Maureen Duffy
T: 856-309-4546
maureen.duffy@amwater.com

Virtual Water

Introduction

The world's water supply is finite, while its population is ever-growing. Finding better ways to protect and manage this limited resource is a constant challenge. On the consumer level, there has been an increased awareness of ways to reduce water use at home – turning off the faucet while brushing teeth, installing water-saving fixtures and watering the lawn less often, for instance. But direct water use accounts for only a small part of the water consumed. A far greater amount is consumed in the production of food and other products. Agriculture, in fact, accounts for as much as 85 percent of worldwide water use.[1] To create sustainable solutions to the growing global scarcity of freshwater, the bigger picture must be considered: indirect water use, also known as "virtual water."

Background

The concept of virtual water was first introduced in 1993 by Tony Allan, a British scientist and Kings College professor who was awarded the 2008 Stockholm Water Prize for his innovation. Arjen Y. Hoeckstra, a professor in water resources management at the University of Twente in The Netherlands, took virtual water a step further to create a "water footprint," which considers both direct and indirect water. Together, direct and indirect water use is what determines the real dependency on water. Hoeckstra and other researchers working with virtual water and the water footprint concept see it as a tool to better manage freshwater resources on a global scale.

While the water footprint concept has been gaining traction in environmental circles, it has not enjoyed the mass awareness of the carbon footprint, a similar idea that has been widely embraced as a way individuals and business can better understand and reduce their effect on climate change. There are, however, important differences that impact the relative practical applications of each concept. For while carbon emissions produced in one location can be offset anywhere in the world, water is a local product, and any meaningful "offsetting" would have to take place where the water was consumed or polluted.[2]

Calculating the Water Footprint

A significant challenge of the virtual water concept is the vast array of variables involved and the lack, to date, of any consensus on how to best consider them in calculating the true impact of water consumption. Hoeckstra has identified three components of a total water footprint:

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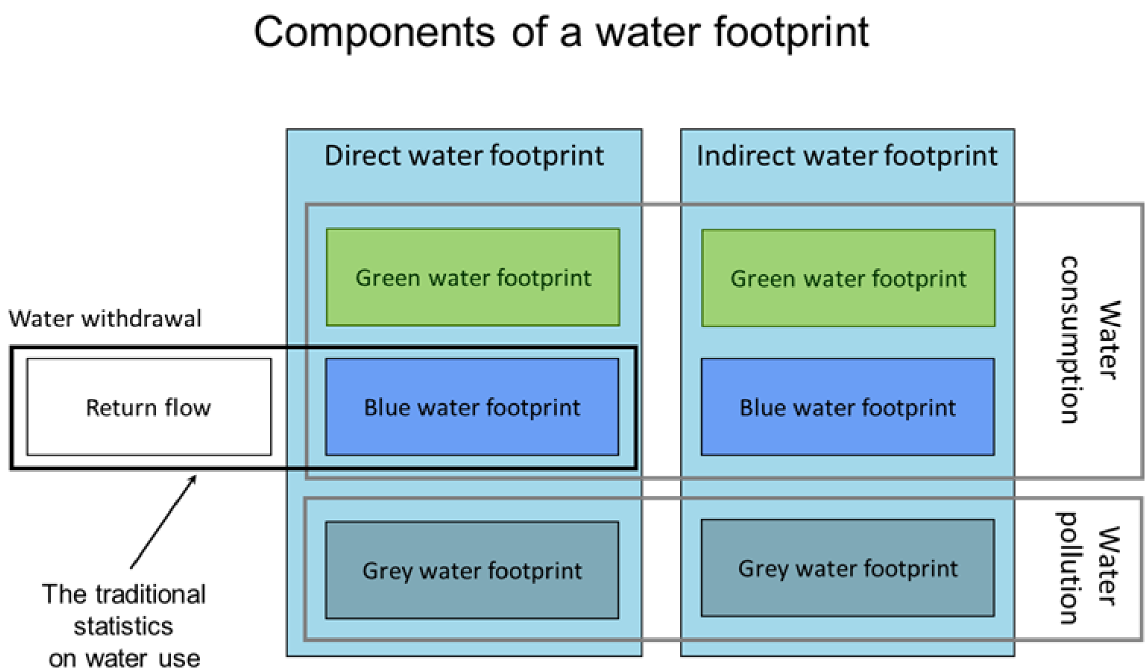
[1] Arjen Y. Hoeckstra
[2] Water Footprint Network, *Water Footprint Manual* (2009)

- The **blue water footprint** is the volume of fresh water that is extracted from surface and groundwater and not immediately returned to the source.
- The **green water footprint** is the volume of water extracted from rainwater stored in the soil. It applies primarily to agricultural and forestry use.
- The **grey water footprint** pertains to water that is polluted in the production process. It calculates the volume of fresh water required to dilute that polluted water to such a level that it meets or exceeds agreed-upon water-quality standards.



Source: Water Footprint Network, Hoekstra et al (2011)

Distinguishing between types of water consumed is an important step to calculating a comprehensive water footprint, whether for an individual product or a nation. Yet plenty of questions remain: In determining the virtual water impact of a particular item, how far back in the supply chain does one go? Does it include water consumed by labor and transportation associated with the product? Would water saved be available for another use?

Watermelons, for instance, are a very water-intensive crop. But their water footprint varies depending on whether they are grown in an arid or humid climate. Clearly stress-weighted factors matter, but just how much weight should a particular stress be given? Peanuts require six times more water than tomatoes to grow, but tomatoes are irrigated whereas peanuts rely exclusively on rain water. Which would be assigned the higher water footprint?

In addition, how does – and how should – an understanding of virtual water change decision making? Should the water industry, for instance, stop installing ductile iron pipe and use PVC if the water footprint of the latter was lower? All other factors being equal, the answer would probably be yes. But if PVC has a much shorter lifespan and its cost is much higher, most likely the answer would be no.

Perhaps the most useful methodology is the simplest: water used adjusted by water stress index (how much water is being extracted in that region and how much water is available). There are many parts of the U.S. where we are overdrawing available water. Water use in those areas is clearly a problem. But in areas where water is abundant, there is less water stress, so the impact is lower.

Impacts on International Trade

In a practical sense, the concept of virtual water has been influencing the flow of trade since the beginning of commerce. Arid regions and nations have long relied on trade with water-rich neighbors to supply water-intensive crops.

Proponents of virtual water trade tout its potential as a policy tool to improve water use efficiency on a global scale. According to the World Water Council, "Local planning and regional collaboration incorporating the notion of virtual water trade could result in exchange of goods, diversification of crops, diet awareness creation, or crop replacement actions for any country."[3] Yet in the same document, the Council acknowledges significant potential risks as well. "Besides the direct financial cost, other costs to be considered related to imports by water deficit countries to solve food deficiency are: (i) increased dependency on main exporting countries; (ii) if not able to compete or adapt, local agriculture may be damaged because of importing food; (iii) the exporting country may start interfering in internal affairs of importing country; and (iv) imports may result in foreign reserve depletion if there is no export compensation of less water intensive or high value commodities."[4]

Map of Ogallala Aquifer

Source: USGS

Virtual water trade carries risk to water-rich countries as well, in the form of environmental impact. The process of producing crops that are exported by the U.S. uses as much as 1/15 of the country's available water, impacting water levels in its aquifers and rivers and increasing evaporation.[5] In particular, the Ogallala Aquifer (also known as the High Plains Aquifer), supplies as much as 30 percent of the total groundwater used to irrigate the nation's cropland, according to the U.S. Geological Survey, and it is doing so at a withdrawal rate that far surpasses its rate of natural recharge.

Consumer Choices

Consumers can consider virtual water in making individual purchasing decisions, and in some cases in order to effect broader lifestyle changes. In general, fruits and vegetables require far less water to produce than meat. Livestock not only directly consumes water but also indirectly consumes it via the grain it eats, which requires water to grow. A vegetarian diet, therefore, carries a smaller water footprint than a meat-based diet.

By following the supply chain from the cultivation of feed grain to the raising of the cattle, to the processing and shipping of the meat, one pound of hamburger has a virtual water impact of 1,900 gallons.[6] With that knowledge, meat eaters can reduce their water footprint by choosing less water-intensive meats such as chicken over beef.

[3] World Water Council, *E-conference synthesis; Virtual Water Trade – Conscious Choices* (2004)
[4] World Water Council, *E-conference synthesis; Virtual Water Trade – Conscious Choices* (2004)
[5] www.wateryear2003.org
[6] Water Footprint Network, www.waterfootprint.org

The conscientious consumer might opt for garments made of synthetic fibers over water-intensive cotton, and drink tap water over bottled, given that the average plastic bottle requires 1.5 gallons of water to produce, or three to five times as much water as it is designed to hold.[7]

A variety of resources are readily available online to help consumers understand the water footprint of items commonly purchased, from foods to household products.

Product	Water Footprint (global average)*
1 orange	13 gallons
1 apple	18 gallons
1 cup coffee	37 gallons
1 glass wine	32 gallons
1 beer	20 gallons
1 lb beef	7,750 gallons
1 lb chicken	1,950 gallons
1 sheet A4 paper	2.6 gallons
1 cotton T-shirt	713 gallons
1 lb. barley	170 gallons
1 lb. rice	450 gallons

*Source: Water Footprint Network, liters converted to gallons

Reuse as a Solution for Today

Clearly, an understanding of virtual water impact also speaks to the need for water reuse, particularly in industrial application. American Water is working to reduce its own footprint by focusing on water loss and conservation. Most American Water service plants practice water recycling by retrieving and recirculating the water collected from backwashing filters. American Water also works to promote wise water use in homes across America through various community outreach efforts and as a partner in the U.S. Environmental Protection Agency's WaterSense program.

Additionally, American Water's contract operations group has a long history of designing, implementing and operating water reuse systems across the United States that collectively recycle nearly two billion gallons of water annually. Its systems have reduced the water footprint for major food and beverage processing operations, whether a juice manufacturer in California or poultry producers in Arkansas and North Carolina. Other notable projects include:

- **Residential buildings –** Five high-rise buildings in Battery Park City, Manhattan employ double piping systems to collect, treat and recycle wastewater and rain water for a variety of purposes, including toilet flushing, air conditioning and irrigation for rooftop gardens and an adjacent park. By reusing wastewater for non-potable applications, these buildings' potable water needs are reduced by nearly half. Together, these five buildings save approximately 56 million gallons of water per year.
- **Community developments –** The Homestead at Mansfield in New Jersey is an active adult, residential development connected to a dedicated wastewater treatment plant. The water reuse system provides up to 250,000 gallons per day of reclaimed water to irrigate landscaped spaces at personal residences and open common areas.
- **Sports facilities** – Gillette Stadium, the home of the New England Patriots, would not have been in Foxboro, Massachusetts, a town with limited water supplies, had it not been for the stadium's water reuse system. The facility's double piping system treats recycled wastewater from the stadium, as well as from adjacent office complexes and stores, saving 250,000 gallons of water for every major event.
- **Commercial complexes –** Wrentham Mall has undertaken the first commercial water reuse project in Massachusetts. Facing space and environmental constraints for wastewater discharge, an onsite water recycling and disposal system was necessary. Now the mall can meet its water requirements, supporting the operation of the facility's 130-store outlet center, office complex, hotel, movie theater and restaurant.

[7] www.h2oconserve.org, Water Footprint Handout

- **Schools –** The Copper Hill School in Raritan Township, New Jersey recycles wastewater from school toilets, the cafeteria and gym showers to be used for toilet flushing, saving the elementary school about 12,000 gallons of wastewater each day. The 20 percent of treated wastewater that is not used in the recycling process is recharged to groundwater.
- **Golf courses –** The Hawk Pointe Golf Course in Washington, New Jersey reclaims and treats wastewater to supply the significant volumes of water required to irrigate the course.

Conclusion

There are conscious choices the consumer can make today to reduce virtual water use. Already, it is easy enough for individuals to understand that certain lifestyle changes, such as eating less or no meat and choosing artificial fibers over cotton, would positively impact their water footprint. And it's possible that, one day, information on water footprints will be required to be included on product labels, helping consumers make conscious choices about their virtual water impact as they shop. Organizations like the Water Footprint Network, founded in 2008 by Hoeckstra, are working to create a common base for water footprint calculations that will make the virtual water concept a more practical, accessible and ultimately valuable tool.

As leaders in the field continue to develop and refine the virtual water concept, its practical applications are certain to increase. In the meantime, reducing direct water use - through leakage control, conservation, or reuse – has a much clearer impact and is achievable today.

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