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The water footprint of Switzerland

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THE WATER FOOTPRINT OF SWITZERLAND

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Summary

Usually, countries do not consider the external water footprint of national consumption, which is related to imported water-intensive commodities, in their national water policies. In order to support a broader sort of analysis and better inform decision-making, the traditional production perspective in national water policy should be supplemented with a consumption perspective. Because many consumer goods are imported, a responsible and fair national water policy should include an international dimension.

This report focusses on Switzerland. The background of the study is the recognition that there is a relation between the import of water-intensive goods to Switzerland and their impacts on water systems elsewhere in the world. Many of the goods consumed in Switzerland are not produced domestically, but abroad. Some goods, most in particular agriculture-based products, require a lot of water during production. These water-intensive production processes are often accompanied by impacts on the water systems at the various locations where the production processes take place. The impacts vary from reduced river water flows, declined lake levels and groundwater tables and increased salt intrusion in coastal areas to pollution of freshwater bodies.

The objective of this study is to carry out a water footprint assessment for Switzerland from a consumption perspective. The assessment focuses on the analysis of the external water footprint of Swiss consumption, to get a complete picture of how national consumption translates to water use, not only in Switzerland, but also abroad, and to assess Swiss dependency on external water resources and the sustainability of imports. The study quantifies and maps the external water footprint of Switzerland, differentiating between agricultural and industrial commodities, and shows how the blue water footprint of Swiss consumption contributes to blue water scarcity in specific river basins and which products are responsible herein.

The total water footprint of national consumption of Switzerland is an average 11 billion m^3 per year for the period 1996-2005, which is 1528 m^3 per year or approximately 4120 litre per day per Swiss citizen. About 68% of this total is ‘green’, 25% ‘grey’ and 7% ‘blue’. Consumption of agricultural commodities makes up the bulk of Switzerland’s water footprint, accounting for 81% of the total. Industrial commodities account for 17%; the remaining 2% relates to domestic water supply. Most of the water footprint of Swiss consumption (82%) lies outside Switzerland.

About 34% of the blue water footprint of Swiss consumption is in river basins that experience moderate to severe water scarcity during at least one month in a year. The priority basins are located in France (Garonne, Loire, Escaut and Seine), Italy (Po), Central Asia (Aral Sea basin), the USA (Mississippi), India (Ganges, Krishna, Godavari, Tapti, Mahi, Cauvery and Penner), Pakistan (Indus), Spain (Guadalquivir, Guadiana, and Tejo), Middle East (Tigris and Euphrates), China (Huang He, Yongding He, Mekong, Huai He and Tarim), West Africa (Nile, Tana) and Côte d'Ivoire (Sassandra). Cotton, rice, sugar cane, grape, sorghum, maize, soybean, sunflower, citrus and coffee are identified as priority products, giving significant contributions to the blue water scarcity in the selected priority basins. Especially cotton, rice and sugar cane give an important contribution to the blue water footprint in many of these basins.

1. Introduction

Problems of water scarcity and pollution can often not be solved by the traditional 'production perspective' alone. Due to the global character of trade in water-intensive commodities, the 'real' consumers of water resources are often not living in the areas where production and associated water use take place. As a result, the 'real' consumers of water resources are not confronted with the impacts caused by their consumption. Usually, countries do not consider the external water footprint of national consumption, which is related to import of water-intensive commodities, in their national water policies. In order to support a broader sort of analysis and better inform decision-making, the traditional production perspective in national water policy should be supplemented with a consumption perspective. Because, in most countries, many consumer goods are imported, a responsible and fair national water policy should include an international dimension.

The concept of water footprint was introduced ten years ago to be able to show the link that exists between consumption of goods and water consumption and pollution elsewhere, in the regions where the goods are produced (Hoekstra, 2003). The water footprint is an indicator of freshwater use that looks not only at direct water use of a consumer, but also at the indirect water use. 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 background of this study is the recognition that there is a relation between the import of water-intensive goods to Switzerland and their impacts on water systems elsewhere in the world. Many of the goods consumed in Switzerland are not produced domestically, but abroad. Some goods, most in particular agriculture-based products, require a lot of water during production. These water-intensive production processes are often accompanied by impacts on the water systems at the various locations where the production processes take place. The impacts vary from reduced river water flows, declined lake levels and ground water tables and increased salt intrusion in coastal areas to pollution of freshwater bodies.

The objective of this study is to carry out a water footprint assessment for Switzerland from a consumption perspective. The assessment focuses on the analysis of the external water footprint of Swiss consumption, to get a complete picture of how national consumption translates to water use, not only in Switzerland, but also abroad, and to assess Swiss dependency on external water resources and the sustainability of imports. The study quantifies and maps the external water footprint of Switzerland, differentiating between agricultural and industrial commodities, and shows how the blue water footprint of Swiss consumption contributes to blue water scarcity in specific river basins and which products are responsible herein.

Although there are several national water footprint studies available in the literature, they usually exclude sustainability assessment. The local impacts of water footprints 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 employed in the current study, which incorporates data on monthly blue water scarcity at the level of river basins to assess how the blue water footprint of Swiss consumption contributes to water scarcity at river basin level. This study makes a substantial step beyond quantifying and mapping the country's water footprint of 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 consumption in Switzerland is quantified according to the national water footprint accounting scheme as shown in Figure 1.

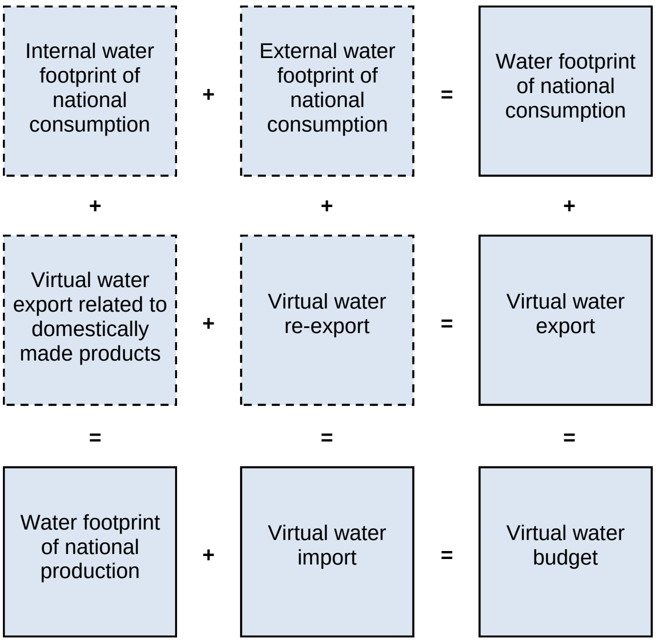

Figure 1. The national water footprint accounting scheme (Hoekstra et al., 2011).

The water footprint of national consumption 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 footprints of crops and derived crop products in the world were obtained from Mekonnen and Hoekstra (2011), 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 footprints of animal products were taken from Mekonnen and Hoekstra (2012). The data related to the water footprint of consumption in Switzerland and the virtual water flows to and from Switzerland were taken from Hoekstra and Mekonnen (2012). In all cases, data refer to the period 1996-2005.

2.2 Identifying priority basins and products

For the blue water footprint of Swiss 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 Swiss consumption, we estimated which parts of 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 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 Swiss 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 Swiss 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 the water footprint of Swiss 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 blue water footprint of Swiss consumption of agricultural products located in that basin is *at least 1%* of total blue water footprint of 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 consumed in Switzerland 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 the water footprint of Swiss 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 blue water footprint of Swiss consumption of industrial products located in that specific basin is *at least 1%* of the total water footprint of 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 Swiss consumption, we assessed the impacts of the grey water footprint of Swiss consumption on a qualitative basis.

3. Water footprint of consumption

The total water footprint of national consumption of Switzerland was 11 Gm^3/year in the period 1996-2005. About 68% of this total is green, 25% grey and 7% blue (Table 1). Consumption of agricultural commodities makes up the bulk of Switzerland's water footprint, accounting for 81% of the total. Industrial commodities account for 17%; the remaining 2% relates to domestic water supply. The water footprint related to Swiss consumption of agricultural commodities is to a large extent green. For industrial products and for domestic water supply, the water footprint is mainly grey and to a lesser extent blue (Table 2). Most of the water footprint of Swiss consumption (82%) lies outside Switzerland (Figure 2).

Table 1. The internal and external water footprint of Swiss 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	
1328	112	520	6158	715	2221	7486	827	2741	82

Table 2. The water footprint of Swiss 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
1328	1	327	6158	570	597	50	32	145	1624	62	161

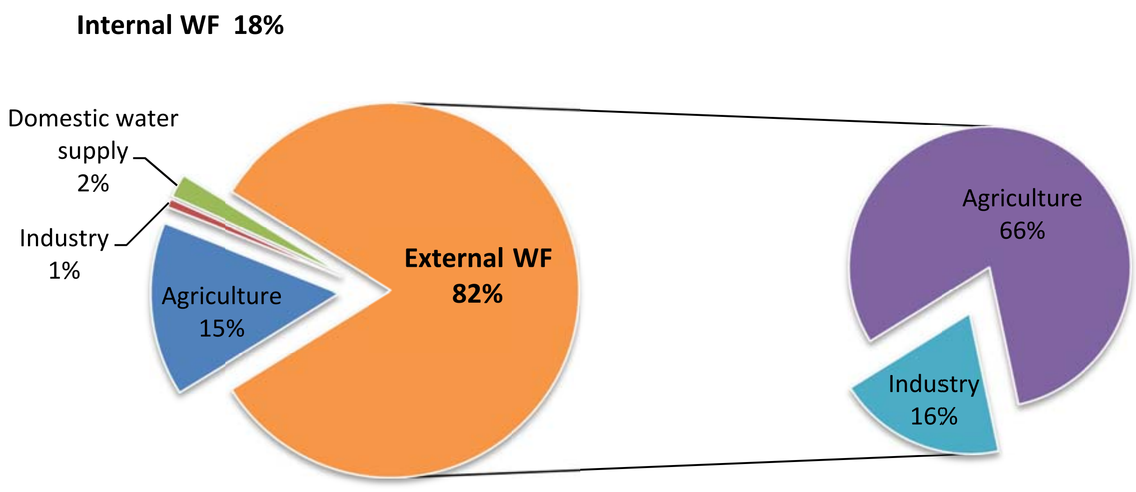

Figure 2. The water footprint of national consumption in Switzerland.

About 18% of the total water footprint of Swiss consumption is internal. This internal footprint mostly relates to the production of agricultural products for the domestic market and to a lesser extent to producing industrial products and to domestic water supply. Swiss consumption is highly dependent on water resources outside its borders, despite being called the 'water tower' of Europe (Mauch and Reynard, 2002). Around 82% of the water footprint of Swiss consumption of agricultural products is external. For industrial products, this is even 96%. Almost hundred per cent of the blue water footprint of Swiss consumption of agricultural products is external. The external industrial water footprint is dominantly grey (92%) due to water pollution in production countries.

The water footprint related to meat consumption is the single largest component in the water footprint of Swiss consumption (23%), followed by industrial products (17%), cereals (9%), sugar and sweeteners (8%), milk (8%), vegetable oils (7%), and coffee & tea (7%). Other products with significant water footprints are fruits, wine and beer, cotton and domestic water supply (Figure 3).

The major products with a large green water footprint of consumption are meat (29%), cereal (10%), sugar and sweeteners (10%), milk (10%), oil (10%), and coffee and tea (9%). The blue water footprint of consumption largely results from the consumption of industrial products (24%), meat (14%), sugar (12%), fruits (9%), cotton (8%) and domestic water supply (7%). Industrial products dominate the grey water footprint of consumption, followed by meat, cereal products and domestic water supply (Figure 4).

Figure 5 shows the ratio of the external to the total water footprint of consumption in EU countries and the world average. The ratio in Switzerland (82%) is one of the highest in Europe and much higher than the world average (22%). Some other European countries with a high external water footprint ratio are the Netherlands, Belgium, Malta, the UK and Luxembourg. A few countries in Europe, most notably Romania, Bulgaria and Hungary, have small external water footprint ratios (less than 20%).

The water footprint of a consumer in Switzerland is on average 1528 m^3/yr. This is below the European average, but greater than the world average (Figure 6). Countries like Portugal, Spain, Cyprus and Greece have very high water footprints per capita, whereas the UK, Ireland and Slovakia have relatively small footprints per capita.

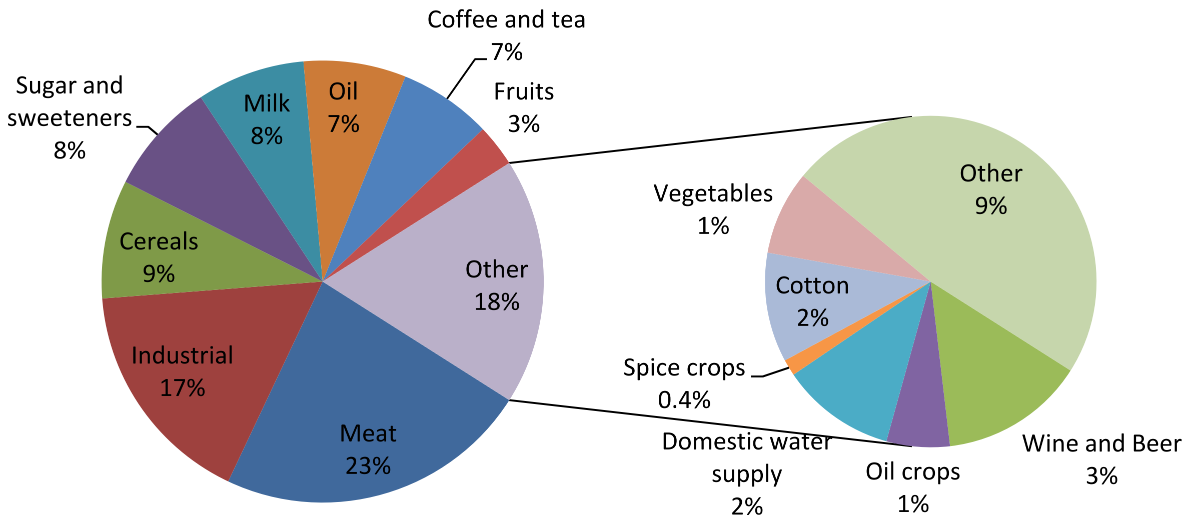

Figure 3. The total water footprint of Swiss consumption shown by consumption category.

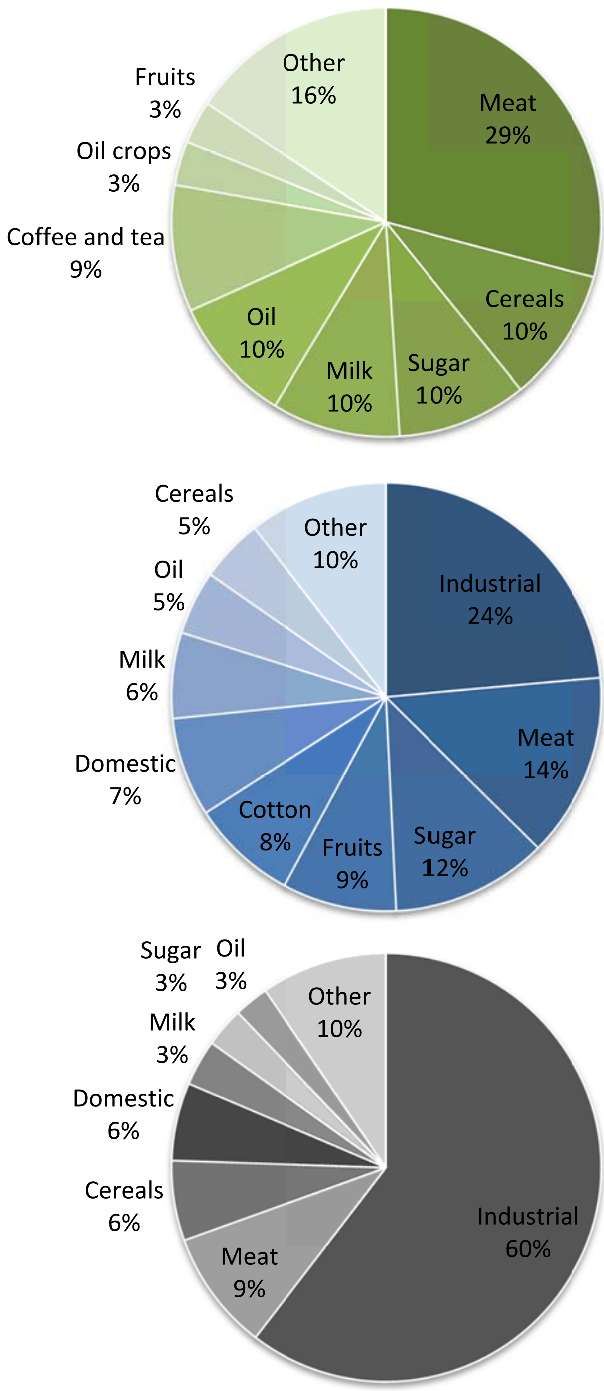

Figure 4. The green, blue and grey water footprint of Swiss consumption per consumption category.

The geographical distribution of the water footprint of Swiss consumption is shown in Figure 7. A large part of the external water footprint of consumption is located in Europe, namely in Germany, France, the Netherlands and Italy. The USA, Russia, India, China, Brazil and Spain are other countries where the external water footprint of Swiss consumption is concentrated. Most of the external blue water footprint is in Germany, the USA, France and Italy. The external grey water footprint is mainly located in Russia, China, the USA and Germany. Imports of industrial products from Germany, Russia, Italy, France, the USA and China are the major sources of the external industrial water footprint of Switzerland.

The external water footprint related to cotton consumption mainly lies in India, China, Pakistan, Uzbekistan and the USA. Cocoa products mainly originate from Ghana, Ecuador and Cote D'Ivoire. Sugar products are mostly imported from France (beet sugar), Mauritius and Brazil (cane sugar). Animal products are imported mainly from France, Brazil, Italy, Australia, the USA, and Argentina. The external water footprint of Swiss consumption of rice lies mainly in Thailand, Myanmar, the USA, India and Pakistan.

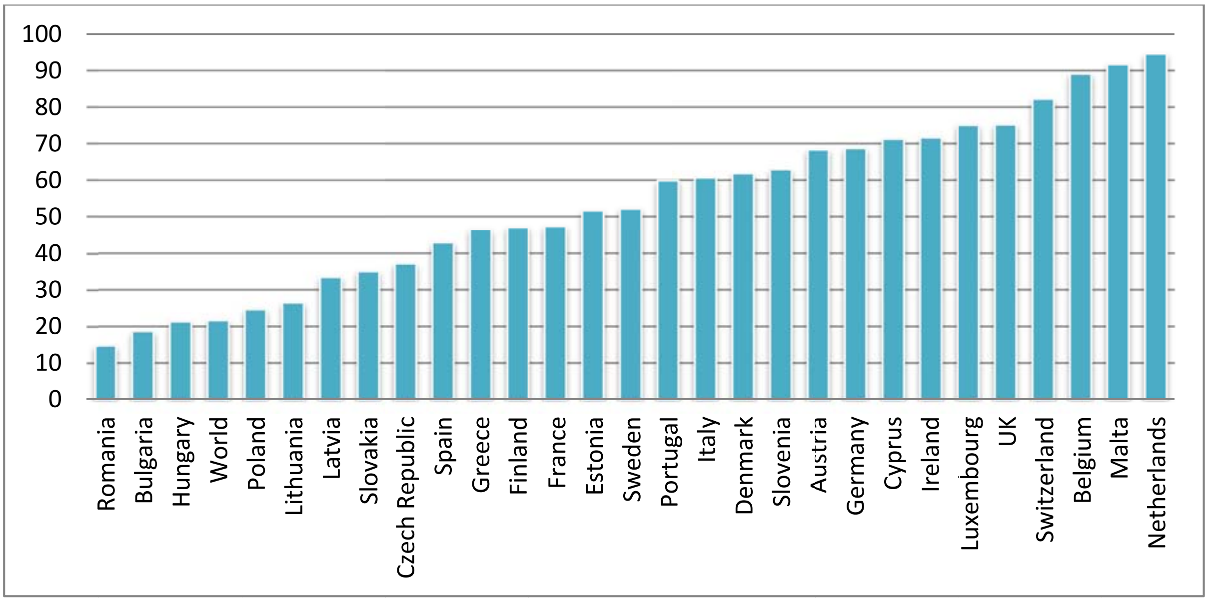

Figure 5. The ratio of the external to the total water footprint in EU countries and the world average (%).

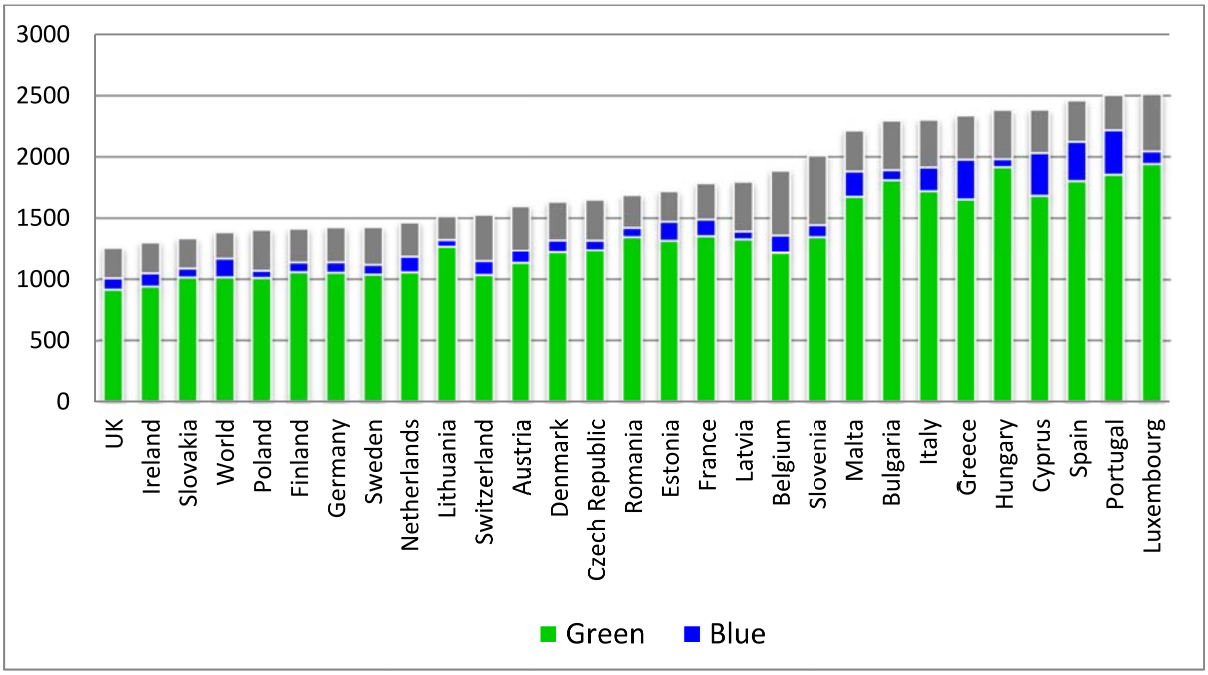

Figure 6. The water footprint consumption per capita in EU countries and the world average (m^3/yr/cap).

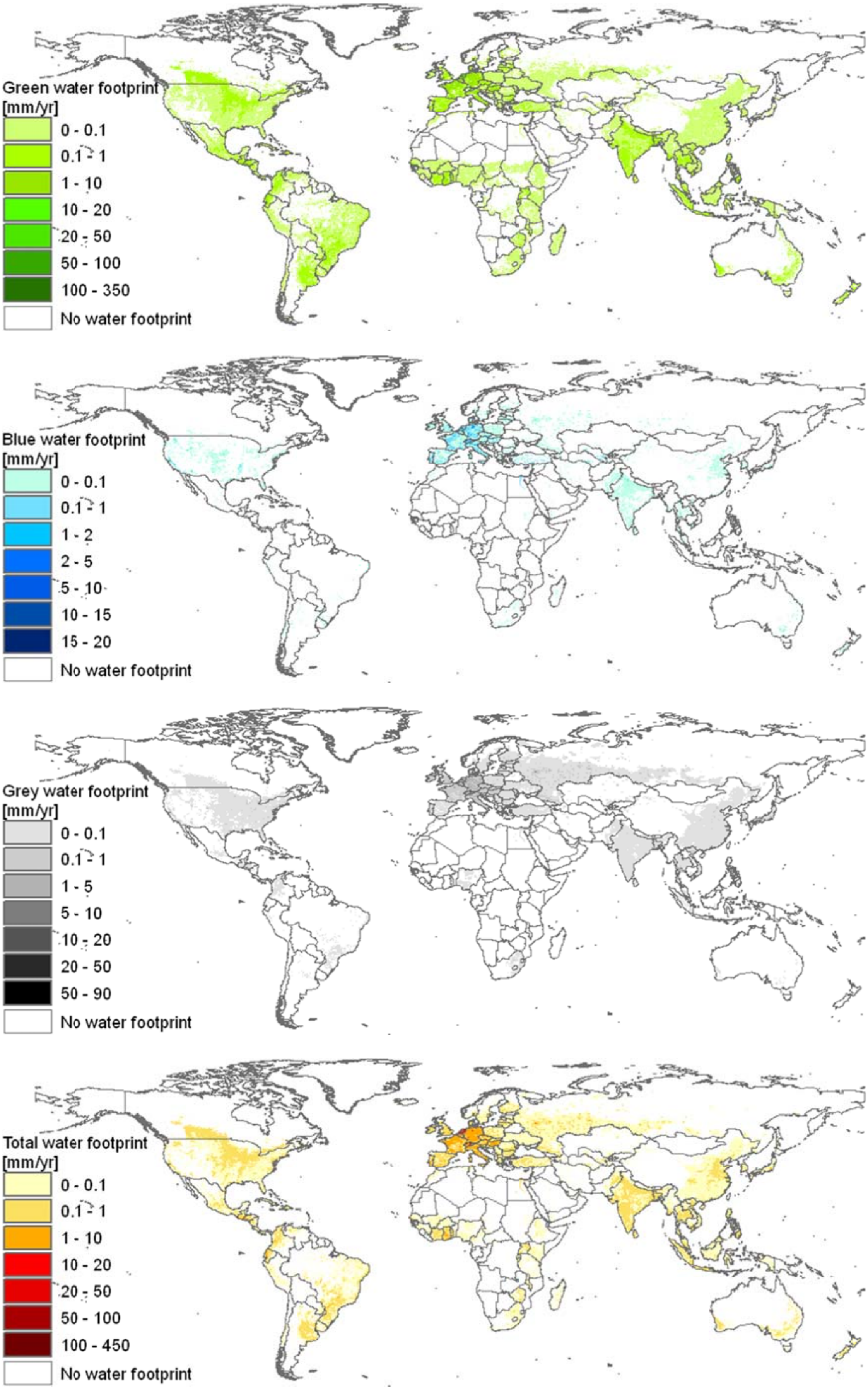

Figure 7. The global water footprint of consumption by the inhabitants of Switzerland (period 1996-2005).

4. Priority basins and products

The water footprint of Swiss consumption presented in the previous section provides a rough impression of its dependence on the world's freshwater resources. In this section we will look at the different components of Switzerland's external water footprint in more detail. Some import products depend on water resources in dry periods in highly water-scarce river basins, while other products originate from basins with lower water scarcity.

About 34% of the blue water footprint of Swiss consumption is in river basins that experience moderate to severe water scarcity during at least one month in a year. All those basins are shown in Appendix I, which also shows, per basin, the size of the water footprint of Swiss consumers in the basin and the number of months that the basin experiences different levels of water scarcity.

Agricultural products

Table 3 presents the river basins across the globe where there is a significant blue water footprint related to Swiss 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 Swiss 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 Swiss 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 Switzerland imports this product or these products in relative small amounts (less than 1% of the blue water footprint of Swiss consumption of agricultural products is located in those basins), these products are obviously contributing to very unsustainable conditions. Table 3 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 Switzerland. The basins listed in Table 3 are shown on the world map in Figure 8.

Cotton, rice, sugar cane, grape, sorghum, maize, soybean, sunflower, citrus and coffee are identified as main priority products, giving significant contributions to the blue water scarcity in the selected priority basins. Especially cotton, rice and sugar cane give an important contribution to the blue water footprint in many of the basins. The priority basins are located in France (Garonne, Loire, Escaut and Seine), Italy (Po), Central Asia (Aral Sea basin), the USA (Mississippi), India (Ganges, Krishna, Godavari, Tapti, Mahi, Cauvery and Penner), Pakistan (Indus), Spain (Guadalquivir, Guadiana, and Tejo), Middle East (Tigris and Euphrates), China (Huang He, Yongding He, Mekong, Huai He and Tarim), West Africa (Nile, Tana) and Côte d'Ivoire (Sassandra).

About 7% of the blue water footprint of Swiss consumption of agricultural products is located in four mainly French river basins: Garonne, Loire, Escaut and Seine. The Garonne basin 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 region especially experiences water shortages during summertime (UNESCO, 2006; AEAG, 2011). Approximately 2% of the blue water consumption in the basin is for producing export products to Switzerland, mainly maize and soybean. 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. One tributary of the Garonne, the Dropt, is particularly sensitive to eutrophication (UNEP, 2004). The Loire river basin experiences significant water scarcity in August and September. The main crop contributing to the blue water footprint in this basin is maize. The Loire basin is considered an important farming area, producing two thirds of the livestock and half of the cereal produced in France. Also in the Loire basin, about 2% of the blue water consumption is for producing export products to Switzerland, mainly maize. The banks of the Loire 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. An important crop contributing to the blue water footprints in these two basins during the dry period is again maize. In the Seine basin, around 2% of the blue water consumption is for the production of maize and sugar beet exported to Switzerland.

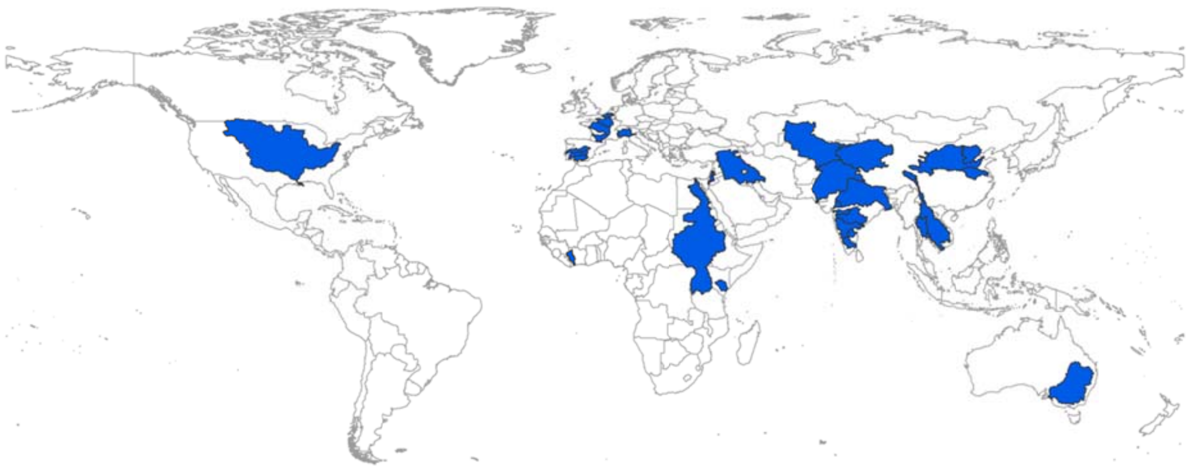

Figure 8. The river basins in the world in which the production of agricultural products for Swiss consumption contributes to moderate, significant or severe blue water scarcity.

About 4% of the blue water footprint of Swiss consumption of agricultural products is located in the Po basin, which is largely situated in Italy. The most important blue water consumers are rice, maize and fodder. The area has extensive irrigation networks; most of the water comes from surface watercourses. The basin faces moderate water scarcity during about two months per year and experiences serious water quality deterioration, amongst others as a result of abundant fertilizer and pesticide use in agriculture.

The Aral Sea basin is one of the most important priority basins, because 3% of the blue water footprint of Swiss consumption is located there, while the basin experiences four months of severe water scarcity per year (July to October) and one-month of moderate water scarcity (June). Cotton production is the dominant factor in the blue water scarcity of the basin. The Aral Sea ecosystem has been experiencing sudden and severe ecosystem damage due to excessive use of water in the region to grow cotton. This unsustainable use of water has great 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 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).

Table 3. Priority basins regarding the blue water footprint of Swiss consumption of agricultural products.

River basin	Percentage of the blue water footprint of Swiss 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	
Po	4.1	2	0	0	Rice, maize, fodder
Aral Sea basin	3.1	1	0	4	Cotton
Mississippi	3.1	2	0	2	Maize, soybean, rice, cotton
Indus	3.0	1	3	8	Rice, cotton
Ganges	2.9	0	2	5	Rice, sugarcane
Garonne	2.6	1	1	1	Maize, soybean
Loire	2.1	0	2	0	Maize
Tigris & Euphrates	1.4	0	1	5	Cotton
Guadalquivir	1.3	1	0	6	Cotton, sunflower, rice
Nile	1.3	0	0	2	Sorghum, sugar cane
Escaut	1.1	0	1	3	Maize
Seine	1.1	2	0	2	Maize, sugar beet
Guadiana	1.0	1	0	6	Grapes, sunflower, citrus, rice
Tejo	0.87	1	0	4	Grapes
Murray	0.74	2	0	6	Rice, cotton
Krishna	0.60	0	0	3	Rice, sugar cane
Chao Phraya	0.51	1	1	7	Rice, sugar cane
Dead Sea	0.46	1	0	5	Melon
Godavari	0.42	2	0	5	Rice, sugar cane
Huang He (Yellow River)	0.27	1	2	4	Maize, rice
Cauvery	0.25	3	1	8	Rice, sugar cane
Yongding He	0.20	0	0	12	Rice, soybean, cotton
Mekong	0.19	1	0	3	Rice, sugar cane
Huai He	0.12	1	5	1	Rice
Tarim	0.11	1	1	9	Rice, cotton
Tapti	0.10	2	1	5	Sugar cane, cotton
Mahi	0.05	2	0	5	Rice
Penner	0.05	1	2	9	Rice, sugar cane
Sassandra	0.05	0	0	2	Sugar cane
Tana	0.02	0	0	1	Coffee

Production of maize, soybean, rice and cotton in the Mississippi river basin contribute approximately 3% to the blue water footprint of Swiss consumption. The basin experience severe water scarcity during August-September, when the blue water footprint is largest but runoff is low.

A significant part of the blue water footprint of Swiss consumers is located in Southeast Asia (Figure 9). The Indus basin faces moderate to severe water scarcity all year round. The densely populated basin (186 persons/km^2) faces severe water scarcity in the period from September to April (Hoekstra et al., 2012). The freshwater reaching the Indus Delta has significantly decreased (90%) as a result of over-usage of water resources in the basin. The decrease in freshwater flow to the Indus Delta has negative impacts on the ecosystems and biodiversity of the Delta (loss of mangrove forestlands and risk of extinction of the Blind River Dolphin) (WWF, 2004). In addition, in various places in the basin, groundwater abstraction, mainly for irrigation, goes beyond the natural recharge, leading to depletion of the groundwater in the basin. The priority products are rice and cotton.

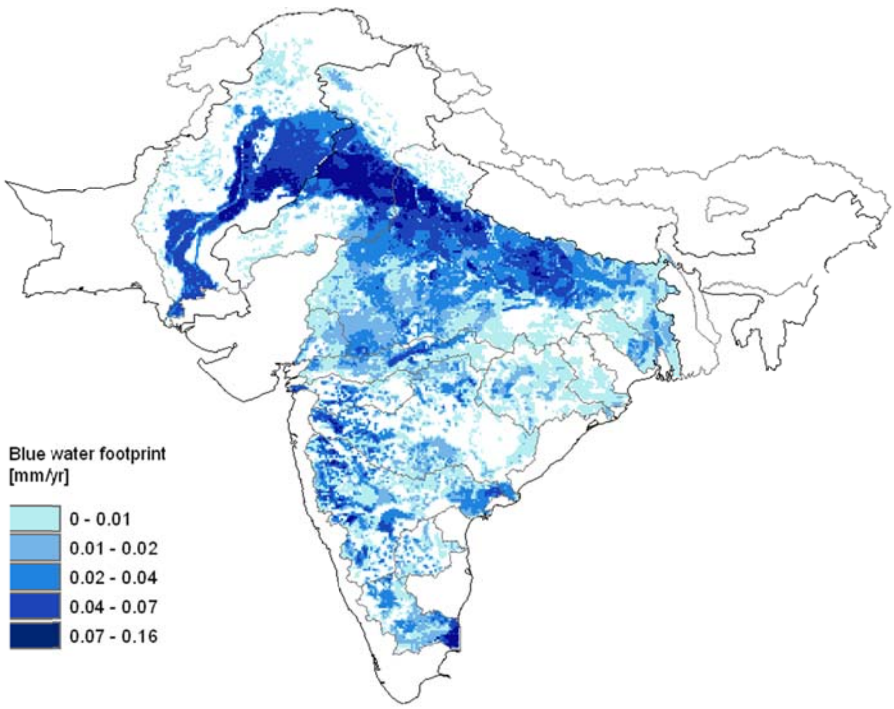

Figure 9. The blue water footprint of Swiss consumption in Southeast Asia.

Other priority basins in Southeast Asia are the basins of the Ganges, Krishna, Godavari, Mahi, Tapti and Penner. All these basins experience severe water scarcity during part of the year. Most of the blue water footprint in these basins is due to evaporation of irrigation water in agriculture, mostly for rice and sugar cane. Around 1% of the blue water footprint within these basins is due to the production of export products to Switzerland. In the Indian state of Maharashtra, sugar cane takes 60% of the total irrigation supply, which causes substantial groundwater withdrawals (WWF, 2004). 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 in India is the pollution of surface and groundwater (Solomon, 2005).

Another priority basin regarding Swiss consumption is the Tigris-Euphrates River Basin, which faces severe water scarcity during five months of the year (June-October). Most of the blue water footprint in the basin is due to evaporation of irrigation water in agriculture, mostly for cotton. Irrigation projects that were implemented in recent years in order to increase the cotton production also brought several environmental consequences: declining groundwater levels, salinity problems due to intensive cotton irrigation, and pollution due to excessive use of pesticides. Besides, the use of water in the upper parts of the basin for cotton production has led to a decrease in the amount of water received by downstream countries, which face water stress especially in the summer (Ercin, 2006).

About 3% of the blue water footprint of Swiss consumption of agricultural products is located in the three basins of the Guadalquivir, Guadiana and Tejo rivers on the Iberian Peninsula (Spain-Portugal). Approximately 1% of the blue water footprint within these basins is related to the production of agricultural commodities that are exported to and consumed in Switzerland. The priority products for Swiss consumers are cotton, sunflower, rice, grape and citrus. The Guadalquivir is Spain's second longest river. The basin faces severe water scarcity during half of the year. Its natural environment is one of the most diverse 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, the impact of mass tourism and intensive irrigated agriculture in the region are causing over-exploitation of regional aquifers, and damaging the ecosystem of the region (UNEP, 2004). The Guadalquivir marshes are also negatively affected due to agricultural activities. Additionally, the river has been 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). The Guadiana River Basin faces severe water scarcity during half of the year as well (June-November). Overexploitation of the aquifer for irrigation purposes is a major problem, occurring mainly in the upper part of the basin (Aldaya and Llamas, 2008).

Priority basins for Swiss consumers in China are the Huang He (Yellow River), Yongding He, Mekong, Tarim and Huai (Figure 10). Rice, sugar cane, cotton and soybean are the products from these basins that are mostly imported by Switzerland. The share of Swiss consumption in the total blue water footprint within these basins is around 1%. The Yellow River is known for recent water scarcity and pollution problems. The river basin faces severe water scarcity for four months of the year (February-May). 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).

The Murray River Basin is a very important basin for agriculture in Australia. Around 1% of Switzerland's blue water footprint is located in this basin, mainly due to the import of cotton and rice. About 2% of the blue water footprint related to crop production in the Murray River Basin is for exports to Switzerland. The basin faces severe water scarcity for half of the year (November-April). The water level of the Murray river has declined significantly particularly due to excessive agricultural water use. Much of its aquatic life, including native fish, are now declining, rare or endangered (Chartres and Williams, 2006).

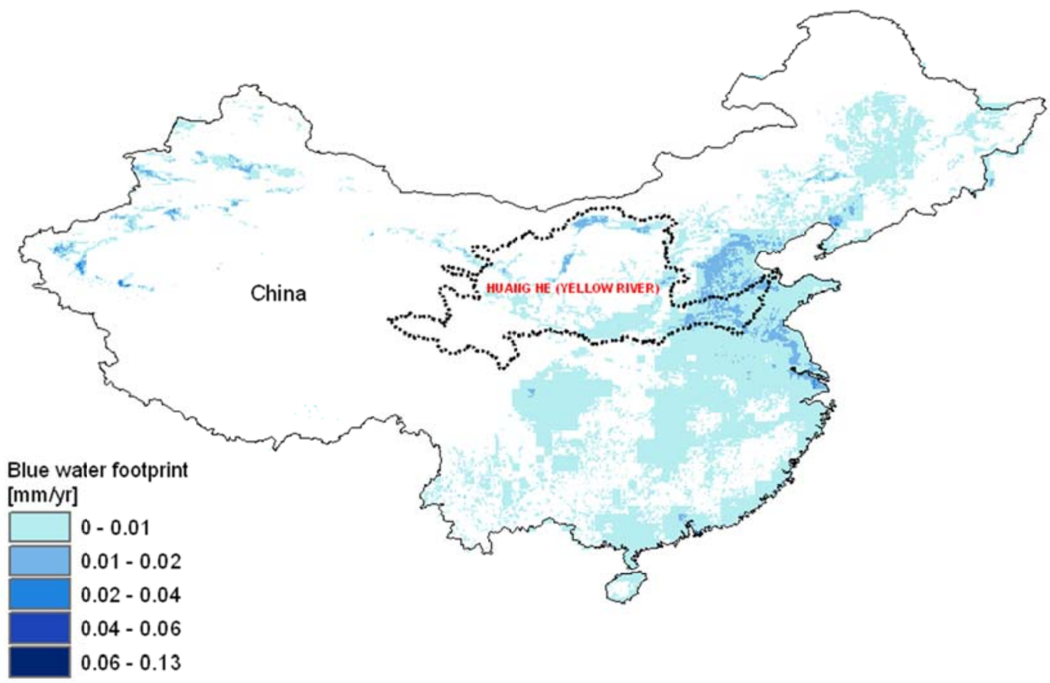

Figure 10. The blue water footprint of Swiss consumption in China.

Industrial products

Table 4 shows the priority basins related to the blue water footprint of Swiss consumption of industrial products. The Po, Volga, Seine, Escaut, Mississippi, Ob, St.Lawrence, Loire, Don, Garonne and Huang He (Yellow River) are identified as the priority basins for industrial products consumed by Swiss consumers. In these basins, the industrial blue water footprint constitutes a significant part of the total blue water footprint. Industrial activities in these basins contribute to water scarcity and cause severe pollution problems, particularly in the Seine (D'Odorico et al., 2010), Huang He (China) and Volga.

Table 4. Priority basins regarding the blue water footprint of Swiss consumption of industrial products.

River basin	Percentage of the blue water footprint of Swiss 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
Po	3.3	2	0	0
Volga	3.3	1	0	0
Seine	2.2	2	0	2
Escaut (Schelde)	1.9	0	1	3
Mississippi	1.7	2	0	2
Ob	1.3	1	0	1
St.Lawrence	1.3	0	0	1
Loire	1.1	0	2	0
Don	0.8	0	2	2
Garonne	0.5	1	1	1
Huang He (Yellow River)	0.4	1	2	4

5. Conclusion

Switzerland, often referred to as the ‘water tower’ of Europe, is known for abundant water resources and strong water governance. Switzerland has 6% of all freshwater reserves in Europe and a freshwater availability per capita that is about three times larger than the European average, which is sufficient to meet all the direct needs of the Swiss economy. However, this study shows that the amount of water required to run the economy of Switzerland and produce the goods and services that the Swiss people consume is much larger than the amount of water used within the nation itself. With an external water footprint that is 82% of the total, Swiss consumption is highly dependent on water resources outside the country. Particularly the consumption of food, beverages, cotton clothes and industrial products relates to substantial amounts of water use elsewhere. This study reveals that by looking at the water hidden in agricultural and industrial commodities, a water footprint assessment not only paints a more complete picture of how much water people consume directly and indirectly, but also allows us to better understand the dependence of a nation’s economy on water resources outside its borders.

The national water footprint of Switzerland presented in this study provides a high-level view of its dependence on the world’s freshwater resources. The sustainability of the different components of Switzerland’s water footprint depends on factors like the water scarcity in the places where the different footprint components are located and the efficiency of water use in those places. More detailed studies at the local watershed level are necessary to better understand the true impact of Switzerland’s water footprint in the various river basins around the world.

Together with a similar study for France (Ercin et al., 2012), this study is the first to use monthly water scarcity values (from Hoekstra et al., 2012) to assess the impacts of the water footprint of the consumers in a country in river basins elsewhere. Introducing a finer temporal scale is vital to reveal the impacts of water use. It is important to address water scarcity on a monthly level from a water use and policy perspective, because a finer temporal scale better reflects the seasonal differences of water use and availability.

A national water footprint assessment can provide valuable information on how national consumption relates to freshwater consumption and pollution elsewhere, how a nation thus depends on foreign water resources and how sustainable the water use elsewhere is. Concerns about sustainable freshwater use and water dependency are to be reflected in a country’s agricultural, economic and trade policies.

References

AEAG (Ed.) (2011) Suivi de l'étiage sur le bassin Adour-Garonne, Adour-Garonne Water Agency, Toulouse, France.

Albiac, J. and Dinar, A. (2008) The management of water quality and irrigation technologies, Earthscan, London, UK.

Aldaya, M.M. and Llamas, M.R. (2008) Water footprint analysis for the Guadiana river basin, Value of Water Research Report Series No. 35, UNESCO-IHE, Delft, The Netherlands.

Cai, X., McKinney, D.C. and Rosegrant, M.W. (2003) Sustainability analysis for irrigation water management in the Aral Sea region, Agricultural Systems, 76(3): 1043-1066.

Chapagain, A.K. and Orr, S. (2009) An improved water footprint methodology linking global consumption to local water resources: A case of Spanish tomatoes, Journal of Environmental Management, 90(2): 1219-1228.

Chartres, C. and Williams, J. (2006) Can Australia overcome its water scarcity problems?, Journal of Developments in Sustainable Agriculture, 1(1): 17-24.

D'Odorico, P., Laio, F. and Ridolfi, L. (2010) Does globalization of water reduce societal resilience to drought?, Geophysical Research Letters, 37(13): L13403.

Ercin, A. E. (2006) Social and economic impacts of the Southeastern Anatolia Project Middle East Technical University, Ankara, Turkey.

Ercin, A.E., Mekonnen, M.M. and Hoekstra, A.Y. (2012) The water footprint of France, Value of Water Research Report Series No. 56, UNESCO-IHE, Delft, the Netherlands.

Fu, G., Chen, S. and Liu, C. (2004) Water crisis in the Huang Ho (Yellow) River: Facts, reasons, impacts, and countermeasures, 7th International River Symposium, Brisbane, Australia.

Glantz, M.H. (1999) Creeping environmental problems and sustainable development in the Aral Sea Basin, Cambridge University Press, Cambridge, UK.

Hoekstra, A.Y. (ed.) (2003) Virtual water trade: Proceedings of the International Expert Meeting on Virtual Water Trade, Value of Water Research Report Series No.12, UNESCO-IHE, Delft, the Netherlands.

Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M., and Mekonnen, M.M. (2011) The water footprint assessment manual: Setting the global standard, Earthscan, London, UK.

Hoekstra, A.Y. and Mekonnen, M.M. (2012) The water footprint of humanity, Proceedings of the National Academy of Sciences, 109(9): 3232–3237.

Hoekstra, A.Y., Mekonnen, M.M., Chapagain, A.K., Mathews, R.E. and Richter, B.D. (2012) Global monthly water scarcity: Blue water footprints versus blue water availability, PLoS ONE 7(2): e32688.

Kampman, D.A., Hoekstra, A.Y. and Krol, M.S. (2008) The water footprint of India,Value of Water Research Report Series No.32, UNESCO-IHE, Delft, the Netherlands.

Mauch, C. and Reynard, E. (2002) The evolution of the national water regime in Switzerland, Institut de Hautes Études en Administration Publique (IDHEAP), Lausanne, Switzerland.

Mekonnen, M.M. and Hoekstra, A.Y. (2011) The green, blue and grey water footprint of crops and derived crop products, Hydrology and Earth System Sciences, 15(5): 1577-1600.

Mekonnen, M.M. and Hoekstra, A.Y. (2012) A global assessment of the water footprint of farm animal products, Ecosystems, 15(3): 401–415.

Micklin, P.P. (1988) Desiccation of the Aral Sea: A water management disaster in the Soviet Union, Science, 241(4870): 1170-1176.

Solomon, S. (2005) Environmental pollution and its management in sugar industry in India: An appraisal, Sugar Tech, 7(1): 77-81.

UNEP (2004) Freshwater in Europe, United Nations Environmental Programme, DEWA/GRID Europe, Geneva, Switzerland.

UNESCO (2006) Water: a shared responsibility - The United Nations world water development report 2, United Nations Educational, Scientific, and Cultural Organization, Paris, France.

Van Oel, P.R., Mekonnen, M.M. and Hoekstra, A.Y. (2009) The external water footprint of the Netherlands: Geographically-explicit quantification and impact assessment, Ecological Economics, 69(1): 82-92.

WWF (2004), Sugar and the environment: Encouraging better management practices in sugar production, WWF Global Freshwater Programme, WWF, Zeist, The Netherlands.

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

Basin name	Countries partly or fully laying with the basin	Agricultural water footprint (m^3/yr)			Industrial water footprint (m^3/yr)		Domestic water footprint (m^3/yr)		Total water footprint (m^3/yr)				Number of months per year that a basin faces low, moderate, significant or severe water scarcity		
		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Moderate	Significant	Severe
Mississippi	USA; Canada	194987000	17826000	41054400	3292240	28150600	0	0	194987000	21118240	69205000	285310240	2	0	2
Po	France; Switzerland; Italy	137626000	23530700	22963100	6457870	41512800	3506060	9106370	137626000	33494630	73582270	244702900	2	0	0
Seine	France; Belgium	116674000	6143230	10200500	4231870	31815200	0	0	116674000	10375100	42015700	169064800	2	0	2
Loire	France	124905000	12204100	11649900	2113600	15858700	0	0	124905000	14317700	27508600	166731300	0	2	0
Ganges	China; Nepal; India; Bangladesh	108234000	16690800	15442800	692311	14782300	0	0	108234000	17383111	30225100	155842211	0	2	5
Volta	Mali; Burkina Faso; Togo; Côte d'Ivoire; Benin; Ghana	153347000	25391	162716	736	13840	0	0	153347000	26127	176556	153549683	0	0	1
Volga	Russia; Kazakhstan	1762210	132491	90182	6447610	141484000	0	0	1762210	6580101	141574182	149916493	0	0	1
Nelson	USA; Canada	128158000	941997	17225600	161152	1222820	0	0	128158000	1103149	18448420	147709569	0	0	2
Escaut (Schelde)	Netherlands; France; Belgium	76755200	6359640	7561630	3735350	36133800	0	0	76755200	10094990	43695430	130545620	0	1	3
Garonne	France; Spain; Andorra	64064700	15005900	7419660	891684	6687600	0	0	64064700	15897584	14107260	94069544	1	1	1
Nile	Egypt; Sudan; Eritrea; Ethiopia; Central African Republic; Congo, Dem Republic of; Kenya; Uganda; Tanzania; Rwanda; Burundi	69851000	7350370	2079920	11887	252875	0	0	69851000	7362257	2332795	79546052	0	0	2
St.Lawrence	USA; Canada	42847300	264059	6886230	2549010	20998000	0	0	42847300	2813069	27884230	73544599	0	0	1
Mekong	China; Myanmar; Viet Nam; Laos; Thailand; Cambodia	54442500	1067900	4451630	363589	7474420	0	0	54442500	1431489	11926050	67800039	1	0	3
Indus	China; Afghanistan; Pakistan; Nepal; India	34974900	16951900	10052700	210112	4447360	0	0	34974900	17162012	14500060	66636972	1	3	8
Ob	Russia; Kazakhstan; Mongolia; China	2000410	98584	59202	2564410	56369600	0	0	2000410	2662994	56428802	61092206	1	0	1
Daule & Vinces	Ecuador	53736000	107560	205156	306	6076	0	0	53736000	107866	211232	54055098	2	1	0
Douro	Spain; Portugal	41992600	4769490	5564890	143913	414890	0	0	41992600	4913403	5979780	52885783	2	0	3
Krishna	India	41596000	3438560	3188880	135851	2881350	0	0	41596000	3574411	6070230	51240641	1	1	7
Murray	Australia	39506900	4234510	1062560	6765	84651	0	0	39506900	4241275	1147211	44895386	2	0	6
Godavari	India	31418200	2371100	2705470	110089	2334930	0	0	31418200	2481189	5040400	38939789	2	0	5
Salado	Argentina	37916100	38854	524920	675	8647	0	0	37916100	39529	533567	38489196	0	0	1
Guadiana	Spain; Portugal	28665500	5802750	3478100	63979	74631	0	0	28665500	5866729	3552731	38084959	1	0	6
Don	Russia; Ukraine	1368210	132138	74052	1522730	33447000	0	0	1368210	1654868	33521052	36544130	0	2	2
Guadalquivir	Spain	27035400	7421760	1697750	162175	0	0	0	27035400	7583935	1697750	36317085	1	0	6
Chao Phraya	Myanmar; Laos; Thailand; Cambodia	24256800	2920430	4316770	187550	3802720	0	0	24256800	3107980	8119490	35484270	2	1	4
Ebro	France; Spain; Andorra	28604300	3472180	3134780	122523	25894	0	0	28604300	3594703	3160674	35359677	0	0	3
Bandama	Mali; Côte d'Ivoire	32715200	259429	78332	80	1420	0	0	32715200	259509	79751	33054460	0	0	2
Huang He (Yellow	China	13173700	1537220	5618480	751647	11186900	0	0	13173700	2288867	16805380	32267947	1	2	4

Basin name	Countries partly or fully laying with the basin	Agricultural water footprint (m^3/yr)			Industrial water footprint (m^3/yr)		Domestic water footprint (m^3/yr)		Total water footprint (m^3/yr)				Number of months per year that a basin faces low, moderate, significant or severe water scarcity		
		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Moderate	Significant	Severe
River)															
Tejo	Spain; Portugal	22416400	4956940	3000500	278221	218369	0	0	22416400	5235161	3218869	30870430	1	0	4
Amur	Russia; Mongolia; Korea, Dem People's Rep; China	7994450	470882	2829760	739898	14198300	0	0	7994450	1210780	17028060	26233290	0	0	2
Niger	Algeria; Mauritania; Mali; Niger; Chad; Burkina Faso; Nigeria; Guinea; Côte d'Ivoire; Sierra Leone; , Benin; Cameroon	22767000	78927	33856	142870	2875550	0	0	22767000	221797	2909406	25898202	0	0	2
Aral Sea basin	Kazakhstan; Uzbekistan; Kyrgyzstan; Turkmenistan; Tajikistan; China; Afghanistan; Pakistan	4116890	17881200	62468	91309	2165790	0	0	4116890	17972509	2228258	24317658	1	0	4
Huai He	China	10452300	694207	3707060	457169	6804120	0	0	10452300	1151376	10511180	22114856	1	5	1
Sassandra	Guinea; Côte d'Ivoire	21006400	97172	39770	59	1045	0	0	21006400	97231	40815	21144445	0	0	2
Columbia	USA; Canada	7009450	5794150	5072420	283675	2411290	0	0	7009450	6077825	7483710	20570985	2	0	0
Tigris & Euphrates	Turkey; Iran; Iraq; Syria; Jordan; Saudi Arabia	9325110	8077500	1550660	78679	1419090	0	0	9325110	8156179	2969750	20451039	0	1	5
Lempa	Guatemala; Honduras; El Salvador	18160200	31330	931752	248	4325	0	0	18160200	31578	936077	19127855	0	0	4
Yongding He	China	7235850	1136750	3188820	426381	6345900	0	0	7235850	1563131	9534720	18333701	0	0	12
Pra	Ghana	18181300	3735	14105	189	3577	0	0	18181300	3924	17682	18202905	0	0	1
Cauvery	India	12430500	1428780	961064	61923	1313350	0	0	12430500	1490703	2274414	16195617	3	1	8
Ulua	Guatemala; Honduras	14698100	12971	973030	36	578	0	0	14698100	13007	973608	15684715	1	0	2
Wisla	Belarus; Poland; Ukraine; Czech Republic; Slovakia	5926860	1103260	697391	613165	6622760	0	0	5926860	1716425	7320151	14963436	0	0	1
Dniepr	Russia; Belarus; Ukraine	2075960	178183	160344	544761	11987700	0	0	2075960	722944	12148044	14946948	0	0	1
Lake Mar Chiquita	Argentina	13100800	217078	208916	1472	18847	0	0	13100800	218550	227763	13547113	1	1	4
Mahanadi(Mahahadi)	India	10504900	518152	1383310	48921	1037600	0	0	10504900	567073	2420910	13492883	0	0	5
Comoe	Mali; Burkina Faso; Côte d'Ivoire; Ghana	12852400	97488	34974	47	843	0	0	12852400	97535	35817	12985752	0	0	2
Santiago	Mexico	11787300	136482	379428	18024	196665	0	0	11787300	154506	576093	12517899	1	0	5
Mono	Togo; Benin; Ghana	12299100	112	62404	289	5477	0	0	12299100	401	67880	12367381	0	0	1
Narmada	India	9208740	1137230	897343	30058	637505	0	0	9208740	1167288	1534848	11910876	2	0	5
Hong(Red River)	China; Viet Nam; Laos	4541060	48872	583076	282990	5796650	0	0	4541060	331862	6379726	11252648	0	1	3
Kizilirmak	Turkey	7606650	1867560	1089380	22722	401562	0	0	7606650	1890282	1490942	10987874	1	2	2
Neva	Finland; Russia; Belarus	346185	4890	14389	445572	9723950	0	0	346185	450462	9738339	10534986	0	0	2
Thames	UK	2162620	54419	242281	714915	6430330	0	0	2162620	769334	6672611	9604565	1	1	1
Orange	Namibia; Botswana; South Africa; Lesotho	6630300	936459	433558	125915	1439500	0	0	6630300	1062374	1873058	9565732	2	1	3
Sakarya	Turkey	6229610	1711830	878920	28808	509105	0	0	6229610	1740638	1388025	9358273	0	1	5
Brazos	USA	5184500	1656110	1000660	124402	1063730	0	0	5184500	1780512	2064390	9029402	0	1	6
Limpopo	Mozambique; Zimbabwe; Botswana;	5837780	1027000	220930	149437	1712060	0	0	5837780	1176437	1932990	8947207	2	0	5

Basin name	Countries partly or fully laying with the basin	Agricultural water footprint (m^3/yr)			Industrial water footprint (m^3/yr)		Domestic water footprint (m^3/yr)		Total water footprint (m^3/yr)				Number of months per year that a basin faces low, moderate, significant or severe water scarcity		
		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Moderate	Significant	Severe
	South Africa														
Tano	Côte d'Ivoire; Ghana	8808170	1716	7738	53	1003	0	0	8808170	1769	8741	8818680	0	0	1
Kuban	Russia; Georgia	142500	27888	6739	364460	7997570	0	0	142500	392348	8004309	8539157	2	0	0
Save	Mozambique; Zimbabwe	7824190	324477	128359	704	14321	0	0	7824190	325181	142680	8292051	1	1	2
Tapti	India	6510880	552794	527229	29899	634151	0	0	6510880	582693	1161380	8254953	2	1	5
Ural	Russia; Kazakhstan	423980	62045	16471	315950	6954920	0	0	423980	377995	6971391	7773366	2	1	1
Shebelle	Somalia; Ethiopia; Kenya	7292260	121855	122929	72	1506	0	0	7292260	121927	124435	7538622	0	0	2
Panuco	Mexico	6977680	93537	190435	17892	195227	0	0	6977680	111429	385662	7474771	1	0	4
Damodar	India	5285820	233607	684092	50152	1063700	0	0	5285820	283759	1747792	7317371	3	0	4
Liao He	China	3278440	428734	1327080	140928	2097460	0	0	3278440	569662	3424540	7272642	1	0	4
Neman	Russia; Latvia; Lithuania; Belarus; Poland	4233360	1223480	719065	38586	816900	0	0	4233360	1262066	1535965	7031391	0	0	1
Colorado(Pacific Ocean)	USA; Mexico	1069460	2029490	490753	326311	2791060	0	0	1069460	2355801	3281813	6707074	0	3	5
Sacramento	USA	978967	2954210	1313570	132659	1134330	0	0	978967	3086869	2447900	6513736	1	0	5
Lake Chad	Algeria; Libyan Arab Jamahiriya; Niger; Chad; Sudan; Nigeria; Central African Republic; Cameroon	5118350	10465	6780	55287	1112750	0	0	5118350	65751	1119530	6303632	0	0	3
San Joaquin	USA	1060300	2894240	1484070	73593	629276	0	0	1060300	2967833	2113346	6141479	1	0	7
Dead Sea	Syria; Lebanon; Jordan; Israel; West Bank; Egypt	2020930	2601240	673777	35664	488042	0	0	2020930	2636904	1161819	5819653	0	0	8
Penner	India	4707700	282637	323050	19295	409246	0	0	4707700	301932	732296	5741928	1	2	9
Lake Turkana	Sudan; Ethiopia; Kenya; Uganda	5575180	52271	54783	28	560	0	0	5575180	52299	55342	5682822	0	0	1
Brahmani River (Bhahmani)	India	4269150	105927	533078	21965	465871	0	0	4269150	127892	998949	5395991	0	0	4
Western Dvina (Daugava)	Russia; Latvia; Lithuania; Belarus; Estonia	2443750	957173	414701	53202	1148880	0	0	2443750	1010375	1563581	5017706	0	0	2
Solo (Bengawan Solo)	Indonesia	4403190	2399	416662	2334	45464	0	0	4403190	4733	462126	4870049	1	0	3
Bravo	USA; Mexico	2198160	906436	432533	124798	1082650	0	0	2198160	1031234	1515183	4744577	0	4	7
Gloma	Sweden; Norway	4072190	138274	95129	24963	246225	0	0	4072190	163237	341354	4576780	0	0	1
Colorado(Caribbe an Sea)	USA	2428650	880027	434182	73548	628891	0	0	2428650	953575	1063073	4445298	1	0	6
Trinity(Texas)	USA	1740690	27597	263038	239152	2044920	0	0	1740690	266749	2307958	4315397	1	1	2
Kokemaenjoki	Finland	2653300	52138	106895	117392	1366520	0	0	2653300	169530	1473415	4296245	0	0	2
Mahi	India	3187900	302636	313647	19505	413699	0	0	3187900	322141	727346	4237387	2	0	5
Rio De Contas	Brazil	4066420	56571	59578	3402	51268	0	0	4066420	59973	110846	4237239	2	0	0
Narva	Russia; Latvia; Belarus; Estonia	1809290	383039	303435	71367	1554650	0	0	1809290	454406	1858085	4121781	0	0	2
Rio Jaguaribe	Brazil	3718760	97093	138722	5088	76677	0	0	3718760	102181	215399	4036340	1	1	3
Vuoksi	Finland; Russia	2287380	27283	91512	112710	1338710	0	0	2287380	139993	1430222	3857595	0	0	2

Basin name	Countries partly or fully laying with the basin	Agricultural water footprint (m^3/yr)			Industrial water footprint (m^3/yr)		Domestic water footprint (m^3/yr)		Total water footprint (m^3/yr)				Number of months per year that a basin faces low, moderate, significant or severe water scarcity		
		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Moderate	Significant	Severe
Negro (Uruguay)	Brazil; Uruguay	3020740	305464	107853	877	15510	0	0	3020740	306341	123363	3450444	0	0	1
Papaloapan	Mexico	3301080	7175	82880	2586	28218	0	0	3301080	9761	111098	3421939	0	0	4
Brantas	Indonesia	3043700	1395	257661	1891	36835	0	0	3043700	3286	294496	3341482	1	1	2
Fitzroy	Australia	2930730	164753	90112	434	5429	0	0	2930730	165187	95541	3191458	1	0	4
Senegal	Mauritania; Mali; Senegal; Guinea	3093990	10015	7673	387	7313	0	0	3093990	10403	14987	3119379	0	0	4
Sanaga	Nigeria; Central African Republic; Cameroon	3087080	997	7891	73	1381	0	0	3087080	1070	9272	3097421	0	0	1
Apalachicola	USA	1373650	126636	249242	130283	1114010	0	0	1373650	256919	1363252	2993821	1	0	0
Kura	Russia; Georgia; Turkey; Armenia; Azerbaijan; Iran	1603490	617207	253293	17381	328274	0	0	1603490	634588	581567	2819645	1	1	2
Tana	Kenya	2617260	122270	66540	75	1451	0	0	2617260	122345	67991	2807596	0	0	1
Hudson	USA	766725	1950	145683	171477	1466250	0	0	766725	173427	1611933	2552085	0	0	1
Balkhash	Kazakhstan; Kyrgyzstan; China	265488	213403	138620	81903	1788510	0	0	265488	295306	1927130	2487924	0	2	3
Luan He	China	1048100	135024	446441	52167	776413	0	0	1048100	187191	1222854	2458145	1	0	5
Tarim	Kyrgyzstan; Tajikistan; China; Afghanistan; Pakistan	577773	605236	566648	42572	634463	0	0	577773	647808	1201111	2426692	1	1	9
Vaenern-Goeta	Sweden; Norway	844011	43789	110734	157314	1235150	0	0	844011	201103	1345884	2390998	0	0	1
Rio Itapicuru	Brazil	2263620	9945	55182	2326	35047	0	0	2263620	12271	90229	2366119	0	0	3
Chira	Ecuador; Peru	2281330	27749	28361	214	1757	0	0	2281330	27963	30117	2339411	0	2	5
Davo	Côte d'Ivoire	2324300	5870	4226	11	197	0	0	2324300	5881	4423	2334604	0	0	2
Gambia	Senegal; Gambia; Guinea-Bissau; Guinea	2299380	213	3691	63	1036	0	0	2299380	276	4726	2304382	0	0	4
Blackwood	Australia	2207460	1860	62900	80	995	0	0	2207460	1939	63895	2273295	0	0	4
Oueme	Nigeria; Togo; Benin	2085700	1	4515	6559	132058	0	0	2085700	6560	136573	2228833	0	0	2
Great Salt Lake	USA	461488	656969	154627	98117	838968	0	0	461488	755086	993595	2210169	1	0	6
Kymijoki	Finland	1023640	19936	40893	88245	1027230	0	0	1023640	108181	1068123	2199943	0	0	2
Colorado (Argentinia)	Chile; Argentina	1431930	615753	73983	1683	16879	0	0	1431930	617436	90862	2140227	0	2	1
Ca	Viet Nam; Laos	1148500	166	56113	35977	772022	0	0	1148500	36143	828135	2012777	2	0	1
Mae Klong	Myanmar; Thailand	1354760	122119	235158	11190	226878	0	0	1354760	133309	462036	1950105	0	0	3
Salween	China; Myanmar; Thailand	1461670	52245	151346	17033	265937	0	0	1461670	69279	417283	1948232	1	0	0
Gudena	Denmark	1028050	337494	151401	39189	388780	0	0	1028050	376683	540181	1944914	1	0	0
Galana	Kenya; Tanzania	1569840	44647	38275	95	1840	0	0	1569840	44742	40114	1654696	0	0	1
St.Johns	USA	237538	22930	93030	128137	1095660	0	0	237538	151067	1188690	1577295	1	1	0
Sittang	Myanmar	1380650	28395	31410	217	4829	0	0	1380650	28613	36238	1445501	0	1	3
Han-Gang (Han River)	Korea, Dem People's Rep; Korea, Republic of	284962	48559	57039	71271	967375	0	0	284962	119830	1024414	1429206	0	0	1
Cross	Nigeria; Cameroon	841993	2	705	22756	458305	0	0	841993	22758	459010	1323762	0	0	1

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		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Moderate	Significant	Severe
Dniestr	Poland; Ukraine; Moldova	429813	15070	30200	42293	801633	0	0	429813	57363	831833	1319009	0	0	1
Lake Vattern	Sweden	721290	36046	125534	43602	341696	0	0	721290	79648	467230	1268168	0	0	1
Sebou	Morocco	543900	521909	59421	8708	105444	0	0	543900	530617	164865	1239383	1	1	5
Rio Paraiba	Brazil	1083520	15585	31651	2941	44322	0	0	1083520	18526	75973	1178019	2	0	2
Connecticut	USA; Canada	243328	2230	54314	91092	778612	0	0	243328	93322	832926	1169577	0	0	1
Saint John	USA; Canada	833586	1509	189575	12484	96584	0	0	833586	13993	286159	1133738	0	0	2
Nueces	USA	530949	162223	150298	27080	231550	0	0	530949	189303	381848	1102100	0	0	12
Oulujoki	Finland; Russia	632805	5010	25526	29820	348797	0	0	632805	34830	374323	1041958	0	1	1
Merrimack	USA	78451	462	14012	99089	847286	0	0	78451	99551	861298	1039301	0	0	1
San Pedro	Mexico	985040	6479	32244	656	7160	0	0	985040	7135	39404	1031579	0	0	5
Armeria	Mexico	957881	14061	28839	528	5761	0	0	957881	14589	34599	1007069	1	0	6
Dramselv	Norway	805082	19076	17826	9221	91109	0	0	805082	28296	108935	942313	0	0	1
Burdekin	Australia	829155	62631	45346	201	2513	0	0	829155	62831	47859	939846	2	0	0
Dalinghe	China	428363	21023	160864	20741	308692	0	0	428363	41764	469556	939683	0	0	6
Southern Bug	Ukraine	432999	20767	27108	18710	425530	0	0	432999	39477	452638	925114	3	2	1
Verde	Mexico	850399	3136	23924	864	9427	0	0	850399	4000	33351	887750	1	0	4
Tugela	South Africa; Lesotho	394989	167744	27089	21822	249460	0	0	394989	189566	276549	861104	2	0	3
Pangani	Kenya; Tanzania	824180	5767	12561	22	460	0	0	824180	5789	13021	842990	3	0	6
Oelfusa	Iceland	754307	0	26582	2421	25689	0	0	754307	2421	52271	808999	0	0	1
Van Golu	Turkey; Iran	478694	161872	70135	4514	79819	0	0	478694	166386	149954	795034	0	0	1
Rio Vaza-Barris	Brazil	724085	6037	26783	1024	15432	0	0	724085	7061	42215	773361	0	0	3
San Antonio	USA	280534	45366	54267	40371	345197	0	0	280534	85737	399464	765734	0	1	11
Issyk-Kul	Kazakhstan; Kyrgyzstan	71886	90078	6348	24774	560310	0	0	71886	114852	566658	753396	1	1	2
Klamath	USA	199354	302058	111584	6050	51736	0	0	199354	308108	163320	670782	1	2	0
Rapel	Chile; Argentina	390978	172149	67434	1028	6169	0	0	390978	173177	73602	637757	1	0	2
Yaqui	USA; Mexico	508193	47776	42867	1637	15485	0	0	508193	49413	58352	615959	0	0	12
Pyasina	Russia	0	0	0	25716	564302	0	0	0	25716	564302	590018	1	1	0
Incomati	Mozambique; South Africa; Swaziland	272696	91967	18178	16463	188264	0	0	272696	108430	206442	587567	1	0	3
Saguenay (Riviere)	Canada	456227	164	44682	8348	61383	0	0	456227	8512	106065	570804	0	0	2
Salinas	USA	127563	138258	171936	13584	116156	0	0	127563	151842	288092	567497	1	0	8
Tranh (Nr Thu Bon)	Viet Nam; Laos	207014	118	14823	14878	319164	0	0	207014	14996	333987	555998	1	1	0
Pur	Russia	0	0	0	20713	454517	0	0	0	20713	454517	475230	0	0	3

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		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Moderate	Significant	Severe
Santa	Peru	415873	27475	29377	198	1430	0	0	415873	27674	30807	474353	0	1	1
Fuerte	Mexico	381040	20969	17113	447	4876	0	0	381040	21416	21989	424445	2	0	3
Corubal	Guinea-Bissau; Guinea	400958	0	1	9	163	0	0	400958	9	164	401131	0	0	4
Biobio	Chile; Argentina	280657	35844	38325	913	5474	0	0	280657	36757	43799	361213	0	0	1
Groot-Vis	South Africa	154652	138884	12635	3694	42234	0	0	154652	142578	54868	352099	0	0	12
Maputo	Mozambique; South Africa; Swaziland	216390	14158	12269	8322	95268	0	0	216390	22479	107538	346407	1	0	3
Negro (Argentinia)	Chile; Argentina	254176	60197	8670	256	3269	0	0	254176	60454	11939	326569	1	0	0
Chelif	Algeria	69229	40565	1838	15300	198362	0	0	69229	55865	200200	325294	0	1	6
Doring	South Africa	158393	117139	16739	2065	23612	0	0	158393	119204	40351	317948	0	1	7
Moose(Trib. Hudson Bay)	Canada	262672	22	21867	3260	23970	0	0	262672	3281	45838	311791	0	0	2
Groot- Kei	South Africa	118825	36850	6431	10761	123012	0	0	118825	47611	129443	295879	0	1	11
Ishikari	Japan	11757	1717	2710	18521	256860	0	0	11757	20238	259570	291565	0	0	2
South Esk	Australia	239419	16252	6526	161	2019	0	0	239419	16413	8544	264376	0	0	2
Gamka	South Africa	118085	64201	9771	3445	39378	0	0	118085	67646	49148	234879	2	1	2
Nizhny Vyg (Soroka)	Russia	137	0	7	9147	200717	0	0	137	9147	200724	210008	0	0	2
Murchison	Australia	200302	90	7281	14	175	0	0	200302	104	7456	207862	0	0	12
Rogue	USA	28795	42719	10503	11469	98068	0	0	28795	54188	108571	191554	1	0	0
Kem	Finland; Russia	0	0	0	8630	166828	0	0	0	8630	166828	175458	1	1	0
Geba	Senegal; Guinea-Bissau; Guinea	174549	0	481	11	173	0	0	174549	11	654	175213	0	0	4
Daryacheh-Ye Orumieh	Turkey; Iran; Iraq	23658	21756	7898	4557	97700	0	0	23658	26312	105599	155569	0	1	3
Penobscot	USA; Canada	46852	205	19198	6661	56959	0	0	46852	6866	76157	129875	0	0	1
Iijoki	Finland	5455	30	212	9537	111015	0	0	5455	9567	111227	126249	0	0	2
Limari	Chile; Argentina	64248	41060	17732	196	1179	0	0	64248	41256	18911	124415	4	1	4
Nyong	Cameroon	106721	0	169	12	210	0	0	106721	12	379	107112	0	0	1
Nadym	Russia	0	0	0	4594	100801	0	0	0	4594	100801	105395	0	0	3
Canete	Peru	86103	10024	7311	53	385	0	0	86103	10077	7696	103876	0	1	1
Nottaway	Canada	68279	1	5704	1171	8611	0	0	68279	1172	14315	83765	0	0	2
Kovda	Russia	0	0	0	3492	76622	0	0	0	3492	76622	80114	0	0	3
Conception	USA; Mexico	62994	4960	4958	527	4944	0	0	62994	5487	9902	78384	0	0	12
Kamchatka	Russia	0	0	0	2715	59578	0	0	0	2715	59578	62294	0	0	3
Angerman	Sweden; Norway	0	0	0	6963	54674	0	0	0	6963	54674	61637	1	1	0
Ord	Australia	25894	23218	2831	7	90	0	0	25894	23225	2920	52040	0	1	9

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		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Moderate	Significant	Severe
Albany	Canada	43426	1	3518	512	3768	0	0	43426	514	7287	51227	0	0	2
Joekulsa A Fjoellum	Iceland	36356	0	1398	243	2581	0	0	36356	243	3979	40578	0	0	2
Lagarfljot	Iceland	27477	0	1044	975	10341	0	0	27477	975	11385	39836	0	0	2
Eyre Lake	Australia	32511	2317	1143	250	3127	0	0	32511	2567	4270	39348	0	0	12
St.Croix	USA; Canada	18882	21	1649	711	5737	0	0	18882	731	7386	26999	0	0	2
Svarta, Skagafiroi	Iceland	18366	0	757	657	6974	0	0	18366	657	7731	26754	0	0	1
Palyavaam	Russia	0	0	0	824	18087	0	0	0	824	18087	18912	0	0	4
Lake Taymur	Russia	0	0	0	651	14292	0	0	0	651	14292	14943	0	1	3
Ozero Sevan	Armenia; Azerbaijan	2093	226	191	531	10111	0	0	2093	757	10302	13152	2	2	1
Skeena	Canada	0	0	0	1199	8819	0	0	0	1199	8819	10019	0	0	1
Varzuga	Russia	0	0	0	436	9573	0	0	0	436	9573	10009	0	0	3
Huasco	Chile; Argentina	4015	2511	2270	36	216	0	0	4015	2547	2485	9047	1	0	4
Severn(Trib. Hudson Bay)	Canada	6475	0	528	181	1334	0	0	6475	181	1863	8519	0	0	2
Ponoy	Russia	0	0	0	359	7868	0	0	0	359	7868	8227	0	0	3
Tana (NO, FI)	Finland; Norway	0	0	0	507	5668	0	0	0	507	5668	6174	0	0	3
Attawapiskat	Canada	5315	0	444	38	278	0	0	5315	38	722	6074	0	0	3
Manicouagan (Riviere)	Canada	529	0	45	370	2722	0	0	529	371	2767	3667	1	1	0
Loa	Bolivia; Chile	857	158	218	273	1633	0	0	857	431	1851	3138	0	0	12
Copper	USA; Canada	0	0	0	217	1852	0	0	0	217	1852	2069	0	0	2
Rupert	Canada	1745	0	145	11	80	0	0	1745	11	225	1981	0	0	2
Churchill, Fleuve (Labrador)	Canada	0	0	0	231	1695	0	0	0	231	1695	1926	0	0	3
Flinders	Australia	482	664	34	18	230	0	0	482	682	264	1428	2	1	0
Nass	Canada	0	0	0	80	586	0	0	0	80	586	666	0	0	1
Nushagak	USA	0	0	0	65	554	0	0	0	65	554	619	0	0	2
Taku	USA; Canada	0	0	0	60	473	0	0	0	60	473	534	0	0	2
Thelon	Canada	0	0	0	58	426	0	0	0	58	426	484	1	1	1
Gascoyne	Australia	108	115	4	7	85	0	0	108	122	89	319	0	0	12
Alsek	USA; Canada	0	0	0	31	239	0	0	0	31	239	270	0	0	2
De Grey	Australia	35	0	1	16	196	0	0	35	16	197	248	0	0	12
Ashburton	Australia	0	0	0	14	180	0	0	0	14	180	195	0	0	12
Fortescue	Australia	3	2	0	14	174	0	0	3	16	174	193	0	0	12
Durack	Australia	80	0	2	6	81	0	0	80	6	82	169	2	1	0

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		Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total	Moderate	Significant	Severe
Grande Riviere De La Baleine	Canada	0	0	0	15	110	0	0	0	15	110	124	0	0	3
Natashquan (Riviere)	Canada	0	0	0	14	101	0	0	0	14	101	114	0	0	2
Eastmain	Canada	0	0	0	12	87	0	0	0	12	87	98	0	0	2
Little Mecatina	Canada	0	0	0	4	29	0	0	0	4	29	33	0	0	3
Hornaday	Canada	0	0	0	1	11	0	0	0	1	11	12	1	0	0
George	Canada	0	0	0	1	6	0	0	0	1	6	7	0	0	3
Back	Canada	0	0	0	0	2	0	0	0	0	2	3	0	0	3
Ferguson	Canada	0	0	0	0	1	0	0	0	0	1	1	0	0	4

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