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Water in Production and Products

The water used for production, known as “virtual” water, constitutes 95% of human water use. As pressure on the world’s water supply rises, recognition of the amount of water used within each step of production could play an important role in managing water use. This POSTnote examines how virtual water use is calculated and its application within the global economy.

Overview

- Global demand for water is forecast to outstrip supply by 40% by 2030 due to factors such as population growth and climate change.
- Recognising dependencies on water is crucial to ensuring security of supply.
- Water should be considered alongside other resources used in production, for example energy.
- There are two levels at which water used in production (“virtual” water) can be assessed: at the inventory level and at the impact level.
- Potential solutions for managing virtual water include a range of options, such as its better measurement and accounting, increased supply chain cooperation and implementing water pricing for agriculture.

Background

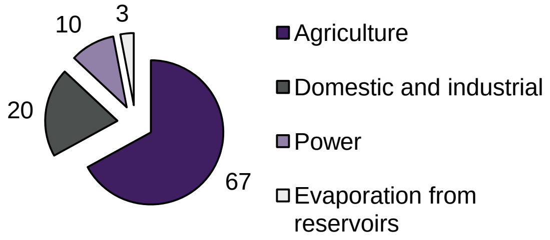
Water is a Limited Resource

Freshwater is essential to human activities, such as growing food to eat or producing material for clothing. However, the UN’s World Water Development Report states that “few countries are conscious of how much water they use, for which purposes and how much they can withdraw without serious environmental consequences”.[1] This is because, on average, 95% of the water which is used is in the form of invisible, “virtual” water associated with production.[2] 86% is used in the production of food (for example, 70 litres are used in the production of one apple, and 15,500 litres for one kilogram of beef), and 9% is associated with industrial production.[2] Despite its importance, businesses are only starting to consider the risks of interruptions of water to their supply chains.

A quarter of the water used for global production (about 2.3 trillion m^3 - roughly equivalent to one billion Olympic-size swimming pools) is ‘exported’ as a product. [3] 76% of the products are agricultural.[3] With projected increases in global population size, meat consumption and economic growth, demand for water is forecast to outstrip supply by 40% over the next 20 years.[4] This situation may worsen as a result of changes in hydrological cycles and precipitation patterns due to climate change (POSTnote 245 and 341).

Although the management of water resources is addressed in the EU through the Water Framework Directive, virtual water has only recently received attention. The UK government’s recent pledge to invest in a “green economy”[5] emphasises the importance of maintaining responsible production processes. A first step towards addressing these commitments and recognising the “true value of water” is through becoming more aware of the local environmental impacts of water use associated with production.[2]

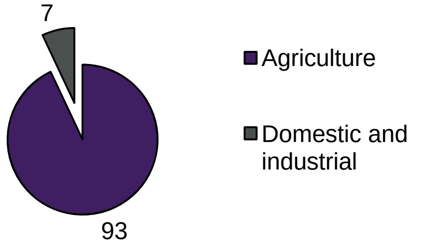
Figure 1. Global Withdrawal of Freshwater (%)[6]



Water Withdrawal and Consumption

Water is withdrawn from rivers, lakes and groundwater for a variety of purposes (Figure 1).[6] The amount of water required for agriculture differs markedly between regions, accounting for 3% of water withdrawn in the UK[7], but as much as 32% in Europe overall and 86% in Africa.[1] Water is being withdrawn in some countries at a level which is unsustainable for shared use, leading to water scarcity (Box 1). Water is also lost from an ecosystem when it evaporates, is transpired during the process of photosynthesis or is included in a product (for example, bottled drinks). These processes are “consumptive” uses of water.[6] The greater this use of water, the less is returned to the environment. Agriculture is the greatest consumer of water (Figure 2).[6]

Figure 2. Global Consumptive Uses of Freshwater (%)[6]



The distinction between water withdrawal and consumption is critical for reducing the focus on those industries that withdraw high volumes of water but return the majority of it at the end of their manufacturing process, such as paper production.

Box 1. Increasing Water Scarcity

Globally, water scarcity currently affects 1 in 3 people;[8] a ratio that is projected to continue.[9] “Physical” water scarcity takes place when demand exceeds local availability. “Economic” water scarcity may also occur where poor governance, or a lack of technical training and financial resources limit access to water, even when sufficient supplies are available. Physical water scarcity has increased over recent decades due to the over-withdrawal of water for economic purposes and climate change. A key example of water scarcity is the drying of the Aral Sea in Central Asia, which has been reduced in volume by 80% since 1960 due to withdrawals from its Amu Darya and Syr Darya river tributaries to grow cotton in the desert.

Understanding Virtual Water Use

Individuals, businesses and governments can improve their awareness of virtual water use by calculating the amount of water they consume and determining the location of their water sources.[2] This will enable the detection of hotspots of usage, both within and outside the country of focus.

Calculating Virtual Water Use

Calculating the amount of water used in production is fundamentally different from determining a product’s carbon footprint. It is more complicated, as water consumption may vary in time and space depending on a range of variables, such as climatic conditions and the techniques used for withdrawal and irrigation.[10] Water use can be assessed at two levels: at the inventory level or at the impact level.

Inventory Methods

Traditionally, the amount of water used in production was calculated by simply subtracting wastewater effluents from freshwater inputs.[10] Recently, more advanced inventory methodologies have been developed, such as the Water Footprint Network’s approach (Box 2), which assesses the volume of both direct and indirect water use.[11]

Box. 2 Water Footprinting Methodology[12]

The Water Footprint Network’s approach separates the quantity of water consumed in space and time based on whether it is “blue” (from surface water, such as lakes and rivers, or from groundwater, such as aquifers), “green” (rain water stored in soil moisture or captured directly) or “grey” (volume of freshwater polluted).

A product’s “water footprint” (WF) is a clear indicator of freshwater use in production that can be calculated at the individual, business, national or global level. Criticisms of this method are primarily based on the lack of environmental impact measures.[10] A large WF does not necessarily correspond to high water stress, as this will depend on the ratio of WF to available water supply. Local water availability may be reduced through consumptive water uses, including if water is returned to a river catchment outside the locality.

A Water Footprint Comparison of Products Manufactured in Australia[13]

Water Footprint (litres)	250g Peanut Snack	575g Pasta Sauce
Blue	127	128
Green	987	21
Grey	39	53
Total WF	1,153	202

To compare the WF of products effectively, it is essential to distinguish between water types. For example, in the table above, although the peanut snack has a larger overall WF, 86% originates from green water, indicating that its ingredients are mainly derived from rain-fed agricultural systems. By comparison, the production of pasta sauce is dominated by blue water consumption, which suggests that its ingredients are grown using abstracted water.

Impact Assessment Methods

Methods that are employed to assess the impacts of water consumption typically follow a “Life-Cycle Impact Assessment” (LCIA) approach (Box 3). These differ from inventory methods as they attribute an environmental impact to the water consumed. LCIA is an environmental management tool for measuring the environmental impacts of a product over its entire “life-cycle”.[14] This approach has been used frequently to assess the carbon footprint of products (POSTnote 383), and has only recently been extended to include the impacts of freshwater use.

Box 3. Life-Cycle Impact Assessment Methodology

LCIA methods determine the impact of water withdrawal based on a range of “characterisation factors”, including water stress (defined as the ratio of total annual freshwater withdrawals to hydrological availability) as well as several “damage-oriented” factors, which relate to the effects of water scarcity on issues such as human health or ecosystem processes.[15] These can be determined either by quantifying the damage directly or through the use of models based on causes and effects analysed elsewhere.[15] LCIA methods may use the above information to provide an aggregated index of impact. Although the LCIA approach enables a better understanding of the effects of water consumption, the complexity of the methods and the uncertainty of impact weightings in single aggregate measures can create difficulties for the interpretation of results. Modelled impacts may also be prone to errors.

Improvements in Virtual Water Calculations

Both inventory and impact assessment methods can be limited by the accuracy of the spatial and temporal data available[11], although these are improving over time:[12]

- Greater localised data enable the calculation of water use volumes at daily and monthly intervals. These may differ depending on the timing of water consumption (for example, more water will be required in summer).

- Using such data makes possible the tracking of changes in the WF of a product both within and between years.
- Water stress weightings can be adjusted according to time of year and local availability of surface and groundwater.

Agreement on Methodologies

A primary concern is the need to standardise methodologies required to attribute the environmental impact of water use. The International Organization for Standardization is developing WF requirements and guidelines for impact assessment, which are expected to be completed by the end of 2013. The UK Department for Environment, Food and Rural Affairs is considering policy options for enabling businesses to measure their water impact, while the European Commission's Directorate-General for the Environment is examining the potential role of water footprinting (Box 2) in EU policy.

Managing Virtual Water Use

Global Dependencies on Water

Given the global dimension of water consumption, it is important that countries recognise their interdependencies when drawing up national water management strategies. By quantifying national WFs, countries can assess their internal and 'imported' water consumption (Box 4).[3] Based on this, they can consider the security of their supply as well as locate potential environmental impacts of their international supply chains.

Box 4. The Water Footprint of the UK[16]

Being the sixth largest net importer of virtual water, the UK plays a key role in the 'movement' of water around the globe. The breakdown of the UK's WF illustrates its heavy dependency on water from elsewhere (data from 2006).

	WF (billion m^3/yr)			
	Internal	Imported	Total	% of total WF
Agricultural products	28.4	46.4	74.8	73
Industrial products	6.9	17.2	24.0	24
Domestic use	3.3	-	3.3	3
Total WF (billion m^3/yr)	38.6	63.6	102.1	100
% of total WF	38	62	100	-

Figure 3. Inter-regional Water Transfers Through Agricultural Trade.[3] Only flows over 15 billion m^3/yr are indicated with arrows. The larger the arrow, the larger the flow.

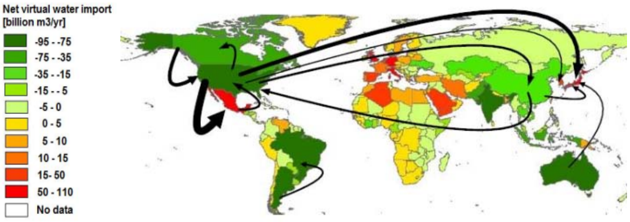


Figure 3 illustrates the average inter-regional water transfers through agricultural trade, based on data collected between 1996 and 2005.[3] North and South America, Southern Asia and Australia are the largest net exporters, whereas the largest net importers include North Africa, the Middle East, Western Europe, Mexico, Japan and South Korea. Trade in oil crops (for example, soybean, oil palm, sunflower and rapeseed) underpins the majority of virtual water transfers.[3] Although global trade is largely regulated by economic and political forces, water availability is beginning to influence decisions indirectly. Water-scarce countries have the potential to lessen their level of scarcity through importing water-rich commodities. Morocco is an example of a country that explicitly uses the virtual water trade to its advantage, through importing water-intensive products such as grain and seed oil and exporting high value (and low-water) fruit and vegetables, such as oranges. Water-scarce countries may also continue to export virtual water if this is beneficial for their economy, as is the case for Australia.

On average, the current trade in virtual water creates water savings compared with production in importing countries. The trade in agricultural products, for instance, saved an average volume equivalent to 4% of their global WF of production each year between 1996 and 2005.[3] A more strategic approach to the virtual water trade could help to minimise pressure on the world's water resources. Setting out national water management strategies in association with global trade flows will require careful consideration. Increasing international water dependencies raises the risks of negative impacts on exporting countries if the environmental impacts and costs of production are not reflected in the price of the traded product.[11]

Virtual Water in Business

Water is one of the most important inputs in the supply chains of producers, wholesalers and retailers. In response to the increasing risk of water scarcity, businesses are becoming more aware of the volume of water which they consume.[17,18] Companies with international supply chains, such as SABMiller and Coca-Cola, are quantifying their WFs and identifying hotspots of use. As well as physical risks associated with water scarcity, there are reputational, regulatory and financial risks for business (Box 5).

Box 5. Risks to Business Caused by Water Scarcity[17]

- **physical risk** - the risk of an interruption of water supply.
- **reputational risk** - the risk of negative publicity and public scrutiny from unsustainable water use.
- **regulatory risk** - the risk of increased water tariffs and stricter regulations on water quality and quantity.
- **financial risk** - the risk that water scarcity could impact on revenue and costs associated with physical and regulatory risks in the company's supply chain.

Business-to-Consumer Strategies

Using consumer choice to influence the amount of water used in production is a potential tool for managing water consumption. Although WF labels could raise awareness of water issues, there are a number of reasons why it is unlikely that a label focussed exclusively on water use will be adopted (Box 6). A further mechanism for improving water use is the Alliance for Water Stewardship's "good water stewardship" certification scheme, although this too may have constraints to its implementation (Box 6).

Rather than focussing on a single label or certification scheme for water, the French Senate have adopted a "multi-criteria sustainability label" approach[19], although the implementation of this law has been delayed.[20] However, UK retailers believe they should be responsible for managing such issues on their clients' behalf rather than providing information to customers.[21]

Box 6. Water-Labelling and Certification Schemes
The idea of water-labelling may not be adopted for the following reasons:

- consumers may not have sufficient background to interpret its meaning and could be confused by the variety of labels already present on packaging; [22]
- the WF of a product may vary significantly over time, making it expensive to continually produce an accurate, up-to-date WF label.
- water labels may not be comparable if different methodologies are used to calculate them; [22]
- labels which focus solely on water *use* may ignore other issues, such as impacts; [22]
- labelling a product as water-intensive could lead to losses of income in countries that are reliant on this trade but are not financially able to shift to more water-efficient practices.

Certification schemes may not be adopted by businesses because:

- The bureaucracy associated with auditing production processes may be difficult for large retailers to manage across their hundreds of supply chains;
- The cost of inspection may be too high for smallholder farmers.

Business-to-Business Strategies

Better cooperation between major supply chain agents could reduce risks from water scarcity. Such cooperation would support the "demand-focussed" approach to water management advocated by the European Commission,[23] based on water efficiency and conservation. In response to water scarcity risks, a few companies have developed specific water strategies to ensure the security of their supply chains (see Box 7). As part of their corporate social responsibility, businesses are increasingly supporting sustainable water management initiatives, such as the UN CEO Water Mandate (in which endorsing CEOs work with partners to tackle global water scarcity) and the Better Cotton Initiative (Box 7). Shifting the financial responsibility associated with investing in more efficient water use techniques (such as rain-fed or drip irrigation) from smallholder farmers to the retailer end of the supply chain can improve management of virtual water in products.

Box 7. Marks and Spencer's Water Sustainability Plan[21]
In January 2007, Marks and Spencer (M&S) launched its "Sustainability Plan A", which is aimed at making its "entire value chain more sustainable". They are working with WWF-UK to better manage the water consumed in products sourced from UK farms (such as meat and dairy products), the production of cotton and the import of flowers from Kenya. M&S is providing financial support to suppliers and farmers to meet best-practice requirements. It also aims by 2020 to source 50% of its supplies from the Better Cotton Initiative. This scheme promotes better agricultural practices to reduce the environmental and social impacts connected with cotton cultivation.

Water Pricing in Agriculture

Tighter management of water use in agriculture could be done through a number of measures, including greater cooperation between farmers that share the same water catchment. However, implementing water metering and pricing is a regulatory mechanism that has been discussed by the Organisation for Economic Co-operation and Development and the World Bank to better manage water usage.[24, 25] This approach involves pricing the water used in agriculture according to the exact amount withdrawn, using a meter. It has been suggested that water pricing should start above a threshold volume, considered as a "minimum water right", to ensure that poor people can satisfy their basic needs.[11] Although several countries (including the UK) already impose limitations through licences on the amount of water that can be withdrawn, agricultural water pricing could promote more efficient water use.[11] For example, water pricing in the Guadalquivir basin in Spain has resulted in a 30% reduction in water consumption.[26] However, unless proper water allocation mechanisms are in place, water savings do not guarantee better water management.

Virtual Water in Context

Virtual water in products should be considered in the wider context of analysing water use in combination with other resources. In addition to the "water-food-trade nexus" detailed above, the "water-energy nexus" is a further key interconnection.[2] All resources involved in production must be evaluated to ensure that reducing the input of one (for example, water) does not lead to increases in the use of others (for example, energy) , which may lead to unfavourable environmental outcomes.

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