultural products located in this basin	Number of months per year that a basin faces moderate, significant or severe water scarcity			Major contributing products
		Moderate	Significant	Severe	
Aral Sea basin	6.4	1	0	4	Cotton
Garonne	5.4	1	1	1	Maize, soybean, animal products
Escaut (Schelde)	4.5	0	1	3	Maize, potato
Loire	4.4	0	2	0	Maize
Indus	3.9	1	3	8	Cotton, rice, sugar cane
Guadalquivir	3.0	1	0	6	Cotton, sun flower, rice, sugar beet
Seine	2.2	2	0	2	Maize, potato, sugar beet
Ganges	2.2	0	2	5	Rice, sugar cane
Guadiana	1.8	1	0	6	Grapes, sunflower, citrus
Tigris & Euphrates	1.6	0	1	5	Cotton, rice
Po	1.6	2	0	0	Rice, animal products
Ebro	1.4	0	0	3	Maize
Sebou	1.4	1	1	5	Sugar beet
Douro	1.3	2	0	3	Maize, sugar beet
Tejo	1.0	1	0	4	Grapes, maize, animal products
Mississippi	0.60	2	0	2	Maize, soybean, rice, cotton
Krishna	0.45	1	1	7	Rice, sugar cane
Godavari	0.31	2	0	5	Rice, sugar cane
Kizilirmak	0.27	1	2	2	Sugar beet
Chao Phraya	0.26	2	1	4	Rice, sugar cane
Sakarya	0.25	0	1	5	Sugar beet
Bandama	0.21	0	0	2	Sugar cane, animal products
Cauvery	0.19	3	1	8	Rice, sugar cane
Yongding He	0.12	0	0	12	Cotton, soybean
Limpopo	0.11	2	0	5	Sugar cane, cotton
Sacramento	0.10	1	0	5	Rice
San Joaquin	0.10	1	0	7	Cotton, maize
Sassandra	0.08	0	0	2	Sugar cane
Comoe	0.08	0	0	2	Sugar cane
Tapti	0.07	2	1	5	Cotton, sugar cane
Murray	0.06	2	0	6	Sugar cane, cotton, rice
Penner	0.04	1	2	9	Rice
Incomati	0.03	1	0	3	Sugar cane
Tugela	0.02	2	0	3	Grape, animal products
Doring	0.01	0	1	7	Sugar cane, grapes
Nueces	0.01	0	0	12	Maize

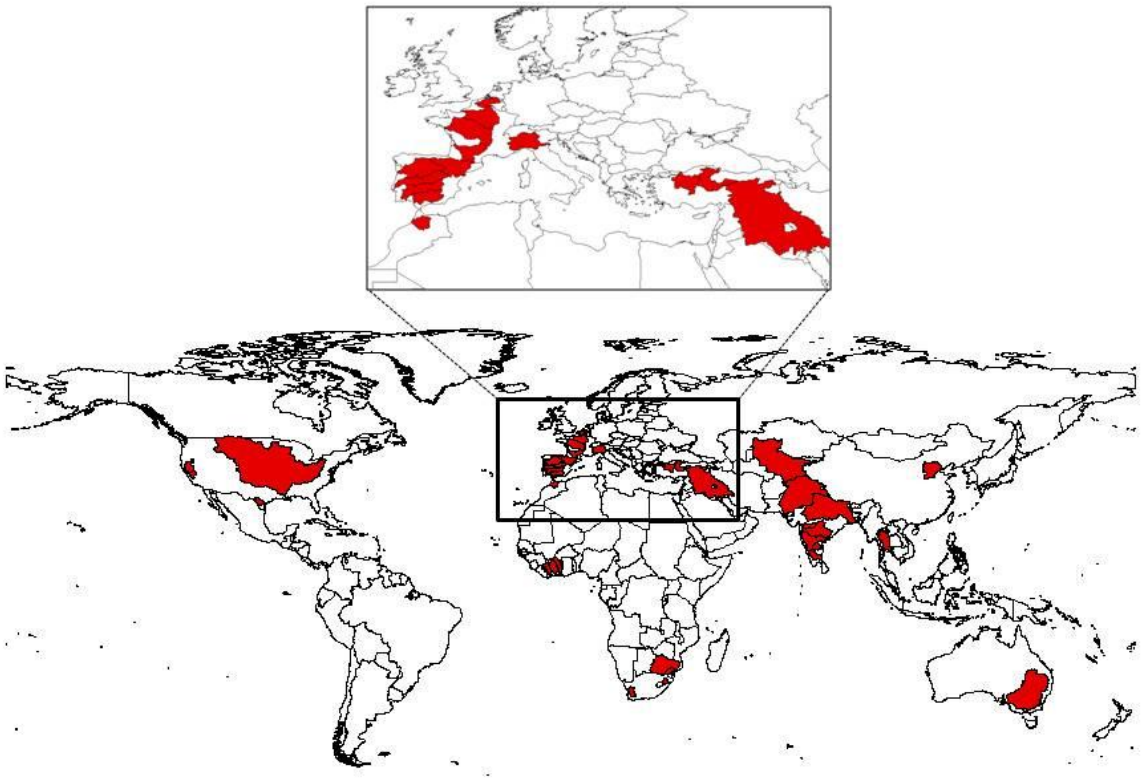

Figure 19. The river basins in the world in which the production of agricultural products for French consumption contributes to moderate, significant or severe blue water scarcity.

Sugar cane. Sugar cane is the second product if it comes to the contribution of French consumers to blue water scarcity in the world. Sugar cane consumed in France contributes to water scarcity in the following priority basins: the Indus (Pakistan), the Ganges (India), the Krishna (India), the Godavari (India), the Chao Phraya (Thailand), the Bandama (Côte d'Ivoire), the Cauvery (India), the Limpopo (South Africa), the Sassandra (Côte d'Ivoire), the Comoe (Côte d'Ivoire), the Tapti (India), the Murray (Australia), the Incomati (South Africa) and the Doring (South Africa). The freshwater reaching to Indus delta has significantly decreased (90%) as a result of over-usage of water sources in the Indus basin. Sugar cane is one of the main water consuming agricultural products in the basin. The decrease in freshwater flow to the Indus delta has negative impacts on the ecosystems and biodiversity of the delta (such as decrease of mangrove forestlands and danger of extinction of the Blind River Dolphin). Additionally, excessive water usage in sugar cane cultivation areas has led to salinity problems (WWF, 2004). Moreover, untreated wastewater discharge from sugar mills causes depletion of available oxygen in water sources, which threatens fish and other aquatic life (Akbar and Khwaja, 2006). India is also facing environmental problems due to sugar cane cultivation. In the Indian state of Maharashtra, sugar cane irrigation is 60% of the total irrigation supply, which causes substantial groundwater withdrawals (WWF, 2004). India's largest river, the Ganges, experiences severe water scarcity. Sugar cane is one of the major crops cultivated in the area and deteriorates the water scarcity. Another problem resulting from sugar cane cultivation and sugar processing activity in India is the pollution of surface and groundwater resources (grey water footprint) (Solomon, 2005).

Rice. Rice has the third largest share in the external blue water footprint of French consumption. In the following priority basins, rice is identified as one of the major products contributing to blue water scarcity: the basins of the Indus (Pakistan), Guadalquivir (Spain), Ganges (India), Tigris & Euphrates (Turkey to Iraq), Mississippi (USA), Krishna (India), Godavari (India), Chao Phraya (Thailand), Cauvery (India), Sacramento (USA) and Murray (Australia). The Guadalquivir is Spain's second longest river. Its natural environment is one of the most varied in Europe. Its middle reaches flow through a populous fertile region where its water is used extensively for irrigation. The lower course of the Guadalquivir is used for rice cultivation. In recent years, mass tourism and intensive irrigated agriculture in the region are causing over-exploitation of regional aquifers, which damages the ecosystem of the region (UNEP, 2004). The Guadalquivir marshes are negatively affected due to agricultural activities. The Guadalquivir is classified as one of the rivers in Europe mostly polluted due to non-point source emissions from agricultural activities (nitrate and phosphate) (Albiac and Dinar, 2008).

Industrial products. There are two river basins that face moderate to severe water scarcity during part of the year and where more than 1% of the blue water footprint of French consumption of industrial products is located: the Seine and the Escaut basins (Table 10). There are seven river basins where this contribution is smaller, but that can be classified as priority basin for another reason. These river basins are the basins of the Volga, St. Lawrence, Ob, Wisla, Don, Yongding He and Colorado. In these basins, water scarcity is severe during part of the year or even the full year, as in the case of the Yongding He (Table 10). Although France imports industrial products from these basins in relative small amounts (less than 1% of the blue water footprint of French consumption of industrial products is located in those basins), these products contribute to very unsustainable conditions because industrial products contribute more than 20% to the total blue water footprint in the basin in the period of severe scarcity.

Table 10. Priority basins regarding the blue water footprint of French consumption of industrial products.

River basin	Percentage of the blue water footprint of French consumption of industrial products located in this basin	Number of months per year that a basin faces moderate, significant or severe water scarcity		
		Moderate	Significant	Severe
Seine	5.5	2	0	2
Escaut (Schelde)	1.5	0	1	3
Volga	0.43	0	0	1
St. Lawrence	0.31	0	0	1
Ob	0.23	1	0	1
Wisla	0.14	0	0	1
Don	0.10	0	2	2
Yongding He	0.09	0	0	12
Colorado (Caribbean Sea)	0.01	1	0	6

Industrial products contribute to pollution as well. France's industrial grey water footprint is located mainly in the Seine, Loire, Rhone, Escaut, Garonne, Volga, Mississippi, Po, St. Lawrence, Tigris & Euphrates, Ob, Huang He (Yellow River) and Yangtze basins (Figure 20). China's longest river, the Yangtze, has been severely polluted. The surface water pollution in the river includes industrial and domestic sewage, animal manures, chemical fertilizers from farmlands, and polluted sediments. The Yellow River in China is known for pollution

problems as well. According to Chinese government estimates, around two-thirds of the Yellow River's water is too polluted to drink. Around 30% of fish species in the river are believed to have become extinct and the river's fish catch has declined by 40% (Fu et al., 2004).

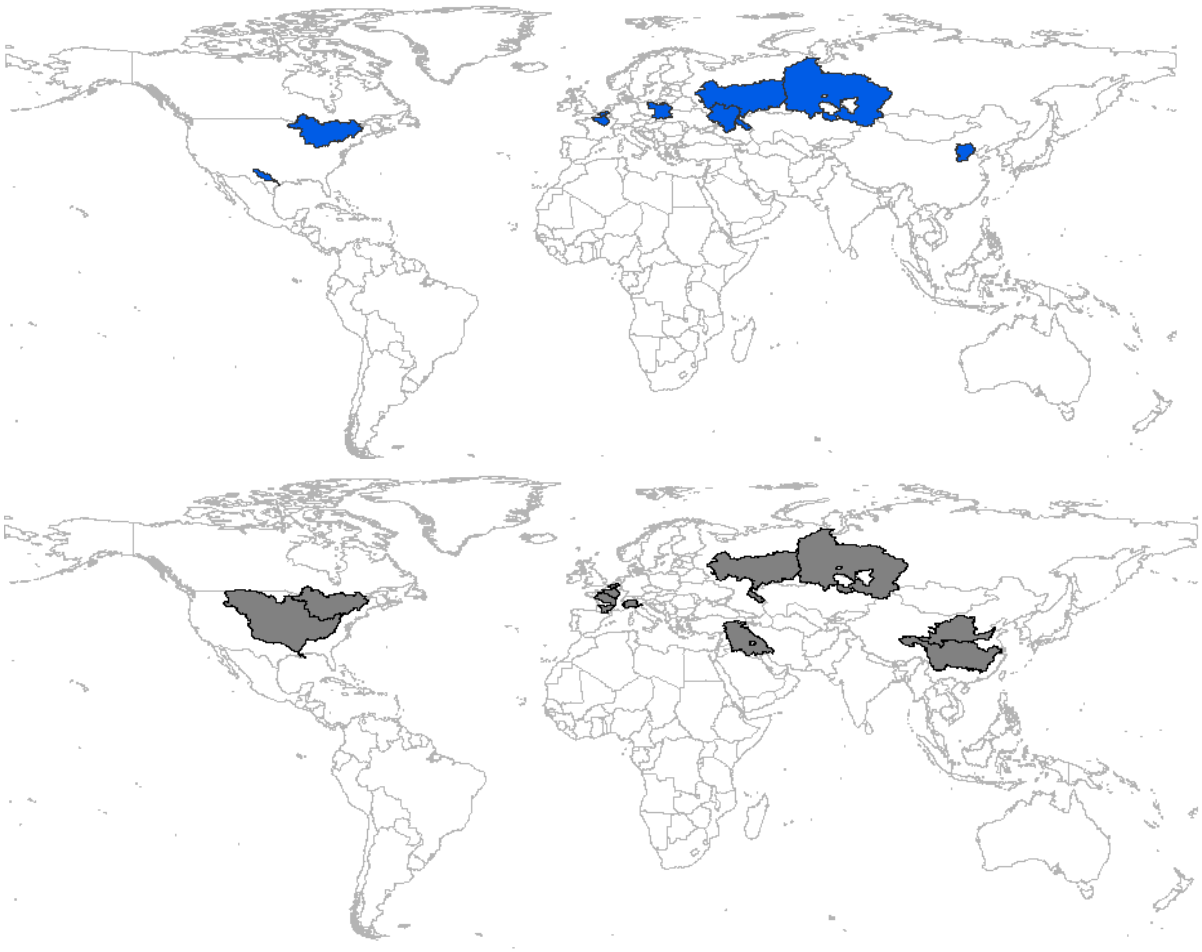

Figure 20. The river basins in the world in which the production of industrial products for French consumption contributes to moderate, significant or severe blue water scarcity (above) or significant water pollution (below).

5. Discussion and conclusion

This study of the water footprint of national production and consumption for France is more detailed than previous national water footprint studies (that were carried out for other countries). It builds on the high-resolution global water footprint study by Hoekstra and Mekonnen (2012) by zooming in on one particular country. The availability of the global study enabled us to map in a relatively precise way the external water footprint of French consumption. The study could make use of another recent study on global blue water scarcity (Hoekstra et al., 2012) to identify which parts of the French external water footprint are located in river basins that experience moderate to severe blue water scarcity during part of the year. The data that are thus generated can play a role in revisiting French national water policy. Linking specific consumer products in a country to water problems elsewhere is still uncommon in governmental thinking about water policy. Making this link visible can help in setting priorities in either national or international context with respect to the most effective measures to reduce water footprints in the basins where most needed. The study addresses questions like: where and when water footprints are largest, where and when they contribute most to local water scarcity and which specific products contribute most to water footprints and water scarcity? By making the links between specific consumer products and water problems visible, the study suggests that consumer product policy can be part of a water policy. The extent to which French government is willing to promote water footprint reductions in water-scarce basins and periods of the year through product-oriented policies is obviously a political question. This study shows how a political debate on this topic could be informed by relevant knowledge on how different products contribute to water scarcity.

Even though the study applies higher spatial and temporal resolutions than previous national water footprint studies, there are still limitations regarding the spatial and temporal detail, which primarily relate to lacking crop and irrigation data on even higher resolutions and to the problem of tracing supply chains and trade flows. One limitation in the study is that the origin of virtual water imports and the external water footprint of consumption have not been traced further than the first tier trade partners. If a product is imported from a country, we assume that the product has been produced in that country and we take the water footprint of the imported product accordingly. Another limitation related to trade data is that the origins of imported commodities are available on country level and not specified as per river basin or in even more geographic detail. In this study, we assumed that an imported product originates from the various river basins within the country proportionally to the production of that product in the various basins.

Another limitation in the study pertains to the problem of distinguishing between different industrial products. Different crop and animal products have been considered separately, but industrial commodities are treated as one product group. In future studies it would be worth trying to analyse different industrial sectors and commodities separately; currently, the major challenge still is the lack of water consumption and pollution data per industrial sector and the complexity of supply chains for many industrial commodities.

In this study, identification of priority river basins and priority products from the perspective of water resource use has been done primarily on the basis of data on the levels of blue water scarcity through the year on a river

basin level. More precise results would be obtained if we could use water scarcity data on a finer spatial resolution level, for example at the level of sub-catchments. Especially for identifying hotspots within large river basins, this would be very helpful. Furthermore, by looking at 'blue water scarcity' from an environmental point of view, we may have neglected social issues of water conflict. For obtaining a more complete overview of potential critical basins and products, it would be helpful to look at other indicators than environmental water scarcity alone. It should further be noted that the blue water scarcity estimates used in this study (from Hoekstra and Mekonnen, 2011; Hoekstra et al., 2012) excluded the evaporation from storage reservoirs and the effect of inter-basin water transfers. This may result in an underestimation of blue water scarcity in basins with significant evaporation from large reservoirs and export of water to another basin and an overestimation of water scarcity in basins that receive significant volumes of water from another basin. The water scarcity estimates also exclude storage effects of large dams, which means that water scarcity may have been underestimated in periods of the year in which water is being stored and overestimated in periods of the year in which the water is being released. Finally, we used a number of criteria to identify priority basins, with certain thresholds (like the threshold of 'at least 1% of the total blue water footprint should be located in the basin') that can be considered as subjective choices. Obviously, changing thresholds will lead to longer or shorter lists of 'priority basins'.

Despite the limitations of the study, it has been proven that it is possible to make a rough sketch of where different economic sectors contribute to scarcity within the country and of which consumer goods contribute to water scarcity in specific river basins outside the country. The study shows that analysis of the external water footprint of a nation is necessary to get a picture of how national consumption depends on foreign water resources.

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Appendix I: Water footprint related to agricultural and industrial production and domestic water supply at sub-national level (Mm^3/year)

Administration	Total related to agricultural production			Related to industrial production		Related to domestic water supply		Total water footprint			
	Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total
Alsace	960	23	182	45	170	19	67	960	87	419	1466
Aquitaine	3862	380	680	70	266	30	105	3862	480	1052	5394
Auvergne	1487	37	165	37	139	15	-55	1487	89	359	1934
Basse-Normandie	1510	13	139	37	142	16	56	1510	66	337	1912
Bourgogne	3885	63	452	42	158	18	62	3885	122	672	4680
Bretagne	3305	39	391	72	273	30	107	3305	141	771	4217
Centre	7823	354	970	66	252	28	99	7823	449	1321	9593
Champagne-Ardenne	4597	75	558	34	130	14	51	4597	123	738	5459
Corse	66	7	7	6	25	3	10	66	16	41	123
Franche-Comte	1003	10	129	31	117	13	46	1003	53	292	1349
Haute-Normandie	1781	13	176	44	166	18	65	1781	76	407	2264
Ile-de-France	1959	72	227	267	1016	113	399	1959	452	1642	4053
Languedoc-Roussillon	2475	158	174	58	221	25	87	2475	241	481	3197
Limousin	312	5	37	17	65	7	26	312	29	128	469
Lorraine	2351	1	271	66	250	28	99	2351	95	619	3064
Midi-Pyrenees	5676	597	882	66	252	28	99	5676	691	1233	7600
Nord-Pas-de-Calais	2162	41	284	86	331	36	128	2162	163	743	3068
Pays de la Loire	3968	247	521	82	312	35	122	3968	363	955	5287
Picardie	3978	109	471	61	230	26	90	3978	195	791	4964
Poitou-Charentes	5322	307	817	40	152	17	60	5322	364	1029	6715
Provence-Alpes-Cote d'Azur	1476	155	114	109	414	46	163	1476	310	690	2476
Rhone-Alpes	2698	146	361	151	574	64	226	2698	361	1162	4220
France total	62700	2849	8018	1488	5654	628	2221	62700	4965	15894	83559

Source of data: Mekonnen and Hoekstra (2011b).

Appendix II: Water footprint of crop production in France (Mm^3/year)

Crop	Green WF	Blue WF	Grey WF	Total WF
Wheat	21014.03	48.09	198.82	21260.94
Rice	55.80	87.17	0.00	142.97
Barely	5387.63	41.44	1434.40	6863.48
Maize	6509.89	1409.36	2391.04	10310.29
Rye	128.24	0.00	0.00	128.24
Oats	442.36	30.78	0.00	473.14
Millet	5.66	0.00	0.00	5.66
Sorghum	160.42	5.73	0.00	166.15
Buckwheat	54.94	4.39	0.00	59.33
Triticale	757.74	69.60	0.00	827.34
Mixed grain	222.13	25.78	0.00	247.91
Potato	515.71	104.28	306.81	926.81
Sugar beet	1328.92	39.17	212.97	1581.06
Beans, dry	7.94	0.35	0.00	8.29
Broad beans, dry	77.12	4.85	0.00	81.97
Peas, dry	1040.65	54.87	0.00	1095.52
Lentils	19.05	1.34	0.00	20.38
Lupins	16.76	1.11	0.00	17.87
Pulses nes	4.36	0.30	175.56	180.22
Chestnuts	37.48	6.89	0.00	44.37
Almonds	8.33	1.17	0.00	9.50
Walnuts	87.39	16.06	0.00	103.45
Hazelnuts (filberts)	14.27	2.62	0.00	16.89
Soybean	330.03	98.35	53.70	482.08
Olives	87.37	5.41	9.39	102.17
Sunflower	2096.65	18.54	888.68	3003.87
Rapeseed	4222.00	18.19	686.18	4926.37
Mustard seed	1.36	0.00	0.55	1.91
Poppy seed	9.22	0.00	6.87	16.09
Linseed	207.81	13.03	0.00	220.84
Hempseed	31.23	0.00	4.17	35.40
Cabbages	34.59	9.49	8.58	52.66
Artichokes	62.63	19.18	10.05	91.85
Asparagus	43.73	9.72	7.31	60.76
Lettuce	46.45	7.79	15.25	69.49
Spinach	8.73	1.36	5.44	15.53
Tomatoes	24.44	8.79	6.29	39.53
Cauliflower	87.46	13.00	26.37	126.83
Pumpkins, squash, gourds	12.35	0.92	3.86	17.13

Appendix II - continued

Crop	Green WF	Blue WF	Grey WF	Total WF
Cucumbers and gherkins	3.33	0.69	0.91	4.93
Eggplants	1.74	0.54	0.49	2.77
Chillies and peppers, green	2.22	0.72	0.65	3.59
Onions + shallots, green	3.48	0.57	2.02	6.07
Onions	34.81	14.30	8.05	57.16
Garlic	9.45	0.32	3.84	13.61
Beans, green	18.24	2.28	8.10	28.62
Peas, green	78.92	11.49	28.28	118.68
String beans	79.91	8.96	29.47	118.33
Carrots	49.06	15.70	13.56	78.32
Green maize (corn)	80.02	29.81	22.61	132.44
Vegetables fresh nes	550.83	225.51	178.48	954.82
Oranges	0.25	0.02	0.01	0.27
Tangerine, mandarin, clement, satsma	9.21	0.82	0.22	10.24
Lemons and limes	0.19	0.02	0.00	0.21
Grapefruit and pomelos	1.62	0.14	0.04	1.80
Apples	361.94	61.78	7.28	430.99
Pears	66.59	11.37	1.34	79.29
Apricots	82.76	12.01	1.71	96.48
Cherries	68.88	11.76	1.38	82.03
Peaches and nectarines	118.84	17.24	2.45	138.53
Plums	109.64	18.71	2.20	130.56
Strawberries	11.68	4.23	0.47	16.39
Raspberries	2.31	0.69	0.15	3.15
Currants	5.86	1.19	0.28	7.34
Grapes	3576.66	22.02	95.03	3693.72
Watermelons	0.76	0.17	0.03	0.95
Cantaloupes and other melons	43.60	2.78	1.83	48.21
Figs	2.14	0.19	0.05	2.39
Avocados	0.10	0.02	0.00	0.12
Kiwi fruit	20.03	6.89	0.46	27.38
Hops	2.46	0.25	0.00	2.71
Flax fibre and tow	248.05	23.88	0.00	271.93
Hemp fibre and tow (hemp tow waste)	3.04	0.00	0.00	3.04
Tobacco	25.72	0.00	0.00	25.72
Fodder crops	11822.99	162.87	1154.74	13140.60

Source of data: Mekonnen and Hoekstra (2010a).

Appendix III: Water footprint of French consumption per agricultural product (Mm^3/year)

Product	Total WF
Wheat	3855
Rice (Milled Equivalent)	742
Barley	9
Maize	548
Rye	32
Oats	16
Cereals, Other	12
Potatoes	721
Roots, Other	1
Sugar (Raw Equivalent)	1828
Sweeteners, Other	2121
Beans	81
Peas	20
Pulses, Other	74
Nuts	849
Soybeans	3
Groundnuts (Shelled Eq)	376
Rape and Mustard seed	7
Coconuts - Incl Copra	101
Olives	178
Soybean Oil	378
Groundnut Oil	613
Sunflowerseed Oil	1997
Rape and Mustard Oil	455
Cottonseed Oil	0
Palm kernel Oil	63
Palm Oil	147
Coconut Oil	2
Sesame seed Oil	57
Olive Oil	1150
Maize Germ Oil	43
Oilcrops Oil, Other	1658
Tomatoes	100
Onions	61
Vegetables, Other	1404
Oranges, Mandarins	1192
Lemons, Limes	59
Grapefruit	143

Product	Total WF
Citrus, Other	2
Bananas	94
Plantains	9
Apples	148
Pineapples	23
Dates	44
Grapes	110
Fruits, Other	1173
Coffee	5311
Cocoa Beans	4289
Tea	170
Pepper	63
Pimento	11
Cloves	20
Spices, Other	112
Wine	2492
Beer	255
Cotton Lint	763
Jute	5
Soft-Fibres, Other	79
Sisal	8
Abaca	1
Hard Fibres, Other	8
Tobacco	252
Rubber	3387
Bovine Meat	13147
Mutton & Goat Meat	993
Pigmeat	8437
Poultry Meat	3703
Meat, Other	9890
Fats, Animals, Raw	784
Butter, Ghee	1518
Cream	260
Hides & Skins	333
Offals	1999
Milk	9699
Eggs	1535

Appendix IV: Water footprint of French consumers in major river basins experiencing moderate to severe water scarcity during part of the year

River basin	Countries partly or fully laying with the basin	Water footprint related to consumption of agricultural products (m^3/year)			Water footprint related to consumption of industrial products (m^3/year)		Water footprint related to domestic water supply (m^3/year)		Total water footprint (m^3/year)				Number of months per year that the basin faces low, moderate, significant or severe blue water scarcity			
		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Low	Moderate	Significant	Severe
Loire	France	8559040000	263409000	836010000	115075000	115075000	82492400	291783000	8559040000	460976400	1242868000	10262884400	10	0	2	0
Seine	France; Belgium	7989540000	132653000	730690000	229302000	229302000	164233000	580905000	7989540000	526188000	1540897000	10056625000	8	2	0	2
Garonne	France; Spain; Andorra	4389030000	323881000	532352000	48532800	48527000	34776800	123009000	4389030000	407190600	703888000	5500108600	9	1	1	1
Escaut (Schelde)	Netherlands; France; Belgium	4158710000	265554000	300067000	60719800	60719800	24962800	88295500	4158710000	351236600	449082300	4959028900	8	0	1	3
Ganges	China; Nepal; India; Bangladesh	702169000	130319000	78960200	3193040	3193040	0	0	702169000	133512040	82153240	917834280	5	0	2	5
Bandama	Mali; Côte d'Ivoire	778226000	12331500	1736200	11460	11460	0	0	778226000	12342960	1747660	792316621	10	0	0	2
Douro	Spain; Portugal	485383000	76840400	52581500	2022670	528516	0	0	485383000	78863070	53110016	617356086	7	2	0	3
Guadalquivir	Spain	399577000	177397000	21335900	2468560	0	0	0	399577000	179865560	21335900	600778460	5	1	0	6
Po	France; Switzerland; Italy	423319000	94587900	43856000	14541500	14541500	222123	785668	423319000	109351523	59183168	591853691	10	2	0	0
Indus	China; Afghanistan; Pakistan; Nepal; India	259373000	229318000	71196900	1685980	1685980	0	0	259373000	231003980	72882880	563259860	0	1	3	8
Ebro	France; Spain; Andorra	427588000	82987100	39667600	2000360	187891	134691	476413	427588000	85122151	40331904	553042055	9	0	0	3
Mississippi	USA; Canada	413629000	35466700	63379100	15737500	15737500	0	0	413629000	51204200	79116600	543949800	8	2	0	2
Niger	Algeria; Mauritania; Mali; Niger; Chad; Burkina Faso; Nigeria; Guinea; Côte d'Ivoire; Sierra Leone; , Benin; Cameroon	496501000	3805570	1195930	694960	694960	0	0	496501000	4500530	1890890	502892420	10	0	0	2
Sassandra	Guinea; Côte d'Ivoire	490897000	4618890	881639	9634	9634	0	0	490897000	4628524	891273	496416796	10	0	0	2
Guadiana	Spain; Portugal	345241000	106266000	32798000	943656	95070	0	0	345241000	107209656	32893070	485343726	5	1	0	6
Volta	Mali; Burkina Faso; Togo; Côte d'Ivoire; Benin; Ghana	472681000	1021280	865438	35693	35693	0	0	472681000	1056973	901131	474639104	11	0	0	1
Aral Sea basin	Kazakhstan; Uzbekistan; Kyrgyzstan; Turkmenistan; Tajikistan; China; Afghanistan; Pakistan	63022300	379939000	749906	1700440	1700440	0	0	63022300	381639440	2450346	447112086	7	1	0	4
Tejo	Spain; Portugal	249307000	60763300	25394900	4146590	278174	0	0	249307000	64909890	25673074	339889964	7	1	0	4
Salado	Argentina	325531000	336892	3136130	7156	7156	0	0	325531000	344048	3143286	329018334	11	0	0	1
Nile	Egypt; Sudan; Eritrea; Ethiopia; Central African Republic; Congo, Dem Republic of; Kenya; Uganda; Tanzania; Rwanda; Burundi	237133000	45426100	8254080	628913	628913	0	0	237133000	46055013	8882993	292071006	10	0	0	2
Mekong	China; Myanmar; Viet Nam; Laos; Thailand; Cambodia	247914000	6133570	30184800	2949750	2949750	0	0	247914000	9083320	33134550	290131870	8	1	0	3
Sanaga	Nigeria; Central African Republic; Cameroon	288027000	71242	459781	55035	55035	0	0	288027000	126277	514816	288668093	11	0	0	1
Comoe	Mali; Burkina Faso; Côte d'Ivoire; Ghana	280960000	4616420	721360	6142	6142	0	0	280960000	4622562	727502	286310063	10	0	0	2
Krishna	India	227511000	26774100	12254200	602074	602074	0	0	227511000	27376174	12856274	267743448	3	1	1	7

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River basin	Countries partly or fully laying with the basin	Water footprint related to consumption of agricultural products (m^3/year)			Water footprint related to consumption of industrial products (m^3/year)		Water footprint related to domestic water supply (m^3/year)		Total water footprint (m^3/year)				Number of months per year that the basin faces low, moderate, significant or severe blue water scarcity			
		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Low	Moderate	Significant	Severe
Nelson	USA; Canada	188013000	3325300	26055100	916876	916876	0	0	188013000	4242176	26971976	219227152	10	0	0	2
Godavari	India	171843000	18462400	10396600	487898	487898	0	0	171843000	18950298	10884498	201677796	5	2	0	5
Chao Phraya	Thailand; Myanmar; Laos; Cambodia	137987000	15346900	28688600	776258	776258	0	0	137987000	16123158	29464858	183575016	5	2	1	4
Tigris & Euphrates	Turkey; Iran; Iraq; Syria; Jordan; Saudi Arabia	38358800	96249100	8735580	11057100	11057100	0	0	38358800	107306200	19792680	165457680	6	0	1	5
Lake Chad	Algeria; Libyan Arab Jamahiriya; Niger; Chad; Sudan; Nigeria; Central African Republic; Cameroon	148018000	761359	258595	260368	260368	0	0	148018000	1021727	518963	149558690	9	0	0	3
Dniepr	Russia; Belarus; Ukraine	127420000	4004780	4125660	2288000	2288000	0	0	127420000	6292780	6413660	140126440	11	0	0	1
Sebou	Morocco	47084500	82858500	1686960	583051	583051	0	0	47084500	83441551	2270011	132796062	5	1	1	5
Huang He (Yellow River)	China	70453200	9768990	23560300	6672290	6672290	0	0	70453200	16441280	30232590	117127070	5	1	2	4
Lake Mar Chiquita	Argentina	112477000	1882250	1248160	15598	15598	0	0	112477000	1897848	1263758	115638605	6	1	1	4
Wisla	Belarus; Poland; Ukraine; Czech Republic; Slovakia	78146300	13029200	7701750	5770780	5770780	0	0	78146300	18799980	13472530	110418810	11	0	0	1
St.Lawrence	USA; Canada	71298100	642983	10522800	12938200	12938200	0	0	71298100	13581183	23461000	108340283	11	0	0	1
Huai He	China	55899500	4411660	15545100	4058230	4058230	0	0	55899500	8469890	19603330	83972720	5	1	5	1
Cauvery	India	67988800	11125100	3693170	274432	274432	0	0	67988800	11399532	3967602	83355934	0	3	1	8
Volga	Russia; Kazakhstan	36696600	2609410	1252410	18116500	18116500	0	0	36696600	20725910	19368910	76791420	11	0	0	1
Amur	Russia; Mongolia; Korea, Dem People's Rep; China	45397000	3056280	11942900	3830190	3830190	0	0	45397000	6886470	15773090	68056560	10	0	0	2
Mahanadi(Mahahadi)	India	57456900	4034550	5315770	216812	216812	0	0	57456900	4251362	5532582	67240844	7	0	0	5
Yongding He	China	38697600	7223980	13371900	3784930	3784930	0	0	38697600	11008910	17156830	66863340	0	0	0	12
Daule & Vinces	Ecuador	64533700	310317	238515	5364	5364	0	0	64533700	315681	243879	65093260	9	2	1	0
Narmada	India	50367500	8854930	3448300	133210	133210	0	0	50367500	8988140	3581510	62937150	5	2	0	5
Gambia	Senegal; Gambia; Guinea-Bissau; Guinea	59979900	3010	61390	4983	4983	0	0	59979900	7993	66373	60054267	8	0	0	4
Hong(Red River)	China; Viet Nam; Laos	48437500	322241	4120950	2951670	2951670	0	0	48437500	3273911	7072620	58784031	8	0	1	3
Don	Russia; Ukraine	45300600	2873590	1412270	4379850	4379850	0	0	45300600	7253440	5792120	58346160	8	0	2	2
Davo	Côte d'Ivoire	55290300	279035	93662	1590	1590	0	0	55290300	280625	95252	55666177	10	0	0	2
Murray	Australia	43752300	3660460	926852	93388	93388	0	0	43752300	3753848	1020240	48526389	4	2	0	6
Kizilirmak	Turkey	26997300	16303000	4650310	273219	273219	0	0	26997300	16576219	4923529	48497048	7	1	2	2
Ob	Russia; Kazakhstan; Mongolia; China	25097000	1938720	749183	9830360	9830360	0	0	25097000	11769080	10579543	47445623	10	1	0	1

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River basin	Countries partly or fully laying with the basin	Water footprint related to consumption of agricultural products (m^3/year)			Water footprint related to consumption of industrial products (m^3/year)		Water footprint related to domestic water supply (m^3/year)		Total water footprint (m^3/year)				Number of months per year that the basin faces low, moderate, significant or severe blue water scarcity			
		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Low	Moderate	Significant	Severe
Pra	Ghana	47271800	25705	51346	15904	15904	0	0	47271800	41609	67250	47380659	11	0	0	1
Thames	UK	34841900	696201	2534940	3829870	3829870	0	0	34841900	4526071	6364810	45732781	9	1	1	1
Rio De Contas	Brazil	44760500	548004	280572	15717	15717	0	0	44760500	563721	296289	45620509	10	2	0	0
Lempa	Guatemala; Honduras; El Salvador	41858500	110017	1635380	2588	2588	0	0	41858500	112605	1637968	43609074	8	0	0	4
Cross	Nigeria; Cameroon	43084800	510	51236	95455	95455	0	0	43084800	95965	146690	43327455	11	0	0	1
Rio Jaguaribe	Brazil	40933700	940535	653293	23506	23506	0	0	40933700	964041	676799	42574539	7	1	1	3
Tapti	India	35611400	4304290	2026030	132510	132510	0	0	35611400	4436800	2158540	42206740	4	2	1	5
Sakarya	Turkey	22109900	14943600	3751890	346390	346390	0	0	22109900	15289990	4098280	41498170	6	0	1	5
Orange	Namibia; Botswana; South Africa; Lesotho	30417200	6201830	1852170	141999	141999	0	0	30417200	6343829	1994169	38755198	6	2	1	3
Columbia	USA; Canada	14632500	11597600	7830980	1369530	1369530	0	0	14632500	12967130	9200510	36800140	10	2	0	0
Damodar	India	28911000	1818960	2628820	222267	222267	0	0	28911000	2041227	2851087	33803314	5	3	0	4
Southern Bug	Ukraine	30055800	576869	854613	99695	99695	0	0	30055800	676564	954308	31686671	6	3	2	1
Tano	Côte d'Ivoire; Ghana	30759800	80578	40965	4588	4588	0	0	30759800	85166	45553	30890518	11	0	0	1
Dniestr	Poland; Ukraine; Moldova	27965900	619105	864894	259078	259078	0	0	27965900	878183	1123972	29968055	11	0	0	1
Penner	India	25748900	2200730	1241420	85514	85514	0	0	25748900	2286244	1326934	29362079	0	1	2	9
Liao He	China	17533200	2724590	5564910	1251010	1251010	0	0	17533200	3975600	6815920	28324720	7	1	0	4
Brahmani River (Bhahmani)	India	23350300	824794	2048510	97347	97347	0	0	23350300	922141	2145857	26418297	8	0	0	4
Rio Itapicuru	Brazil	24916500	96337	259869	10744	10744	0	0	24916500	107081	270613	25294194	9	0	0	3
Senegal	Mauritania; Mali; Senegal; Guinea	22967400	401093	103190	140265	140265	0	0	22967400	541358	243455	23752213	8	0	0	4
Solo (Bengawan Solo)	Indonesia	21662500	47278	1895610	25549	25549	0	0	21662500	72827	1921159	23656485	8	1	0	3
Ulua	Guatemala; Honduras	22383600	58132	1165580	2468	2468	0	0	22383600	60600	1168048	23612248	9	1	0	2
Mono	Togo; Benin; Ghana	23098400	3989	110484	988	988	0	0	23098400	4977	111472	23214849	11	0	0	1
Limpopo	Mozambique; Zimbabwe; Botswana; South Africa	14623100	6682430	756786	166651	166651	0	0	14623100	6849081	923437	22395618	5	2	0	5
Mahi	India	17436300	2356450	1205280	86445	86445	0	0	17436300	2442895	1291725	21170920	5	2	0	5
Kura	Russia; Georgia; Turkey; Armenia; Azerbaijan; Iran	8657560	7260600	1544530	1498210	1498210	0	0	8657560	8758810	3042740	20459110	8	1	1	2
Negro (Uruguay)	Brazil; Uruguay	19437400	332806	325038	2050	2050	0	0	19437400	334856	327088	20099344	11	0	0	1
Shebelle	Somalia; Ethiopia; Kenya	17825400	786992	195982	1869	1869	0	0	17825400	788861	197851	18812112	10	0	0	2

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River basin	Countries partly or fully laying with the basin	Water footprint related to consumption of agricultural products (m^3/year)			Water footprint related to consumption of industrial products (m^3/year)		Water footprint related to domestic water supply (m^3/year)		Total water footprint (m^3/year)				Number of months per year that the basin faces low, moderate, significant or severe blue water scarcity			
		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Low	Moderate	Significant	Severe
Oueme	Nigeria; Togo; Benin	18199600	31356	57547	25413	25413	0	0	18199600	56769	82960	18339329	10	0	0	2
Colorado (Argentinia)	Chile; Argentina	12202500	5330490	441445	115798	115798	0	0	12202500	5446288	557243	18206031	9	0	2	1
Santiago	Mexico	15273200	1032200	564648	120636	120636	0	0	15273200	1152836	685284	17111320	6	1	0	5
Brazos	USA	11048200	3294100	1545150	594649	594649	0	0	11048200	3888749	2139799	17076748	5	0	1	6
Gudena	Denmark	13574800	1681540	1268470	138231	138231	0	0	13574800	1819771	1406701	16801272	11	1	0	0
Brantas	Indonesia	14974200	27488	1172240	20700	20700	0	0	14974200	48188	1192940	16215328	8	1	1	2
Neman	Russia; Latvia; Lithuania; Belarus; Poland	9622600	2429710	1022640	773476	773476	0	0	9622600	3203186	1796116	14621902	11	0	0	1
Lake Turkana	Sudan; Ethiopia; Kenya; Uganda	13618100	341195	89374	859	859	0	0	13618100	342054	90233	14050388	11	0	0	1
Rio Paraiba	Brazil	11926700	150971	149057	13587	13587	0	0	11926700	164558	162644	12253902	8	2	0	2
Sacramento	USA	2086190	5876080	2028320	634121	634121	0	0	2086190	6510201	2662441	11258832	6	1	0	5
San Joaquin	USA	2259520	5756810	2291590	351781	351781	0	0	2259520	6108591	2643371	11011482	4	1	0	7
Ca	Viet Nam; Laos	9609230	6936	529012	392052	392052	0	0	9609230	398988	921064	10929282	9	2	0	1
Ural	Russia; Kazakhstan	6304670	1235830	222414	1455510	1455510	0	0	6304670	2691340	1677924	10673934	8	2	1	1
Maputo	Mozambique; South Africa; Swaziland	6589560	3857870	52439	9619	9619	0	0	6589560	3867489	62058	10519107	8	1	0	3
Panuco	Mexico	9041220	707409	283396	119754	119754	0	0	9041220	827163	403150	10271533	7	1	0	4
Colorado(Pacific Ocean)	USA; Mexico	2228220	4138320	757219	1560490	1560490	0	0	2228220	5698810	2317709	10244739	4	0	3	5
Tarim	Kyrgyzstan; Tajikistan; China; Afghanistan; Pakistan	3097350	3846900	2376980	378279	378279	0	0	3097350	4225179	2755259	10077788	1	1	1	9
Mae Klong	Myanmar; Thailand	7730700	641858	1563020	46223	46223	0	0	7730700	688081	1609243	10028024	9	0	0	3
Nyong	Cameroon	9977110	27	9828	15614	15614	0	0	9977110	15641	25442	10018192	11	0	0	1
Luan He	China	5605270	858071	1872090	463082	463082	0	0	5605270	1321153	2335172	9261595	6	1	0	5
Narva	Russia; Latvia; Belarus; Estonia	5506250	1759020	715960	246984	246984	0	0	5506250	2006004	962944	8475198	10	0	0	2
Salween	China; Myanmar; Thailand	7312810	153252	601446	149924	149924	0	0	7312810	303176	751370	8367356	11	1	0	0
Han-Gang (Han River)	Korea, Dem People's Rep; Korea, Republic of	5176430	1195650	888215	530564	530564	0	0	5176430	1726214	1418779	8321423	11	0	0	1
Colorado(Caribbean Sea)	USA	5175480	1750420	670432	351566	351566	0	0	5175480	2101986	1021998	8299464	5	1	0	6
Rio Vaza-Barris	Brazil	7970260	58480	126129	4731	4731	0	0	7970260	63211	130860	8164331	9	0	0	3
Balkhash	Kazakhstan; Kyrgyzstan; China	1441170	2663600	622920	1662760	1662760	0	0	1441170	4326360	2285680	8053210	7	0	2	3
Bravo	USA; Mexico	3259100	2580050	664739	609135	609135	0	0	3259100	3189185	1273874	7722159	1	0	4	7

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River basin	Countries partly or fully laying with the basin	Water footprint related to consumption of agricultural products (m^3/year)			Water footprint related to consumption of industrial products (m^3/year)		Water footprint related to domestic water supply (m^3/year)		Total water footprint (m^3/year)				Number of months per year that the basin faces low, moderate, significant or severe blue water scarcity			
		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Low	Moderate	Significant	Severe
Sittang	Myanmar	6599030	7317	1539	10308	10308	0	0	6599030	17625	11847	6628502	8	0	1	3
Trinity(Texas)	USA	3709440	54893	406165	1143160	1143160	0	0	3709440	1198053	1549325	6456818	8	1	1	2
Dead Sea	Syria; Lebanon; Jordan; Israel; West Bank; Egypt	1595210	3828820	639538	168166	168166	0	0	1595210	3996986	807704	6399900	4	0	0	8
Kuban	Russia; Georgia	2970580	549248	93627	1024330	1024330	0	0	2970580	1573578	1117957	5662115	10	2	0	0
Chelif	Algeria	3258730	1381670	122716	338534	338534	0	0	3258730	1720204	461250	5440184	5	0	1	6
Incomati	Mozambique; South Africa; Swaziland	3262420	1763080	79471	18868	18868	0	0	3262420	1781948	98339	5142708	8	1	0	3
Tana	Kenya	4145900	769569	85746	2389	2389	0	0	4145900	771958	88135	5005993	11	0	0	1
Apalachicola	USA	2927260	251886	384862	622760	622760	0	0	2927260	874646	1007622	4809528	11	1	0	0
Geba	Senegal; Guinea-Bissau; Guinea	4618930	287	5842	360	360	0	0	4618930	647	6202	4625779	8	0	0	4
Western Dvina (Daugava)	Russia; Latvia; Lithuania; Belarus; Estonia	2644150	856975	327922	336562	336562	0	0	2644150	1193537	664484	4502171	10	0	0	2
Papaloapan	Mexico	4277330	54261	123338	17309	17309	0	0	4277330	71570	140647	4489548	8	0	0	4
Save	Mozambique; Zimbabwe	3372860	572860	77990	1688	1688	0	0	3372860	574548	79678	4027086	8	1	1	2
Vaenern-Goeta	Sweden; Norway	2000720	105966	190984	728411	728411	0	0	2000720	834377	919395	3754492	11	0	0	1
Van Golu	Turkey; Iran	1700730	1414880	299927	54323	54323	0	0	1700730	1469203	354250	3524183	11	0	0	1
Neva	Finland; Russia; Belarus	931163	31284	38595	1261440	1261440	0	0	931163	1292724	1300035	3523922	10	0	0	2
Hudson	USA	1633900	3878	224953	819672	819672	0	0	1633900	823550	1044625	3502075	11	0	0	1
Fitzroy	Australia	3245670	142419	78603	5990	5990	0	0	3245670	148409	84593	3478672	7	1	0	4
Dalinghe	China	2290900	133600	674562	184116	184116	0	0	2290900	317716	858678	3467294	6	0	0	6
Great Salt Lake	USA	983436	1306750	238764	469004	469004	0	0	983436	1775754	707768	3466958	5	1	0	6
Issyk-Kul	Kazakhstan; Kyrgyzstan	590137	1589070	64292	535295	535295	0	0	590137	2124365	599587	3314089	8	1	1	2
Chira	Ecuador; Peru	3154370	87338	56577	3286	3286	0	0	3154370	90624	59862	3304856	5	0	2	5
Rapel	Chile; Argentina	1863790	706709	393815	157602	157602	0	0	1863790	864311	551417	3279518	9	1	0	2
Tugela	South Africa; Lesotho	1696090	1106200	114847	24187	24187	0	0	1696090	1130387	139034	2965510	7	2	0	3
Tranh (Nr Thu Bon)	Viet Nam; Laos	2494440	2565	139748	159180	159180	0	0	2494440	161745	298928	2955113	10	1	1	0
Galana	Kenya; Tanzania	2570110	281649	51544	2897	2897	0	0	2570110	284546	54442	2909098	11	0	0	1
Corubal	Guinea-Bissau; Guinea	2898210	28	144	3373	3373	0	0	2898210	3400	3516	2905127	8	0	0	4
Negro (Argentinia)	Chile; Argentina	2181200	521962	51797	2979	2979	0	0	2181200	524941	54776	2760917	11	1	0	0
Blackwood	Australia	2444680	1608	54867	1098	1098	0	0	2444680	2705	55965	2503350	8	0	0	4

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River basin	Countries partly or fully laying with the basin	Water footprint related to consumption of agricultural products (m^3/year)			Water footprint related to consumption of industrial products (m^3/year)		Water footprint related to domestic water supply (m^3/year)		Total water footprint (m^3/year)				Number of months per year that the basin faces low, moderate, significant or severe blue water scarcity			
		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Low	Moderate	Significant	Severe
Lake Vattern	Sweden	1734390	88928	216996	191491	191491	0	0	1734390	280419	408487	2423296	11	0	0	1
Kokemaenjoki	Finland	978324	242556	72477	514860	514860	0	0	978324	757416	587337	2323077	10	0	0	2
Gloma	Sweden; Norway	382751	54326	27933	922295	922295	0	0	382751	976621	950228	2309600	11	0	0	1
Pangani	Kenya; Tanzania	2021810	61536	40320	224	224	0	0	2021810	61760	40544	2124114	3	3	0	6
Vuoksi	Finland; Russia	844322	126925	62080	490237	490237	0	0	844322	617162	552317	2013801	10	0	0	2
Biobio	Chile; Argentina	1334110	147146	223812	140288	140288	0	0	1334110	287434	364100	1985644	11	0	0	1
Nueces	USA	1131460	322670	232080	129442	129442	0	0	1131460	452112	361522	1945094	0	0	0	12
St.Johns	USA	506197	45609	143650	612503	612503	0	0	506197	658112	756153	1920462	10	1	1	0
Santa	Peru	1547630	94510	85347	3005	3005	0	0	1547630	97515	88352	1733497	10	0	1	1
Saint John	USA; Canada	1223870	3511	289130	69274	69274	0	0	1223870	72786	358404	1655060	10	0	0	2
Groot-Vis	South Africa	664002	915882	53567	4094	4094	0	0	664002	919976	57662	1641640	0	0	0	12
Doring	South Africa	680064	772479	70969	2289	2289	0	0	680064	774768	73258	1528090	4	0	1	7
Daryacheh-Ye Orumieh	Turkey; Iran; Iraq	531191	681387	141377	73144	73144	0	0	531191	754531	214521	1500242	8	0	1	3
Connecticut	USA; Canada	506699	4437	83814	435704	435704	0	0	506699	440141	519518	1466357	11	0	0	1
Armeria	Mexico	1241160	106340	42916	3534	3534	0	0	1241160	109874	46450	1397484	5	1	0	6
San Pedro	Mexico	1276350	49000	47985	4392	4392	0	0	1276350	53392	52376	1382118	7	0	0	5
Kymijoki	Finland	377436	92745	27726	387025	387025	0	0	377436	479770	414751	1271957	10	0	0	2
Klamath	USA	424827	600811	172300	28922	28922	0	0	424827	629733	201222	1255781	9	1	2	0
Verde	Mexico	1101890	23720	35603	5782	5782	0	0	1101890	29502	41386	1172778	7	1	0	4
San Antonio	USA	597821	90236	83795	192974	192974	0	0	597821	283210	276769	1157799	0	0	1	11
Merrimack	USA	167181	919	21636	473654	473654	0	0	167181	474573	495290	1137044	11	0	0	1
Yaqui	USA; Mexico	664641	283219	63986	9030	9030	0	0	664641	292249	73016	1029906	0	0	0	12
Burdekin	Australia	918256	54140	39555	2772	2772	0	0	918256	56912	42327	1017495	10	2	0	0
Gamka	South Africa	507000	423381	41425	3818	3818	0	0	507000	427199	45242	979441	7	2	1	2
Salinas	USA	271838	275003	265491	64934	64934	0	0	271838	339937	330425	942200	3	1	0	8
Groot- Kei	South Africa	510179	243013	27265	11926	11926	0	0	510179	254939	39191	804309	0	0	1	11
Saguenay (Riviere)	Canada	636335	603	67224	49347	49347	0	0	636335	49950	116571	802856	10	0	0	2
Dramselv	Norway	75671	7495	5234	343205	343205	0	0	75671	350700	348439	774810	11	0	0	1
Fuerte	Mexico	493727	158586	25466	2991	2991	0	0	493727	161577	28457	683762	7	2	0	3

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River basin	Countries partly or fully laying with the basin	Water footprint related to consumption of agricultural products (m^3/year)			Water footprint related to consumption of industrial products (m^3/year)		Water footprint related to domestic water supply (m^3/year)		Total water footprint (m^3/year)				Number of months per year that the basin faces low, moderate, significant or severe blue water scarcity			
		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Low	Moderate	Significant	Severe
Limari	Chile; Argentina	305898	168561	103553	30037	30037	0	0	305898	198598	133590	638086	3	4	1	4
Oulujoki	Finland; Russia	233328	23308	17307	130527	130527	0	0	233328	153835	147834	534997	10	0	1	1
Moose(Trib. Hudson Bay)	Canada	366369	79	32900	19270	19270	0	0	366369	19349	52170	437888	10	0	0	2
Canete	Peru	320423	34480	21242	808	808	0	0	320423	35288	22050	377761	10	0	1	1
Ishikari	Japan	103191	23400	19637	101890	101890	0	0	103191	125290	121527	350008	10	0	0	2
South Esk	Australia	265147	14049	5692	2227	2227	0	0	265147	16275	7919	289342	10	0	0	2
Rogue	USA	61363	84970	16218	54822	54822	0	0	61363	139792	71040	272196	11	1	0	0
Oelfusa	Iceland	230466	0	13217	693	693	0	0	230466	693	13910	245069	11	0	0	1
Murchison	Australia	221827	78	6351	193	193	0	0	221827	271	6544	228642	0	0	0	12
Penobscot	USA; Canada	99843	407	29644	31842	31842	0	0	99843	32249	61486	193577	11	0	0	1
Pyasina	Russia	0	0	0	72226	72226	0	0	0	72226	72226	144451	10	1	1	0
Conception	USA; Mexico	81635	37515	7379	2874	2874	0	0	81635	40388	10253	132276	0	0	0	12
Nottaway	Canada	95234	2	8582	6922	6922	0	0	95234	6925	15504	117662	10	0	0	2
Pur	Russia	0	0	0	58174	58174	0	0	0	58174	58174	116348	9	0	0	3
Loa	Bolivia; Chile	4049	649	1274	41890	41890	0	0	4049	42540	43164	89753	0	0	0	12
Iijoki	Finland	2011	139	144	41827	41827	0	0	2011	41966	41971	85947	10	0	0	2
Albany	Canada	60570	5	5294	3029	3029	0	0	60570	3034	8323	71927	10	0	0	2
Angerman	Sweden; Norway	0	0	0	32285	32285	0	0	0	32285	32285	64570	10	1	1	0
Kem	Finland; Russia	0	0	0	27690	27690	0	0	0	27690	27690	55379	10	1	1	0
Nizhny Vyg (Soroka)	Russia	2848	0	101	25690	25690	0	0	2848	25690	25791	54328	10	0	0	2
Huasco	Chile; Argentina	19088	10308	13256	5477	5477	0	0	19088	15785	18733	53605	7	1	0	4
Ord	Australia	28676	20071	2469	99	99	0	0	28676	20170	2568	51414	2	0	1	9
Eyre Lake	Australia	36004	2003	997	3450	3450	0	0	36004	5453	4447	45904	0	0	0	12
St.Croix	USA; Canada	27412	75	2497	3718	3718	0	0	27412	3794	6215	37421	10	0	0	2
Nadym	Russia	0	0	0	12902	12902	0	0	0	12902	12902	25803	9	0	0	3
Kovda	Russia	0	0	0	9807	9807	0	0	0	9807	9807	19614	9	0	0	3
Kamchatka	Russia	8	0	1	7625	7625	0	0	8	7626	7626	15260	9	0	0	3
Skeena	Canada	0	0	0	7090	7090	0	0	0	7090	7090	14180	11	0	0	1
Tana (NO, FI)	Finland; Norway	0	0	0	6547	6547	0	0	0	6547	6547	13095	9	0	0	3

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River basin	Countries partly or fully laying with the basin	Water footprint related to consumption of agricultural products (m^3/year)			Water footprint related to consumption of industrial products (m^3/year)		Water footprint related to domestic water supply (m^3/year)		Total water footprint (m^3/year)				Number of months per year that the basin faces low, moderate, significant or severe blue water scarcity			
		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Low	Moderate	Significant	Severe
Severn(Trib. Hudson Bay)	Canada	9031	0	795	1073	1073	0	0	9031	1073	1868	11971	10	0	0	2
Joekulsa A Fjoellum	Iceland	11108	0	695	70	70	0	0	11108	70	765	11942	10	0	0	2
Lagarfljot	Iceland	8395	0	519	279	279	0	0	8395	279	798	9472	10	0	0	2
Attawapiskat	Canada	7413	0	668	223	223	0	0	7413	223	891	8527	9	0	0	3
Ozero Sevan	Armenia; Azerbaijan	4704	1025	532	941	941	0	0	4704	1965	1473	8142	7	2	2	1
Svarta, Skagafiroi	Iceland	5611	0	376	188	188	0	0	5611	188	565	6364	11	0	0	1
Manicouagan (Riviere)	Canada	738	2	67	2189	2189	0	0	738	2190	2256	5184	10	1	1	0
Palyavaam	Russia	0	0	0	2315	2315	0	0	0	2315	2315	4630	8	0	0	4
Lake Taymur	Russia	0	0	0	1829	1829	0	0	0	1829	1829	3658	8	0	1	3
Rupert	Canada	2434	0	218	64	64	0	0	2434	64	282	2780	10	0	0	2
Churchill, Fleuve (Labrador)	Canada	0	0	0	1363	1363	0	0	0	1363	1363	2725	9	0	0	3
Varzuga	Russia	0	0	0	1225	1225	0	0	0	1225	1225	2450	9	0	0	3
Copper	USA; Canada	0	0	0	1036	1036	0	0	0	1036	1036	2072	10	0	0	2
Ponoy	Russia	0	0	0	1007	1007	0	0	0	1007	1007	2014	9	0	0	3
Flinders	Australia	534	574	30	253	253	0	0	534	827	283	1644	9	2	1	0
Nass	Canada	0	0	0	471	471	0	0	0	471	471	942	11	0	0	1
Thelon	Canada	0	0	0	342	342	0	0	0	342	342	685	9	1	1	1
Taku	USA; Canada	1	0	0	329	329	0	0	1	329	329	659	10	0	0	2
Nushagak	USA	0	0	0	310	310	0	0	0	310	310	619	10	0	0	2
De Grey	Australia	39	0	1	216	216	0	0	39	216	217	473	0	0	0	12
Gascoyne	Australia	120	100	4	93	93	0	0	120	193	97	410	0	0	0	12
Ashburton	Australia	0	0	0	199	199	0	0	0	199	199	398	0	0	0	12
Fortescue	Australia	4	2	0	192	192	0	0	4	193	192	389	0	0	0	12
Alsek	USA; Canada	0	0	0	174	174	0	0	0	174	174	347	10	0	0	2
Durack	Australia	89	0	2	89	89	0	0	89	89	91	268	9	2	1	0
Grande Riviere De La Baleine	Canada	0	0	0	88	88	0	0	0	88	88	176	9	0	0	3
Natashquan (Riviere)	Canada	0	0	0	81	81	0	0	0	81	81	162	10	0	0	2

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River basin	Countries partly or fully laying with the basin	Water footprint related to consumption of agricultural products (m^3/year)			Water footprint related to consumption of industrial products (m^3/year)		Water footprint related to domestic water supply (m^3/year)		Total water footprint (m^3/year)				Number of months per year that the basin faces low, moderate, significant or severe blue water scarcity			
		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Low	Moderate	Significant	Severe
Eastmain	Canada	0	0	0	70	70	0	0	0	70	70	139	10	0	0	2
Little Mecatina	Canada	0	0	0	23	23	0	0	0	23	23	47	9	0	0	3
Hornaday	Canada	0	0	0	9	9	0	0	0	9	9	17	11	1	0	0
George	Canada	0	0	0	5	5	0	0	0	5	5	10	9	0	0	3
Back	Canada	0	0	0	2	2	0	0	0	2	2	4	9	0	0	3
Ferguson	Canada	0	0	0	1	1	0	0	0	1	1	2	8	0	0	4

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