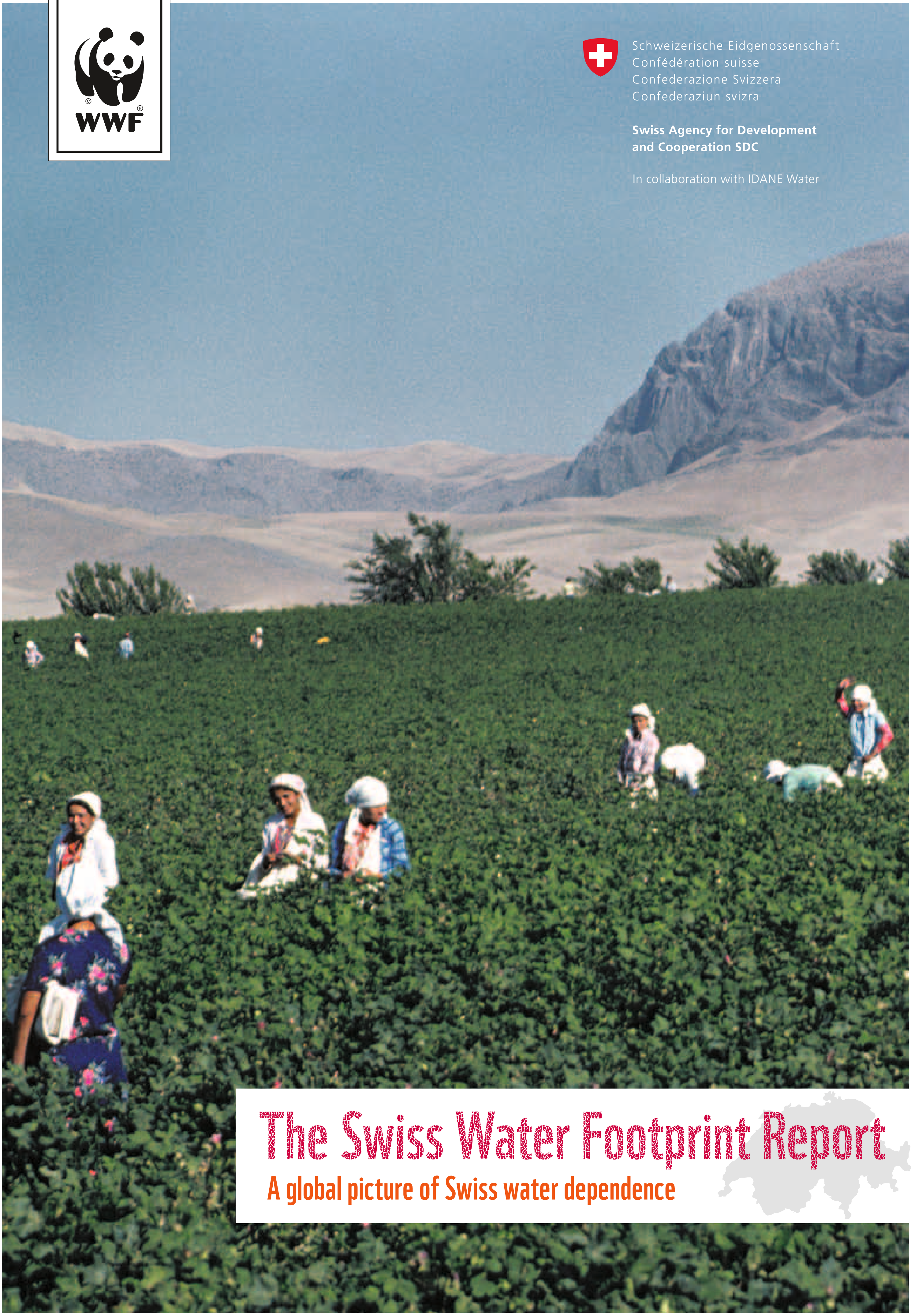

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In collaboration with IDANE Water

The Swiss Water Footprint Report

A global picture of Swiss water dependence

Lead author
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Data
Ercin A.E, Mekonnen M.M and Hoekstra A.Y (2011) Dataset water footprint Switzerland, University of Twente, Enschede, the Netherlands
All maps are produced by Ertug Ercin and Mesfin Mekonnen of the University of Twente

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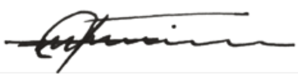
CONTENTS

Switzerland and global water challenges

The welfare of Switzerland depends on water from other countries: this is what you will discover in this study carried out by WWF in partnership with SDC and specialized Universities, in collaboration with the interdepartmental group of the Swiss Federal offices concerned with water issues (IDANE Wasser).

Ambassador Martin Dahinden, Director of the Swiss Agency for Development and Cooperation (SDC)



Freshwater is essential to all forms of life and fundamental for human health, for sustainable socio-economic development, and for food security. At the beginning of the third millennium, water resources, water services and ecosystems services feel direct impacts of rapid global changes: population growth, migration, urbanization, climate change, land-use changes and economic development.

This study uses the concept of water footprint to account for the total volumes of rainfall, surface and groundwater which are utilized globally for the production of goods and services consumed by Switzerland's population, as well as the impact of wastewater discharged into the environment as a result of this production.

With its abundant water resources and responsible water management practices, we would like to believe that Switzerland is immune from global freshwater challenges. This is not the case! While we import products – in particular, food – that are water-intensive, our service-based exports are not. This means that 82 per cent of Switzerland's water footprint is made out of our country, and often in regions where water resources are more scarce than in ours. This underlines the relevance of Switzerland's engagement and responsibility to contribute to resolving global water issues – and not just out of international solidarity, but also because our own development depends on it.
This is the reason why Swiss international cooperation is deeply engaged in water issues, both at the global level and locally in the field. One way that Switzerland is contributing is through its engagement in developing the ISO norm 14046, a standard for the industrial sector's water footprint.

It is also with this vision that we aim to mobilize Swiss expertise with the creation of the Swiss Water Partnership. This platform brings together various Swiss stakeholders active on water issues, from the public and private sectors, academia and civil society. The goal is to increase their outreach at the international level and to join forces to better respond to global water challenges.

I hope that you will enjoy reading this document.

Purpose of this report

In this report, WWF-Switzerland in partnership with the Water Initiatives section of the Swiss Agency for Development and Cooperation (SDC) set out to explore the water footprint of Switzerland and its highly globalized economy.

Our aim is to shed light on the freshwater underpinnings of the Swiss economy by:
- Visualizing the amount and origin of the water that is needed to produce the goods and services for the inhabitants of Switzerland;
- Presenting examples of the river basins and water bodies impacted by the production of key commodities, and the nature of those impacts;
- Highlighting the linkages and concepts of shared water risks;
- Providing recommendations and posing questions on research needs, citizen actions, water stewardship by the private sector and changes to public policy.

The intention of this report is to begin a more meaningful debate in Switzerland about the role of water in the economy. The issues raised here will require that we think and act more responsibly in the face of growing water scarcity in areas that produce the Swiss inhabitant's consumer goods. The findings of this report support the dialogue on water use in recipient countries of Swiss foreign aid. A water footprint perspective informs decisions on where and how Swiss funds are best invested in the water sector. A final and important intention is to inspire Swiss companies to reflect on future water trends and water risks their global operations face.

Summary

We all need water for our basic survival, for cultivating crops, for generating energy and for producing the goods that we use every day.

Although less than 1 per cent of water on the Earth is currently accessible for direct human use, there is enough water available to meet human and environmental needs. The challenge is to secure enough water of good quality in a way that doesn't destroy the very ecosystems from which we take our water supplies – rivers, lakes and aquifers.

The use of freshwater ecosystem services is now well beyond levels that can be sustained, even at current demands. A growing body of evidence on climate change indicates that the distribution of rainfall will change drastically and become more erratic in the future. A recent McKinsey report[1] predicts that by 2030, global water requirements will have grown from 4,500 billion m^3 today to 6,900 billion m^3. This hike in demand will exceed our current reliable and accessible water supplies by 40 per cent. These worrying trends make managing and conserving water resources so vitally important. In order to do so effectively, we must understand how water moves through the natural environment, the economies of nations, the production practices of agriculture and industry, and the lives of people. Water footprinting techniques allow us to do so. A water footprint also serves as a metaphor. The resulting numbers of volumetric water use can trigger a dialogue on water as a shared resource, and collective action can follow these numbers.

Water represents just one consideration in a government's agricultural, energy, industrial and trade policy and strategy. A water footprint should ideally be embedded in a broader narrative around water management, productive water use, domestic and international trade of a country, consumption and the political economy of targeted sectors.

What is a water footprint?

"Water footprint" is a measure of water use, and can be calculated for individuals, companies, cities and countries. It includes direct water use (such as for drinking and cleaning) as well as indirect use (the water required to produce goods and services). This indirect water use is described as "virtual" water. The Swiss water footprint has been calculated by adding the sum of all agricultural products produced and consumed (both within the country and imported), the sum of all industrial products produced and consumed (both within the country and imported) and the water used by households for washing, cooking and cleaning. Climatic and hydrologic conditions where the goods are produced have been taken into consideration.

The results: How large is the Swiss water footprint?

A large part of the Swiss water footprint is accounted for by water used in other nations to produce commodities. Only 18 per cent of the water footprint is produced within Switzerland. A remarkable 82 per cent results from imported goods and services.

The average Swiss consumes 162 liters[1] of water per person per day for domestic purposes such as drinking, cooking, cleaning or washing. When the virtual water used to produce the food, beverages, clothing and other consumed products is included, the water footprint amounts to 4,200 liters per person per day.

Switzerland's total water footprint amounts to 11,000 Mm^3 or 11 billion liters per year. The production and consumption of agricultural commodities makes up the bulk of the Swiss water footprint, accounting for 81 per cent of the total. Industrial commodities account for 17 per cent, while the remaining 2 per cent is household water use.

How can a water footprint assessment contribute to more sustainable and equitable water use?

A high water footprint is not a bad thing per se. A product using a lot of water but originating from a water abundant region or from a region with sound water management in place does no harm. What is required is to identify places and seasons where the water footprint is unsustainable. Water footprints are of concern when rivers, lakes or aquifers are depleted or polluted due to unsustainable water use, causing environmental, economic or social damage.

Detailed data and maps have been produced for those river basins across the globe that have a significant Swiss water footprint while facing water scarcity. This hotspot analysis lists the Aral drainage, the Indus basin, Ganges basin, Euphrates and Tigris basin and the Nile basin as the most critical river basins. All of these river basins produce agricultural goods in places and times of water scarcity that are consumed in Switzerland.

What should be done?

It is important not to equate water scarcity with unsustainable production. On the contrary, water scarce regions are often poorer than water abundant regions and should not be punished by business and consumers avoiding their products. What farmers, governments and enterprises in these critical regions must do is manage water risks well. The purpose of this report is to improve understanding of the implications of importing goods from regions facing water stress, motivate Swiss business and Swiss foreign aid to lend and invest better and produce more sustainably.

Progressive companies are already investing in assessing and managing water risks. They realize that the supply chains for almost every product Switzerland imports are exposed to risk. These companies measure and make their water use transparent to the public. They assess the status of the river basins they operate in and their impact on water resources. By determining corporate water risks and formulating responses, they become better water stewards.

Above all, awareness of water issues needs to be raised significantly. The Swiss water footprint report will serve as an entry point for decision-makers. It forms a solid basis for more precise water footprint assessments that will lead to more robust responses to future water challenges.

1 http://www.trinkwasser.ch/ – Schweizerischer Verein des Gas- und Wasserfaches SVGW

1: Water trends

Why bother with how much water the Swiss consume?

Water – the lifeblood of our societies

All great civilizations emerged around reliable water sources. The waters of the majestic streams of the Mekong, Ganges, Indus, Euphrates and Tigris gave rise to flourishing societies. Water was and is the basis of well-being. But our blue planet's freshwater resources are limited, even though Earth consists mainly of water. The total amount of water globally available supply is enormous, about 1.36 billion cubic kilometers[2]. Unfortunately, 97 per cent of all available water is too salty for human consumption. Of the remaining 3 per cent, most is frozen in polar ice caps or glaciers. Or it lies hidden away in deep groundwater aquifers, inaccessible for humans. This leaves us with a meager 1 per cent to be shared among not only more than 7 billion people, but all freshwater and terrestrial organisms.

"Water use has been growing at more than twice the rate of population increase in the last century."

SOURCE: FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO) AND UN-WATER

© Bret Stirnton / Getty Images

Water is a so-called renewable resource. The global hydrologic cycle wields ultimate control over our water supplies, and explains why we will not run out of water. Rain falls from the clouds, returns to the salty sea through freshwater rivers and evaporates back to the clouds. Thus precipitation continuously supplies the continents with water that replenishes lakes, rivers and groundwater. While we may temporarily deplete our

2 Gleick, Peter H. (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources (Oxford University Press, New York).

> "Around 30% of the world's freshwater is stored underground in the form of groundwater (shallow and deep groundwater basins up to 2,000 metres, soil moisture, swamp water and permafrost). This constitutes about 97% of all the freshwater that is potentially available for human use."
>
> SOURCE: UNEP

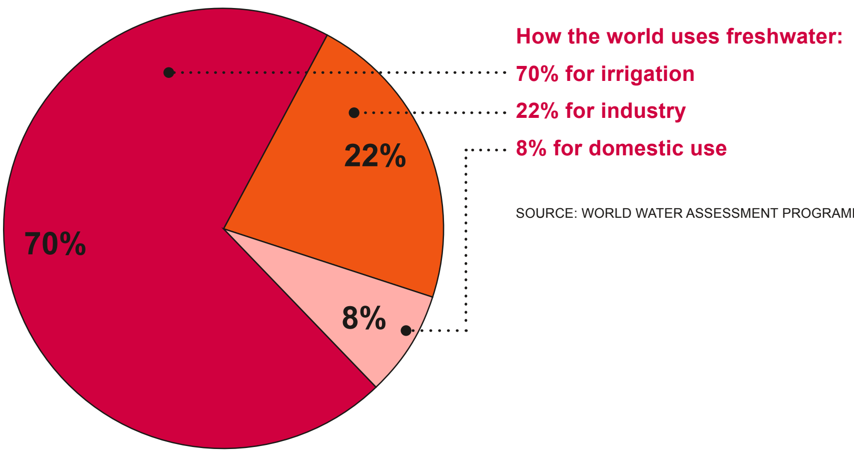
supplies, precipitation will eventually rebuild them. But there is little comfort in this scientific truth, as this may take thousands of years. The diminishing freshwater bodies of Lake Chad or Aral Sea may be the most drastic testimonies to this fact. The significance of water will not be clearer to anyone than to the people who used to live on the shores of these long-gone lakes.

Earth scientists are suggesting that we proclaim a new epoch called Anthropocene[3] because of the global environmental effects precipitated by the industrial revolution and its succeeding economic development. The enormous consumption of resources and associated pollution has brought the Earth's ecosystem close to or often beyond "planetary capacities"[4].

Will there be enough water tomorrow? Future water trends and risks

Challenges in managing unevenly distributed water resources are well known. 884 million people do not have access to clean water, while 2.6 billion lack access to sanitation services[5]. Thus, one-sixth of the planet's population does not have a reliable source of clean water to meet their daily requirements of 50 liters per day[6]. To any Swiss citizen, that amount is used daily to flush the toilet.

Is the widely talked about global water crisis[7] indeed a reality, and will predicted future water wars indeed shape the 21st century? Even if these gloomy scenarios may seem exaggerated to some, wars about water are already a reality. Water plays a prominent role in a number of conflicts in transboundary river basins such as the Nile basin, the Indus or the Jordan[8], of whose waters 98 per cent are diverted by Israel, Syria and Jordan.



SOURCE: WORLD WATER ASSESSMENT PROGRAMME (WWAP)

3 Zalasiewicz, J. et al. (2008). "Are we now living in the Anthropocene". GSA Today 18 (2): 4–8
4 Rockström J. et al. (2009). "A safe Operating Space for Humanity", in: Nature 461, p. 472-475
5 Progress on Sanitation and Drinking Water: 2010 Update. WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation. World Health Organization and UNICEF (2010), pp. 6-7.
6 Gleick, Peter H. "Basic Water Requirements for Human Activities: Meeting Basic Needs." Water International (IWRA) 21 (1996): 83-92.
7 Human Development Report 2006: Beyond scarcity: Power, poverty and the global water crisis, United Nations Development Program UNDP.
8 For a full list of conflicts revolving around water see http://www.worldwater.org/conflict.html

© Bret Stirnton / Getty Images

"Every day, 2 million tons of human waste are disposed of in water courses."

SOURCE: WORLD WATER ASSESSMENT PROGRAMME (WWAP)

Competition for shared water resources is increasing rather than decreasing for various reasons. First, most economies are still growing, many emerging economies rapidly so. Their growth is fuelled both by non-renewable (such as coal and oil) as well as renewable resources (such as forests and water). Water pollution further decreases the availability of usable water. This is a serious yet unresolved issue accompanying economic growth in developing countries and emerging economies. Second, a large number of groundwater aquifers are overexploited due to poor water management. Drastic examples include the Pakistani and Indian Punjab, South India's Deccan plateau, Egypt's Nile delta and the North China Plain. And third, it is not population growth in the poorest countries, but increasing resource consumption per capita in rich countries that exacerbates the scramble for water. The poorest countries with rapid population growth have so far only used a tiny fraction of their irrigation potential.

Finally, a growing body of evidence on climate change indicates that the distribution of rainfall will change drastically and become more erratic in the future. A recent McKinsey report[9] predicts that by 2030, global water requirements will have grown from 4,500 billion m^3 today to 6,900 billion m^3. This hike in demand will exceed our current reliable and accessible water supplies by 40 per cent.

These worrying trends make managing and conserving water resources so vitally important. And, in order to do so effectively, we must understand how water moves through the natural environment, the economies of nations, the production practices of agriculture and industry, and the lives of people.

9 Charting our Water Future: Economic frameworks to Inform Decision Making. Munich: 2030 Water Resource Group. McKinsey and Company (2009), p. iv.

2: Water footprint

You and I, and everything we buy, leave traces elsewhere…

“Water footprint of a cup of black coffee: 140 liters: This includes the water used for growing the coffee plant, harvesting, refining, transporting and packaging the coffee beans, selling the coffee, and brewing the final cup.”

CHAPAGAIN, A.K. AND HOEKSTRA, A.Y., 2007

The industrialization and globalization process of the past two centuries has changed water issues from being mainly local affairs concerning river basins to becoming regional and global issues. Water use is clearly more than what we touch and see, but rather the significant volumes of water that are required to produce the agricultural and industrial goods we consume. Practically all business sectors depend on water. The amount of water required to flow through our economies and produce the goods we consume dwarfs the daily drinking water intake of Swiss citizens. Everyday items such as your daily fruit juice, the shirt you wear or your smart phone were produced or built using water from somewhere. Few people consider that they actually have such close ties to Chinese factory workers, Tanzanian farmers or Peruvian business managers. We are connected by a trace of “virtual water”.

Virtual water has also been called embedded water or shadow water – different terms that reflect the fact that the amount of water physically contained in the product is negligible compared to the amount that went into its production. The concept of virtual water allows precise and practical applications since the amounts of water that go into production processes can be quantified. This methodology made calculations on global virtual water flows related to the international trade of commodities possible. The information on total water used in the supply chain of goods and services led to the quantification of the full extent of our water needs. The concept of “water footprint” was born.

By looking at the hidden dimension of water in agricultural and industrial commodities, a water footprint assessment not only paints a more complete picture of how much water our lifestyles require, but also allows us to better understand our economies’ dependence on various kinds of water both in spatial and temporal dimensions.

What is a water footprint?

This definition by the Water Footprint Network is embraced by a large number of academic institutions, NGOs, private and public sector actors. There are other water accounting methods available including life cycle assessments. Some of these assessments also use the term water footprint to refer to water use.

Water footprint as an indicator of human appropriation of freshwater resources can be measured as volume over time (mostly m^3/yr). A country's water footprint is the volume of water used to produce goods and services consumed by the inhabitants of a country, including imported goods. It can be separated into two components, "internal" and "external", based on where the actual water use occurs. The "internal water footprint" of a country is the volume of water used from domestic water resources to produce goods and services consumed within the country. A part of total water used in domestic production is also exported in the form of exported goods and services. The "external water footprint" of a country is the volume of water used in other countries imported (mainly by means of virtual water) and consumed within the country. In this context, the term "water use" is defined as the volume of water either evapotranspirated, incorporated into the product or polluted in the process. This metric not only shows the locations when and where the actual water use occurs, but also distinguishes the source of the water:

- The **blue water footprint** refers to the volume of surface water and ground water consumed during production processes (i.e. evaporated or incorporated into the product).
- The **green water footprint** refers to the volume of rainwater consumed (i.e. evaporated or incorporated into the product).
- The **grey water footprint** refers to the volume of freshwater that is required to assimilate the load of pollutants. It is calculated as the volume of water that is required to maintain the water quality according to agreed water quality standards.

SOURCE: 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.
HTTP://WWW.WATERFOOTPRINT.ORG/?PAGE=FILES/WATERFOOTPRINTASSESSMENTMANUAL

Figure 1:
The water footprint of a product.

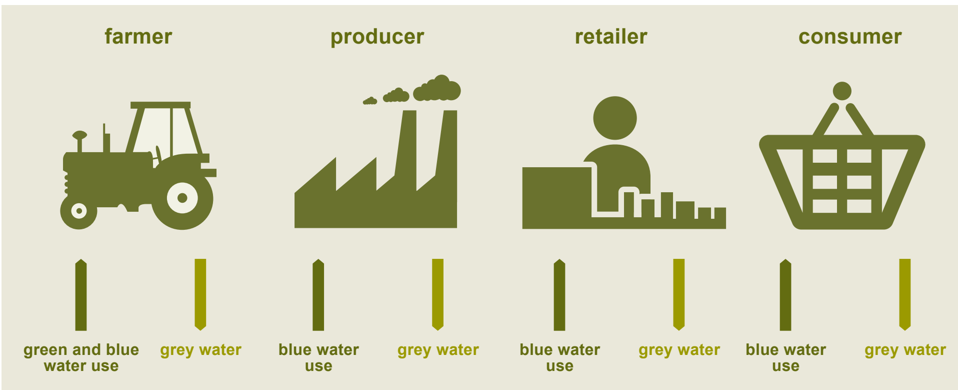
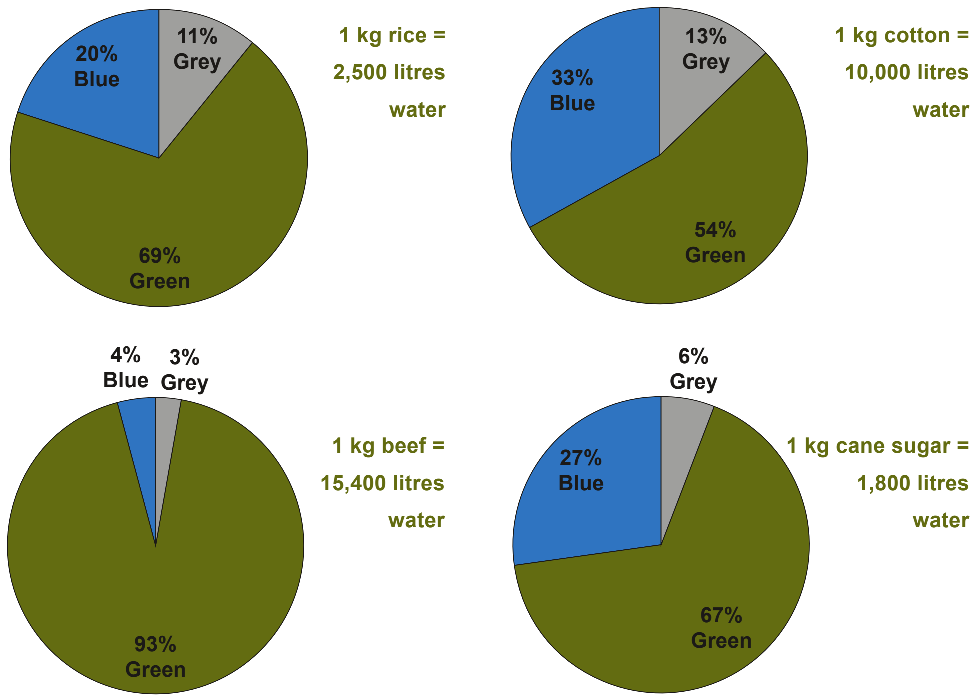


Figure 2:
A selection of agricultural products and their green, blue and grey water footprint.



Water footprint of industrial products

"Water withdrawals are predicted to increase by 50% by 2025 in developing countries, and 18% in developed countries."

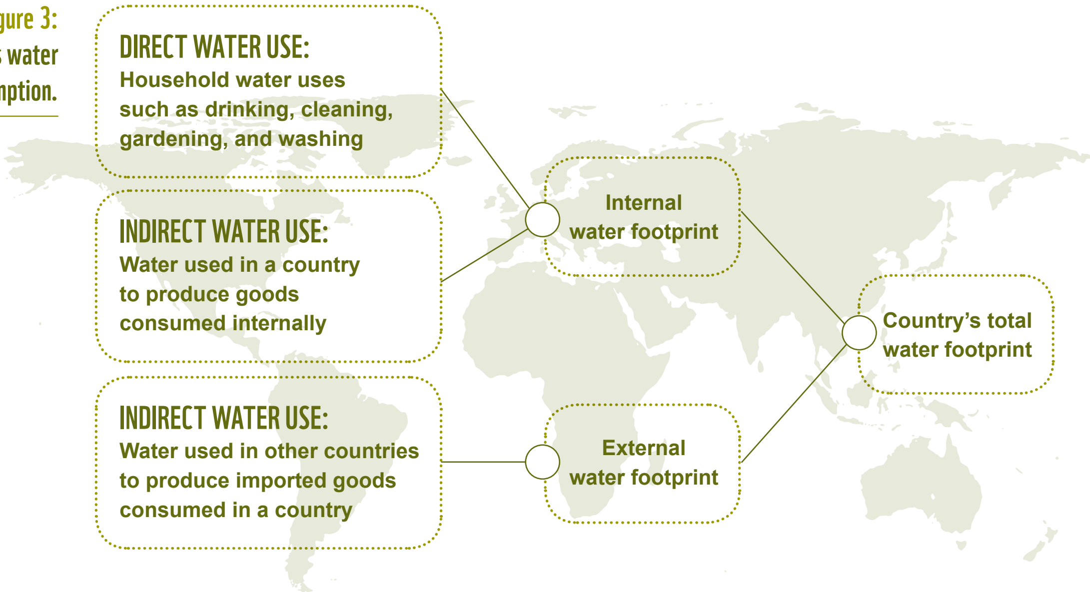
SOURCE: GLOBAL ENVIRONMENT OUTLOOK: ENVIRONMENT FOR DEVELOPMENT (GEO-4)

The global average water footprint of industrial products has been calculated according to the Water Footprint Network*. It is possible to assess the water footprint of specific industrial products, but to do this globally is very time-consuming due to the immense diversity of industrial products and production chains. In order to obtain a global rough figure for the water footprint of industrial products we can look at the average water need of industrial products not per unit or per kilogram, but per unit of value. Taking the added value of industries into account, we can estimate that the global average water footprint of industrial products is 80 liters per US$.

*SOURCE: WATER FOOTPRINT PRODUCT GALLERY OF WFN'S WEBSITE
HTTP://WWW.WATERFOOTPRINT.ORG/?PAGE=FILES/PRODUCTGALLERY&PRODUCT=INDUSTRIAL

The following figure outlines the required components for the calculations of a country's water footprint.

Figure 3: Components of a country's water footprint of consumption.



© Edward Parker / WWF-Canon

What's in a number? From metrics to impacts

A water footprint assessment is not only about accounting – what matters most in any discussion about water is how the numbers relate to impacts. Understanding the true impact of a country's water footprint requires a shift in focus to the local watershed or level where the footprint is left. This report aims to improve and deepen our understanding of the Swiss water footprint. Unlike the rather generic rankings of countries where the Swiss water footprint is high – as in WWF Switzerland's first report[10] – more of the actual impacts on blue water resources are now examined.

In order to feed the world's projected nine billion by 2050, green water productivity offers immense opportunities. While volumetric water footprint figures are approximations, they provide the basis for further discussion on allocation, management and use of water both on global and local scales.

10 Der Wasserfussabdruck der Schweiz (Sonnenberg et al.); WWF Schweiz (2010)

3: The big Swiss thirst

Our water footprint worldwide: Switzerland's total water footprint amounts to 11,000 Mm^3 per year. This corresponds to more than 30 billion liters per day, which on a per capita basis, makes the average Swiss water footprint around 1,500 m^3/year – equal to a daily water requirement of 4,200 liters. For comparison, the global average is 1,385 m^3/year/capita.

The production and consumption of agricultural commodities makes up the bulk of Switzerland's water footprint, accounting for 81 per cent of the total. Industrial commodities account for 17 per cent of the country's total water footprint. The remaining 2 per cent of Switzerland's water footprint goes into domestic water use (drinking, cleaning, washing, cooking).

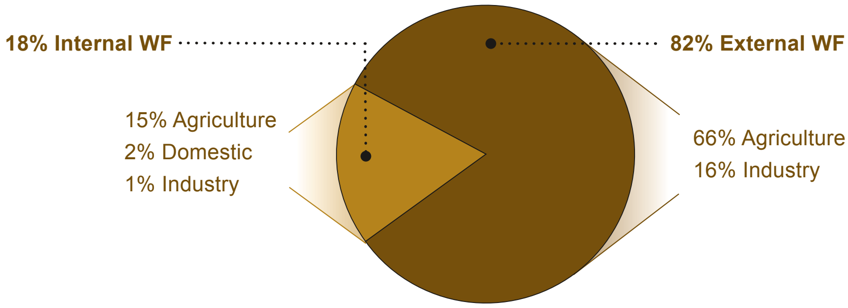
Switzerland exports virtual water also, either via domestically produced products or by re-exporting imported products. The "Swiss water accounts", an overview of all Swiss virtual water imports and exports are given in Annex 4.

It is acknowledged that water footprint figures are approximations. Sources of data insecurity lie in the complex trading pattern, in lack of precise data on consumption and in weak hydrologic, climatic and soil data from some regions. Grey water footprint needs further refinement; for example, pollution by heavy metals needs to be studied further. We cannot overstate the fact that WWF appreciates water footprint figures less for their absolute values, and much more as a way to visualize the complexity of water.

Table 1: Breakdown of Switzerland's water footprint of national consumption.

Unit: Mm^3/year	Internal	External	Total	%
Agricultural products	1,656	7,325	8,980	81
Industrial products	82	1,769	1,851	17
Domestic water use	223	0	223	2
Total	**1,960**	**9,094**	**11,054**	**100**
%	18	82	100	

Figure 4:
Swiss water footprint of consumption: Categories and their contribution to the external and internal water footprint.



© Edward Parker / WWF-Canon

With an internal water footprint accounting for only 18 per cent, these results contrast sharply with Switzerland being named Europe's "water tower". An impressive 82 per cent of Switzerland's water consumption is dependent on water resources outside its borders. The import of virtual water in consumer goods and services creates the Swiss external water footprint across the globe. This in turn poses questions to business and investors about their knowledge of where their own water footprints land. Do they really know enough about the effect of their supply chains and investments on other parts of the world?

Figure 5:
How sectors contribute to the Swiss water footprint of consumption.

A closer look at the water footprint of agricultural products (81 per cent of the total water footprint) reveals in which product categories this water is embedded. The bulk of Switzerland's agro-water footprint is produced by consuming meat (28 per cent), cereals (11 per cent), sugar (10 per cent), milk (10 per cent), edible oils (9 per cent) and coffee and tea (8 per cent).

Figure 6: Swiss water footprint of consumption per agricultural good.

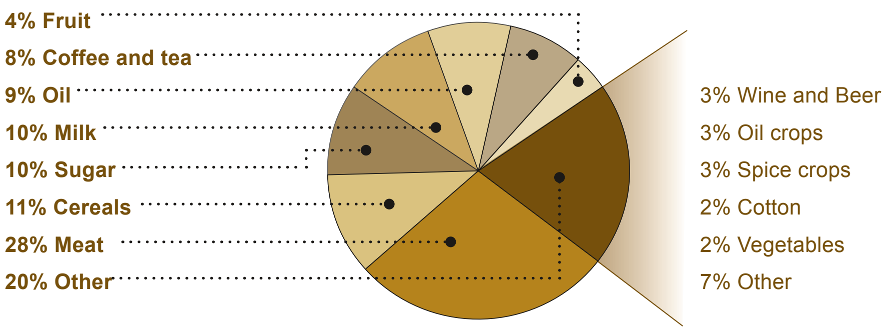
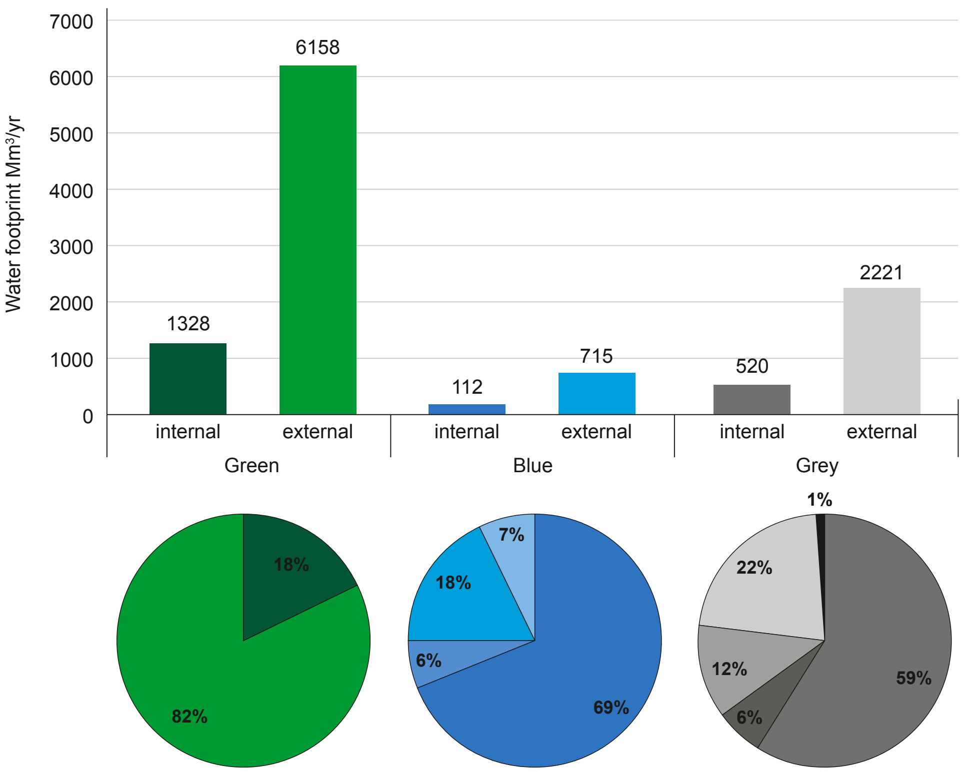


Figure 7: The breakdown of the green, blue and grey water footprint with respective external and internal shares.



82% = Agriculture external
18% = Agriculture internal

69% = Agriculture external
18% = Industry external
7% = Domestic
6% = Industry internal

59% = Industry external
22% = Agriculture external
12% = Agriculture internal
6% = Domestic
1% = Industry internal

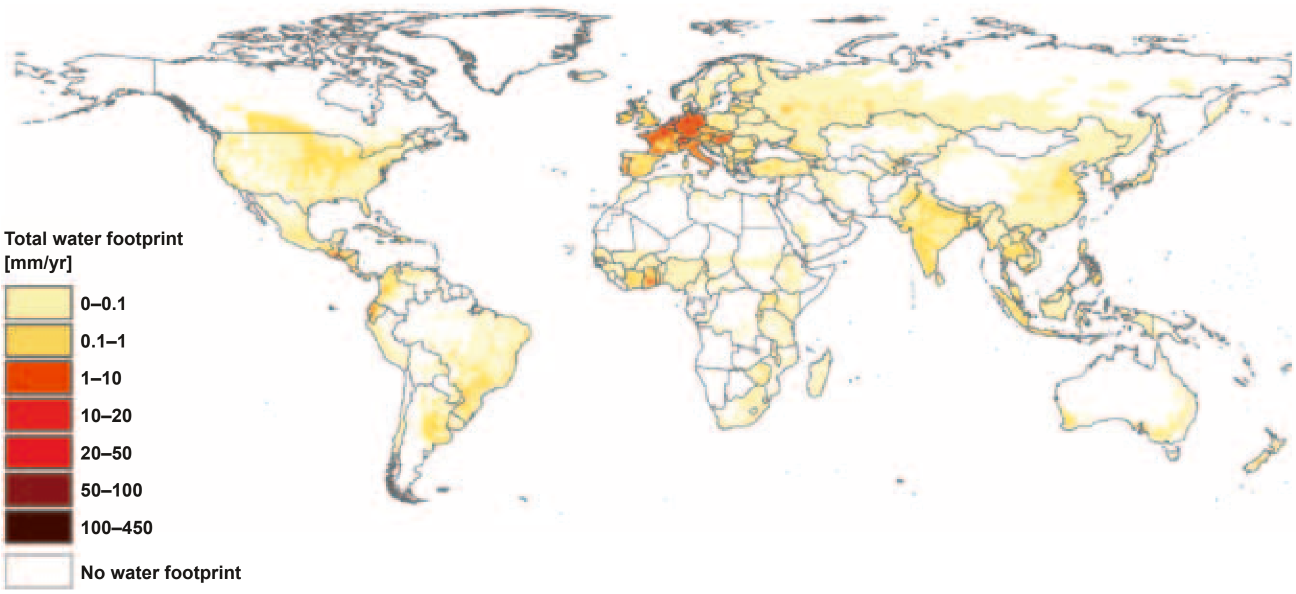


Figure 8:
Map of Switzerland's total water footprint worldwide. This map combines the different forms of freshwater appropriation as captured in the green, blue and grey water footprints. These detailed maps are found in Annex 1.

4: Hotspots of Switzerland's Water Footprint

Tracking the Swiss water footprint across the globe – on whose garden do we trample?

"Over 1.4 billion people currently live in river basins where the use of water exceeds minimum recharge levels, leading to the desiccation of rivers and depletion of groundwater."

SOURCE: HUMAN DEVELOPMENT REPORT 2006

Previous WWF national water footprint reports focused on average figures for countries where the footprint originates. However, hydrologic, climatic and soil regimes, water availability and resulting water scarcity vary significantly across large nations.

Using the boundaries of large river catchments is a much more appropriate geographic delineation of water footprints. The refined data set described in this report is based on grid cells (measuring 5 by 5 arc minutes or 10 by 10 km) and allows us to map the size of water footprints in a more detailed fashion within river basins.

Earlier water footprint studies highlighted water footprints as a comparative unit by focusing on volumetric figures. This did little to distinguish between water consumed in regions of water abundance and water from scarcity-plagued regions. The new assessment tools that are applied in this report allow better estimates of the actual hydrological impact of our water consumption.

Seasonality is another factor often not captured in existing water footprint reports. It matters when a product is produced. For the first time, this report uses data that allowed us to overlay water footprints with monthly water scarcity indices. This linking of Swiss water consumption with the production of goods in water scarce areas leads to more robust water footprint information. "Harmless" water footprints can be filtered from "harmful" ones.

Annex 1 and 2 include global maps that provide more detail and are more accurate than previous water footprint maps of Switzerland. But in order to determine whether Switzerland's water footprint is located in more sensitive and water-stressed regions, we need to identify blue water footprint hotspots. "Blue water scarcity" is a concept that allows an analysis of a river basin that tells us when the blue water footprint overshoots blue water availability, thus when scarcity of blue water resources is exacerbated by water consumption (for a detailed description see Annex 3).

Why focus on blue water scarcity and not on green water scarcity?

After calculating a water footprint, the next step is a sustainability assessment. The new data and maps on blue water scarcity help identify hotspots, specific catchments and periods of the year where blue water is over-abstracted. It can then be assessed at the local level whether this has negative impacts on the environment and the economy. While the same steps could be carried out for green water scarcity, the relevance of blue water is still much greater in most cases. In simple terms, blue water scarcity often means only the powerful and wealthy continue to have access to any water at all, while green water scarcity will limit biomass growth and thus food production. Competition for green water has come into focus in the debate on biofuels[11]. It is argued that the high demand for biofuels to replace fossil fuels threatens local food production and food security.

A better understanding of green water footprint is key to meeting the crop production requirements to feed the additional 2 billion people on our planet by 2050 as forecast by the UN. While impacts of green water footprints are low, opportunities are vast. Increasing productivity of rainfed agriculture will take pressure off rivers and aquifers. Entire regions such as Sub-Sahara Africa are far from meeting ideal levels of green water productivity.

In this report we have not focused on river basins facing strong grey water footprints. The largest contributors to the external grey water footprint of Switzerland are Germany, Russia, Italy, France and the US. Of course, water pollution that creates the grey water footprint is a serious issue and deserves closer attention, but such an analysis would go beyond the scope of our study. The supply chain of most industrial products reaches out to a number of river basins, so the level of complexity is very high. Data on water pollution is very limited and the methodology of grey water still lacks robustness.

Water footprint hotspots of Swiss consumption

More than 400 river basins worldwide were screened for blue water scarcity on a monthly basis. For two examples, we show how the blue water scarcity (BWS) index enables us to identify “hotspots”: river basins where the Swiss water footprint overlaps with water scarcity. These cases imply that lakes, rivers and groundwater aquifers cannot meet the required demand – water is over abstracted in an unsustainable manner.

Table 2: External water footprint of Switzerland in major river basins that experience blue water scarcity.

Basin	Agricultural water footprint (m3/yr)			Industrial water footprint (m3/yr)		Domestic footprint (m3/yr)		Total water footprint (m3/yr)			
Name	Green	Blue	Grey	Blue	Grey	Blue	Grey	Green	Blue	Grey	Total
Huang He (Yellow River)	13173700	1537220	5618480	751647	11186900	0	0	13173700	2288867	16805380	32267947
Indus / Pakistan	34974900	16951900	10052700	210112	4447360	0	0	34974900	17162012	14500060	66636972

Basin name	Water scarcity (%)													Number of months per year that a basin faces low, moderate, significant or severe water scarcity			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average	Low	Moderate	Significant	Severe
Huang He (Yellow River) / China	40	607	512	413	260	187	168	110	50	37	31	49	205	5	1	2	4
Indus / Pakistan	271	399	411	316	167	171	136	162	256	340	328	290	271	0	1	3	8

Low BWS (<100 per cent) / Moderate BWS (100-150 per cent) / Significant BWS (150-200 per cent) / Severe BWS (>200 per cent); the BWS index is described in Annex 3

11 Fingerman, K. R., Berndes, G., Orr, S., Richter, B. D. and Vugteveen, P. (2011), Impact assessment at the bioenergy-water nexus. Biofuels, Bioproducts and Biorefining, 5: 375–386. doi: 10.1002/bbb.294

Switzerland's water footprint was then overlaid with this scarcity data of river basins. The water footprint of Switzerland that is located in those basins was calculated, plus monthly information on the severity of blue water scarcity. It is important to keep in mind that previous such data was calculated for nations, not for river basins. Also, this is the first seasonal analysis, as it matters when during the year a crop is produced. All river basins from which Switzerland imports goods and which face water scarcity have been listed. If we rank these hotspots by their share of the total Swiss water footprint, the following river basins comprise the top 10:

Hotspots related to Switzerland's water footprint of consumption of agricultural products – blue water footprint

Table 3: The ten global river basins with the largest Swiss water footprint that face water scarcity.

River basin	Basin countries	% in total agricultural WF of consumption of Switzerland	Number of months per year that a basin faces moderate, significant or severe water scarcity			Major crops that contribute to blue WF in river basin
			Moderate	Significant	Severe	
Po	Italy, Switzerland	4.13	2	0	0	rice, maize, fodder
Aral Drainage	Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan	3.14	1	0	4	cotton, fodder, rice
Mississippi	USA	3.13	2	0	2	maize, soybean, rice, fodder, cotton
Indus	Afghanistan, India, China, Pakistan	2.97	1	3	8	wheat, rice, cotton, sugarcane, rapeseed
Ganges	India, Nepal, Bangladesh	2.93	0	2	5	wheat, rice, sugarcane, rapeseed
Garonne	France, Spain	2.63	1	1	1	maize, soybean, fodder
Loire	France	2.14	0	2	0	maize
Tigris & Euphrates	Turkey, Syria, Iraq	1.42	0	1	5	wheat, barley, cotton, rice, pulses, maize
Guadalquivir	Spain, Portugal	1.30	1	0	6	cotton, sunflower, rice, sugar beet, maize
Nile	Ethiopia, Sudan, South Sudan, Egypt, Uganda, DR Congo, Kenya, Tanzania, Rwanda, Burundi	1.29	0	0	2	wheat, sorghum, sugar cane, fodder

Note the ranking is done according to the river basin's share of the total water footprint. The severity and frequency of water scarcity does not add to the rankings, except that river basins without blue water scarcity do not feature in the list. Weighing these factors for a ranking would be a complicated exercise without added value.

Some of these river basins are located in wealthy industrialized countries such as Italy, France or the United States. As already stated, this report recommends against using water footprint metrics as comparative units. These rankings should not lead to prescriptive responses. However, a look at the full dataset reveals interesting features. Many river basins ranking high in terms of blue water scarcity and contributing to the Swiss water footprint are located in least developed countries and emerging economies. Many of these are focus countries of Switzerland's development and economic cooperation. Swiss companies invest significant amounts in these regions. All top ranking river basins benefit from Swiss overseas development assistance or from Swiss business investment.

Limits in import data accuracy allow only estimates of exported product quantities to Switzerland on river basin level, but by listing the major crops that rely on blue water in these river basins it is a fairly simple step to identify key products that make their way from these river basins to Switzerland.

Hotspots related to Switzerland's water footprint of consumption of agricultural products – blue water footprint

(selected river basins in developing countries and emerging economies)

River basin	Basin countries	% in total agricultural WF of consumption of Switzerland	Number of months per year that a basin faces moderate, significant or severe water scarcity			Major crops that contribute to blue WF in river basin
			Moderate	Significant	Severe	
Aral Drainage	Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan	3.14	1	0	4	cotton, fodder, rice
Indus	Afghanistan, India, China, Pakistan	2.97	1	3	8	wheat, rice, cotton, sugarcane, rapeseed
Ganges	India, Nepal, Bangladesh	2.93	0	2	5	wheat, rice, sugarcane, rapeseed
Tigris & Euphrates	Turkey, Syria, Iraq	1.42	0	1	5	wheat, barley, cotton, rice, pulses, maize
Nile	Ethiopia, Sudan, South Sudan, Egypt, Uganda, DR Congo, Kenya, Tanzania, Rwanda, Burundi	1.29	0	0	2	wheat, sorghum, sugar cane, fodder
Krishna	India	0.60	1	1	7	rice, wheat, sugar cane
Chao Phraya	Thailand	0.51	2	1	4	rice, sugar cane
Godavari	India	0.42	2	0	5	wheat, rice, sugar cane
Huang He (Yellow River)	China	0.27	1	2	4	wheat, maize, rice
Cauvery	India	0.25	3	1	8	rice, sugar cane
Narmada	India	0.20	2	0	5	wheat
Yongding He	China	0.20	0	0	12	wheat, rice, maize, soybean, cotton
Mekong	China, Laos, Thailand, Vietnam, Cambodia, Myanmar	0.19	1	0	3	rice, sugar cane
Limpopo	South Africa	0.18	2	0	5	sugar cane, cotton, fodder

Table 4 and figure 9: Fourteen hotspots – the river basins across the globe facing both the largest agricultural water footprint of Swiss consumption and periods of severe water scarcity.

The new dataset thus allows one to visualize and track the Swiss water footprint of consumption to water scarce watersheds across the globe and compare this with blue water scarcity. This reveals some uncomfortable news for the Swiss community of virtual water users. Cotton, sugarcane, wheat, rice and soy are among critical products, as they are produced in places and during periods with scarce water sources. Despite severe blue water scarcity, agricultural production continues to consume water at unsustainable rates. Stretches of degraded soils can be found in many of the basins. Often harmful mono-cropping and unregulated and unsustainable irrigated farming practices lead to degraded soil and water systems, and declining yields[12].

Sugarcane monocultures © Adriano Gambarini / WWF-Brazil)

The following outline of response options will provide an idea of how this data can be used, but also its limits. We are fully convinced that meaningful responses to any water footprint analysis require more detailed knowledge, both on exact trade patterns as well as on hydro-climatic, social and political factors. It is key to find an adequate level of spatial resolution for this exercise.

This study serves as an entry point to these further water footprint assessments by outlining whether Switzerland has a water footprint in a given watershed, in which precise area on grid cell level the footprint is located, and how the water footprint can be distinguished between its blue, green and grey components. What needs to be avoided are simplistic conclusions, such as calling for reducing or even boycotting the import of goods from "hotspot" regions.

As we will explain in the final chapters, the recommendation to a company or policymaker is to manage water well. In other words, good water stewardship[13] is possible in areas with even the highest water footprints and in the midst of water scarce regions. So it is not a smart choice by an investor, a company or a consumer to avoid water scarce regions. On the contrary, future challenges force us to manage risks and mitigate impacts in these critical regions[14]. Recommended responses around water must go beyond efficiency gains and reduction of the footprint numbers. A narrow focus on reducing a water footprint could be counter to development needs, or undermine poverty reduction strategies. A water footprint adds significant value by engaging all water users around water as a shared and scarce resource.

12 See for example Ali, Mubarik and Byerlee, Derek, 2002. "Productivity Growth and Resource Degradation in Pakistan's Punjab: A Decomposition Analysis", Economic Development and Cultural Change 50(4):839-864.
13 http://wwf.panda.org/what_we_do/how_we_work/conservation/freshwater/water_management/
14 Understanding Water Risks (WWF, S. Orr et al. 2009) and Investigating Shared Risk in Water (WWF, G. Pegram, S. Orr et al. 2009) available on http://wwf.panda.org/what_we_do/how_we_work/conservation/freshwater/water_management/

5: Water-smart future

Issues to be addressed, response options to be recommended.

The world's 7 billion people are appropriating 54% of all the accessible freshwater contained in rivers, lakes and underground aquifers.

SOURCE: WWAP

The days of plenty are over, and water experts across the globe have shown that water demand will increase; demand is on track to outstrip supply by 40 per cent. Plus, reliable and accessible supplies are becoming increasingly unreliable under the current pace of climate change.

Supply chains for almost every product Switzerland imports are exposed to water-related risks: food, clothing, beer, books, medical supplies, electronics and whatever else one can think of. Denying these truths is careless for Swiss companies operating abroad, Swiss financial institutions investing in risk-exposed river basins and Swiss development and economic cooperation. This report shows that Switzerland's consumption habits contribute to the water footprint in a number of water-stressed river basins across the world. Whether in hotspots or not, there are also plenty of opportunities for aid agencies, governments, business, farmers and consumers to use the water footprint concept to manage water better.

Concrete response options for better water stewardship

In 60% of European cities with more than 100,000 people, groundwater is being used at a faster rate than it can be replenished.

SOURCE: WORLD BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT (WBCSD)

The Water Footprint Assessment Manual[15] features a full library of potential response options, including ideas for farmers, consumers, governments and businesses. For our purpose, it is useful to stress how water footprint metrics can translate to mitigation strategies. No prescriptive measures can be derived from national water footprint accounts such as this. Developing and understanding a water footprint will not make any difference on the ground unless partners and stakeholders develop practical responses that address the underlying problems.

Public sector responses (including Swiss economic and development cooperation)

Many of the following responses may also be relevant within Switzerland, but here the focus is on regions outside Switzerland identified as hotspots.
Water represents just one consideration in a government's agricultural, energy, industrial and trade policy and strategy. A water footprint should ideally be embedded in a broader narrative around water management, productive water use, domestic and international trade of a country, consumption and the political economy of targeted sectors. Key elements in a governmental strategy aimed at water footprint reduction, as supported by the Water Initiatives Division of SDC, are:

15 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.

- Raising **awareness** of politicians, executives and the broader public about the importance and value of water in the economy and society;
- Motivating technically and economically **efficient use of water in water** supply, energy generation, industrial production, agricultural cultivation and trade, including a consideration of comparative advantages;
- Supporting **economic or social development** goals, including growth and equity, where water is an important resource for facilitating development;
- Encouraging **responsible use of water** to support long-term availability and quality, and so as not to adversely impact natural ecosystems;
- Informing integrated spatial and economic development planning by highlighting the links between water and agricultural, industrial and energy production and consumption in different parts of a country (a useful guide for watershed management in the Swiss context is available from the Federal Office for Environment)[16];
- Informing **national security** considerations, including food and energy security, where external reliance on virtual water plays an important role;
- Fostering **strategic dialogue** between diverse groups such as government, private sector and civil society, through the development of a common language and understanding of water and economic issues;
- Advising government departments, entities and municipalities on in-house water use and efficiency.

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Response for companies – managing water risks and taking a fair share of water responsibility

How can economies and businesses flourish in a changing and uncertain water future, the effects of which reach far beyond traditional water-intensive industries? It's not surprising that only few companies have assessed their exposure to water risk – water is a resource we have been able to take for granted. Water footprint reports point to the fact that this is no longer the case. Even a small shock to the system could have serious consequences for a company's direct operations, as well as supply chains, brand reputation, profits and growth opportunities. Any foresighted response by companies must include much more than becoming efficient

16 http://www.bafu.admin.ch/wasser/01444/08981/index.html?lang=en

water users. Companies aiming to be good water stewards need to become advocates for better water management. The root cause of water risk is often not the availability or use of water, but governance. Unless an entire river basin is managed in a sustainable way, one company's improved efficiency will likely be overshadowed by increased usage by a competitor or a neighboring community. This makes water the ultimate shared resource – and everyone's responsibility. Steps toward managing water risks and becoming better water stewards include:

- Defining a company's unique water-related risks;
- Integrating water strategy into operational plans; if required adapted management of supply chains;
- Improving water use efficiency and supporting local stakeholders to improve water use efficiency;
- Exploring in detail a business's dependence on water and the potential implications; Engaging stakeholders on the ground;
- Identifying the policy and governance gaps that increase a company's risk, and seeking solutions with policymakers and local partners;
- Achieving compliance with all relevant policies, and become active in efforts to set standards for water use;
- Becoming an advocate for government accountability.

Existing national water footprint reports include action points for farmers and consumers, as well. However, clear links are not easy to establish between a national water footprint account and these target audiences. The mentioned options can make solid contributions to mitigate looming regional and local water crises, but each response option will require more detailed water footprint assessments.

Looking ahead: Issues that need to be addressed further

Labeling products with average water footprints does not advance the cause of good water stewardship

Water footprinting is a useful tool to build awareness around the water used in the value chain to produce the products we consume. Given the general lack of proper water pricing mechanisms or other ways of transmitting production information, consumers have little or no incentive to take responsibility for the impacts on remote water systems, ecosystems or communities. One of our key lessons after publishing early national water footprint reports has been that most readers were easily misled to think consumers can be advised to make simple choices to positively influence water footprints. At this point of the methodology's evolution, the use of consumer labeling will be at best counterproductive and at worst misleading. This is due to the underlying complexity of determining a company's water footprint and the level of detail that lies behind the number, in terms of local environmental, economic and social impacts. For now, consumers and citizens can take more informed choices and keep water on the agenda of stores they buy from, people they vote for and companies they invest in.

One of our key lessons after publishing early national water footprint reports has been that most readers were easily misled to think consumers can be advised to make simple choices to positively influence water footprints. The specifics and complexities of the global water cycle and its regional variations mean that seemingly logical choices can be wrong from a water sustainability point of view: A cup of coffee consuming 140 liters, but grown in a well-managed agro-forestry system in the moist Kenyan highlands may be less damaging than a 30 liter cup of tea originating from an erosion-prone tea monoculture nearby. Without knowing the details of Kenya's water scarcity pattern, a consumer simply cannot decide which product has fewer negative environmental consequences.

Solutions are to be crafted where the water comes from: at the catchment

National water footprint reports cannot satisfy the demand for simple solutions. The spectrum of response options is solid, but any action requires additional refinement. WWF's experience in water footprint assessments can be said to be most fruitful on the river basin level.

It is within a catchment that a multi-stakeholder process can be initiated with most vigor. Every water user across a watershed has a clear self-interest in having and keeping access to enough clean water. Risks are shared by all, and once this simple truth sinks in, responsibilities will be shared too.

Switzerland's consumption relies on water resources from river basins across the world. Water is a fundamental and necessary good for survival and production. It is a renewable good but is only available in limited quantity and accessibility. Ensuring the availability of water to those who need it is one of the world's most pressing issues. This will become even more so as populations are predicted to grow, the way we use land changes and the impact of climate change becomes more apparent. Swiss authorities and Swiss enterprises should commit themselves to ensure responsible and sustainable management of the world's precious water resources.

A good start is a full examination of their own water footprint and risks, combined with strategies to engage proactively where it matters most.

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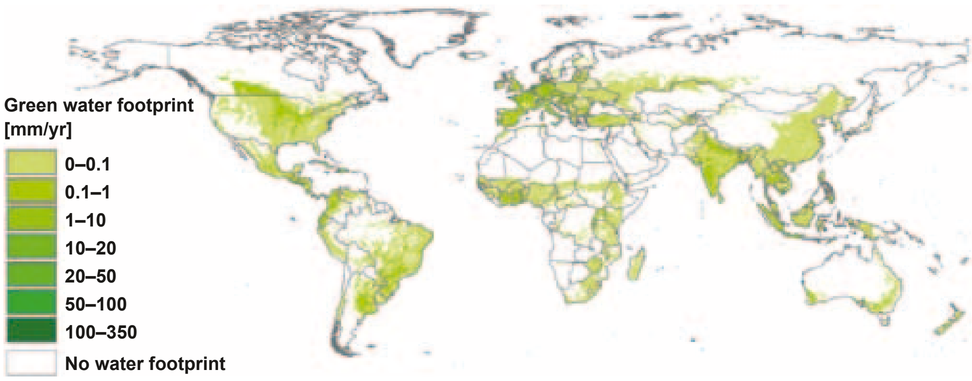
Annex 1: The global water footprint of consumption by the inhabitants of Switzerland (period 1996-2005)

Figure 10:
Map of Switzerland's green water footprint worldwide.



A green water footprint refers to the volume of rainwater consumed during the production process, mainly of agricultural and forestry products. The green water footprint stands for the total rainwater evapotranspiration (from fields and plantations) plus the water incorporated into harvested crops or wood. Green water footprint thus refers to rain-fed agriculture.

Figure 11:
Map of Switzerland's blue water footprint worldwide.

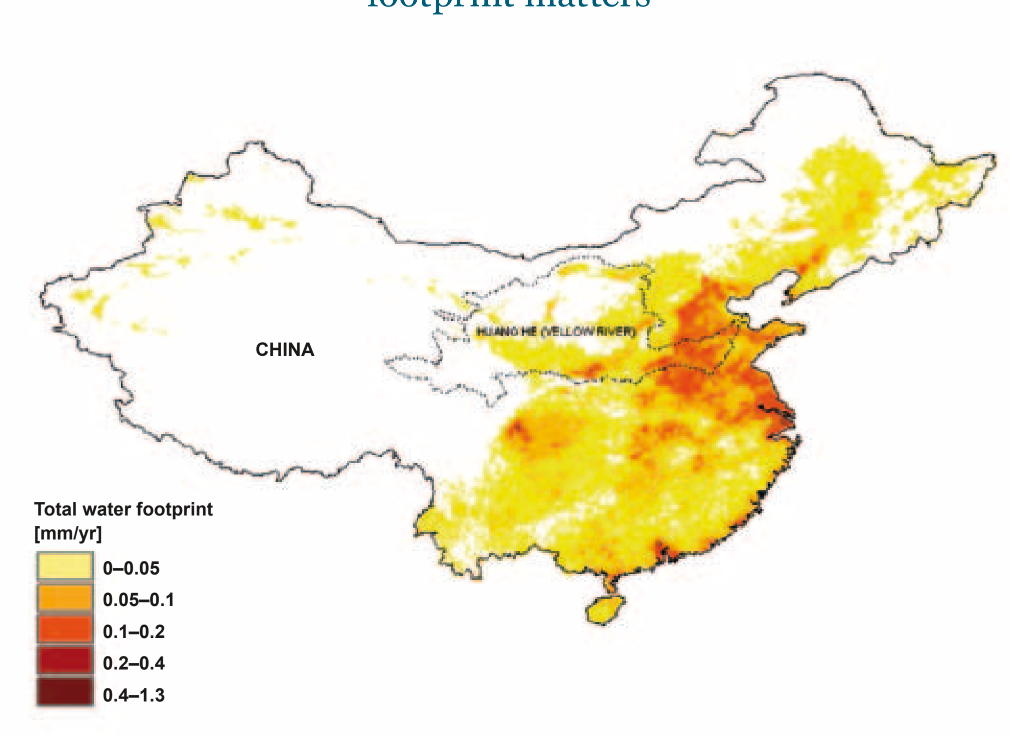
The blue water footprint measures the volume of groundwater and surface water consumed, i.e., withdrawn and then evaporated.

Figure 12:
Map of Switzerland's grey water footprint worldwide.

The grey water footprint measures the volume of water flow in aquifers and rivers polluted by agriculture and industry processes and from non-treated household wastewater. It is calculated as the volume of water that is required to dilute pollutants to such an extent that the quality of the water remains above agreed water quality standards.

Annex 2: The Swiss water footprint of consumption in two selected river basins where the Swiss water footprint matters

Figure 13:
Map of Switzerland's water footprint in China and in the Huang He / Yellow River basin.



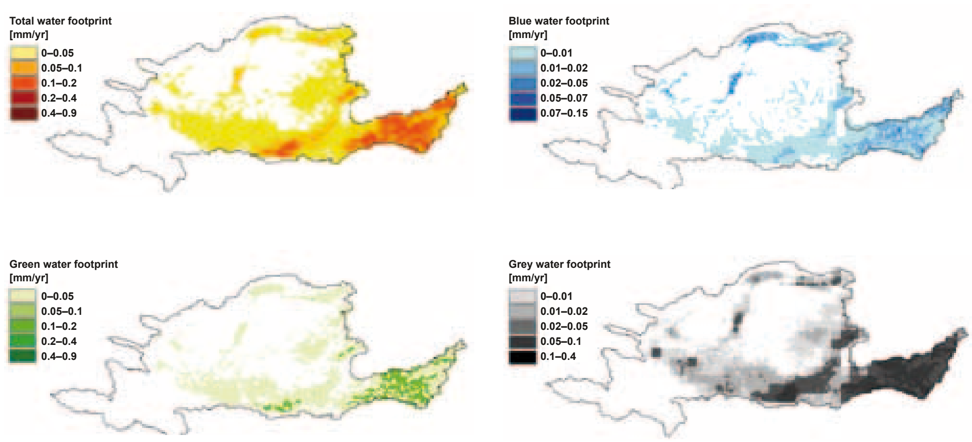
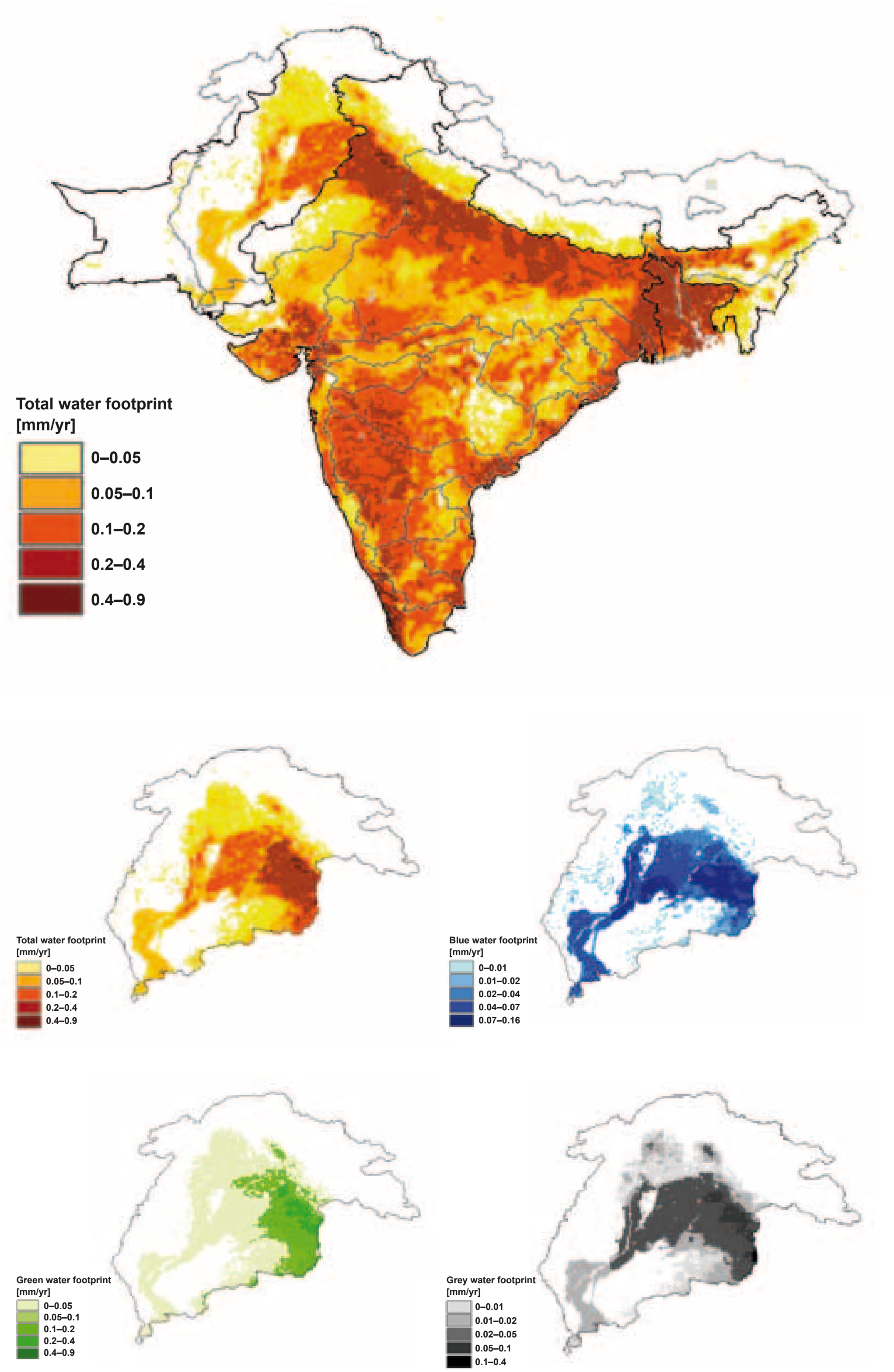


Figure 14:
Map of Switzerland's water footprint in South Asia and in the Indus River basin.



Annex 3: Methodology

In order to bring the magnitude of water use into the spotlight – at both our individual and national levels – we employ the metric of water footprints as devised by the University of Twente and adopted by the Water Footprint Network.

The calculations of the Swiss water footprint for this report were conducted by the Department of Water Engineering and Management of the University of Twente[17] in the Netherlands. Data and methodology were improved in many ways:

- **Longer data periods were considered.** Previous calculations of the Swiss water footprint were confined to a three-year period, while now a ten-year span between 1996 and 2005 served as the basis.
- **A more precise methodology was used.** Previous Swiss reports used trade data for the analysis applying a "top-down" methodology. This time the more robust "bottom-up" methodology[18] was applied, based on consumption data of the inhabitants of Switzerland. The bottom-up approach calculates the water footprint of national consumption by adding the direct and indirect water footprints of consumers within Switzerland. Data on national consumption of agricultural products per country were taken from the Supply and Utilization Accounts (SUA) of the Food and Agriculture Organization of the United Nations (FAO[19]).
- **Spatial and temporal resolution was increased.** The new water footprint analysis conducted for this report employed smaller grid cells (10 by 10 km), thus enabling an aggregation of the water footprint on river basin level. The new maps allow a refined image of water footprints with their variations across the catchments.
- **Better distinction between blue, green and grey water footprint.** This key information allows us to ask sustainability questions. It matters whether supplies of blue water (rivers, lakes, aquifers) or green water (in soils) become overstretched, as the implications are different.

Blue water scarcity

A.Y. Hoekstra and M.M. Mekonnen recently introduced the Blue Water Scarcity[20] (BWS) index. Conventionally, global water scarcity is measured on the basis of annual runoff and water withdrawal data. An impact assessment based on these statistics is less useful for three major reasons: First, the traditional water scarcity maps do not capture the seasonal variability in river flows, and thus easily could lead to incorrect interpretations. Second, they are based on water withdrawal data, and a large chunk of that water returns to the same river basin. Third, these maps are based on the assumption that every drop of water

17 Ercin A.E, Mekonnen M.M and Hoekstra A.Y (2011) Dataset water footprint Switzerland, University of Twente, Enschede, the Netherlands
18 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. pages 54-59.
19 http://faostat.fao.org/site/354/default.aspx
20 Hoekstra, A.Y. and Mekonnen, M.M. (2011) Global water scarcity: monthly blue water footprint compared to blue water availability for the world's major river basins, Value of Water Research Report Series No. 53, UNESCO-IHE, Delft, the Netherlands.

could be eventually abstracted without considering the environmental flow requirements in these locations. Hence, a new blue water scarcity indicator has been developed that is based on monthly values, water consumption data instead of water withdrawal, and takes into account the environmental flow requirements. The blue water scarcity in a river basin at a certain period is defined as the ratio of the total "blue water footprint" in the river basin at that period to the "blue water availability" in the basin at that period.

Low blue water scarcity (<100 per cent): the blue water footprint is lower than 20 per cent 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 per cent): the blue water footprint is between 20 and 30 per cent of natural runoff; runoff is moderately modified; environmental flow requirements are not met.

Significant blue water scarcity (150-200 per cent): the blue water footprint is between 30 and 40 per cent of natural runoff; runoff is significantly modified; environmental flow requirements are not met.

Severe water scarcity (>200 per cent): The monthly blue water footprint exceeds 40 per cent of natural runoff, so runoff is seriously modified; environmental flow requirements are not met.

A blue water scarcity of 100 per cent means that the available blue water has been fully consumed. The blue water scarcity is time-dependent; it varies within the year and from year to year.

Annex 4: Swiss water accounts

The Swiss water footprint accounts

Figure 15:
The Swiss water accounts (detailed data of all virtual water exports and imports is available).

Internal water footprint of national consumption 1'960	+	External water footprint of national consumption 9'094	=	Water footprint of national consumption 11'054
+		+		+
Virtual water export related to domestically made products 1'408	+	Virtual water re-export 3'326	=	Virtual water export 5'134
=		=		=
Water footprint within the area of the nation 3'368	+	Virtual water import 12'390	=	Virtual water budget from top 16'188 from left 15'758

The top line calculation is called bottom-up approach, the lower line top-down. The bottom-up and top-down calculations theoretically result in the same figure, provided that there is no product stock change over a year. The top-down calculation can theoretically give a slightly higher (lower) figure if the stocks of water-intensive products increase (decrease) over the year.

The internal water footprint is the water use within the country in so far it is used to produce goods and services consumed by the national population. The external water footprint of a country is the annual volume of water resources used in other countries to produce goods and services imported into and consumed in the country considered. It is equal to the virtual-water import into the country minus the volume of virtual-water exported to other countries as a result of re-export of imported products. The virtual-water export consists of exported water of domestic origin and re-exported water of foreign origin. The virtual-water import will partly be consumed, thus constituting the external water footprint of the country, and partly be re-exported. The sum of virtual water import and water use within a country is equal to the sum of the virtual water export and the country's water footprint. This sum is called the virtual-water budget of a country.

SOURCE: 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.

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To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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