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Tools for Sustainability: Water Footprints

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TOOLS FOR SUSTAINABILITY: WATER FOOTPRINTS

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Abstract

There have been significant global developments in water footprinting in the past few years and a growing adoption and application of the water footprint concept to improve water management outcomes. This article provides an overview of the principles and ideas underlying water footprints and their current status in sanctioned water dialogue and governance in Australia. Arguments are advanced as to why and how water footprint initiatives generally, and water footprint labelling of consumer products specifically, can contribute to the efficient use and sustainability of freshwater resources. The article concludes that any initiative will require both the cooperation and goodwill of industry organisations and policy guidance from government.

Introduction

> 'Nothing is more powerful than an idea whose time has come'.
>
> Victor Hugo (1802 - 1885)

Recently, a work colleague drew my attention to an information snippet in the February 2011 edition of WME (Water Materials, Energy) magazine reporting University of Western Australia Adjunct Professor Brent Clothier's call for water footprint labelling of products so that consumers would know how much water was used to produce or manufacture those

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products. Clothier is quoted as saying, *"increase[d] consumer awareness of water use [will] encourage the purchase and subsequent production of more water efficient products"*.[1] Had it not been for this and the ongoing encouragement of a former colleague now completing her PhD research at Edith Cowan University on sustainable water management in Western Australia, it is unlikely this article would have been written.

As far as I am aware, Clothier's statement is the only contemporary public expression in Australia that water footprints (and by extension the closely related concept of virtual water) are worth considering in the context of water use efficiency and resource conservation. In general, the idea of virtual or embodied water having any practical water policy value or contributing to improved water use efficiency, water allocation, water conservation or sustainable water resource management has, to date, been summarily dismissed or entirely ignored by most government agencies and commentators prominent in Australian water reform. It is suspected that this should 'merely' indicate a widespread unawareness of water footprinting because there is a very substantial body of research that discusses the scope (and limitations) of water footprint initiatives for addressing these vital water issues. But the situation may be worse, with some evidence of awareness and apparent dismissal of even basic concepts, such as virtual water, as a means of improving water management decisions and outcomes. Worse still, it is clear from anecdotal evidence that Australia has yet to devise any relevant practical national initiatives or policies, despite occasional proposals by researchers that some things can be done.

So what is virtual water, what are water footprints, how are these concepts connected, and how can they be applied to help sustain fresh water resources?

Virtual water

Virtual water is the precursor of water footprints. Coined about three decades ago by the 2008 Stockholm Water Prize Laureate Professor John Anthony (Tony) Allen of King's College University of London, the term refers to the volume of water embedded or embodied in commodities. It is the total volume of fresh water required to produce different goods, services, foodstuffs, products, etc. The virtual water content of a given product is the total volume of water required to make the product through every stage of its production.

It is axiomatic that a finished product does not physically contain all of the water actually required to produce it, but this does not obviate the fact that a comparatively large volume of fresh water will have been required in the production process. Although the word 'virtual' implies that the water doesn't (or didn't) really exist and therefore wasn't really used, it is important to understand that the virtual water content of something is the volume of real water consumed in its production. This is also the reason why referring to 'embodied' (or even embedded) rather than 'virtual' water is often preferred, the term being analogous to the better known idea of embodied energy. Most importantly, the physical

[1] (WME Magazine February 2011 Vol 22 No 1, p11)

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water content of a product is almost always just a small fraction of its virtual/embodied water content.

For example, a cup of coffee might contain only about 250 ml of water, but it takes about 140 litres of fresh water to grow, produce and process the coffee beans. On top of that, if you take milk and sugar in your cup of coffee, the fresh water required to produce these could add about another 50 or 60 litres. If you buy your coffee in a take away container, there will be an additional 8 litres of water embedded in the container and its lid. Then, you might include the water required for the production of the fuel needed to transport the coffee from where it was produced to where it goes into a cup and is consumed, as well as the water needed in the production of energy for the purposes of grinding the coffee beans and heating the water or milk. So the virtual water content of just one take away cup of coffee could be as much as 200 litres. A responsible consumer who is subjected to and largely accepting of domestic water restrictions as a means of 'saving water' might think this is worth knowing because it is an indicator of the impact of fresh water consumption on the total water cycle. Fresh water is scarce, not water in general.

About 22 kilolitres of water are required to produce 1 kilogram of beef, but only 1.1kilolitres of water are required to produce 1 kilogram of wheat. In general, meat products are significantly more water intensive than agricultural foodstuffs to produce and the 'value' of various products relative to their virtual water content can be measured in different ways. If you have produced and are selling 1 kilogram of beef into a market somewhere, you are likely to derive greater income from this than from the sale of a kilogram of wheat into that same market. If you are unconcerned about water consumption or the cost of acquiring water to make your products, you could compare the selling price relative to production costs of beef and wheat solely in terms of net income derived from the sale of each product. Alternatively, you might value these products in terms of their calorific, nutritional, or other content. If you are solely concerned with minimising water consumption, you could value the products by preferring to produce, sell or consume the one that has the smallest virtual water content per unit of yield (e.g. per kilocalorie) per kilogram.

It can be seen that different products have different virtual water contents, can be valued in different ways, and valued in different ways relative to their virtual water content per unit of production. What should also be apparent is that the virtual water content of commodities and services provides a useful indication of their impact on the overall water resource and has implications for national food and water security, cross border trade, water allocations, water use, and so on. For example, in relation to international trade Australia is a net exporter of virtual water, meaning that it exports more embodied water in the products it sells overseas than it imports in the products it buys from overseas. Perhaps this isn't a sustainable long term trade outcome, albeit seemingly unintentional, given that Australia is the driest inhabited continent on the planet and has been subject to increasing water stress and local water shortages in recent years.

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The idea of minimising the impact on water short and water stressed regions or States by importing from water rich locations rather than locally producing water intensive goods and services gives rise to the application of virtual water principles to fundamental policy questions such as the relationship between food, water and trade, in particular to making a choice or striking a balance between food security and water security.

Bearing in mind that Australia is a net exporter of embodied water, should it elect to use its water resources to the extent possible to ensure the local production of all the food (especially water intensive agricultural production) it needs to sustain its population and thereby minimise any reliance on the importation of food? Conversely, should Australia decide that water security is more important and rely on the importation of water intensive foods from water rich nations to feed its population? Does it have a choice? What is the optimal balance between food and water security? How would the decision impact on trade? It is not apparent that these questions have been considered by government in Australia. The virtual water concept suggests that solutions to local water problems lie beyond the catchment in which they occur. Tony Allen has referred to this as looking at the larger "problemshed" for a solution rather than just the "watershed" as we do now. The range of possible virtual water initiatives is considerable.

In Australia, the only known initiative attempting to look at virtual water on a reasonably large scale is "*The Virtual Water Cycle of Victoria*" concluded in July 2008 by the University of Sydney in collaboration with GHD for the Smart Water Fund and the Victorian Water Trust. As an interesting aside about the report, for some reason or other its front cover includes a photo of Harris Dam near Collie in WA. In relation to what it sets out to do the project is a significant original achievement though there is, as I have sought to suggest, a great deal more that can be achieved via practical virtual water initiatives and there have, to my knowledge, been little or no further developments in Victoria. Nevertheless, what are the current prospects of anything happening in Australia, such as Clothier's suggestion?

The National Water Commission (NWC), whose functions, as defined in Section 7 of the *National Water Commission Act 2004* include specific functions relating to implementation of the National Water Initiative ("the overall objectives of which are to increase the productivity and efficiency of Australia's rural and urban water use while ensuring community needs are met and river and groundwater systems are returned to environmentally sustainable levels of extraction")[2], has this to say about the concept of virtual water:

'*The measurement of virtual water cannot provide a useful and reliable benchmark for choosing between alternative uses of the nation's scarce water resource*'. The NWC then provides two illustrative examples of why this is so and concludes ' … *the NWC considers that the measurement of virtual water has little practical value in decision making regarding*

[2] Hussey K and Dovers S, Editors, (2007). Managing Water for Australia – The Social and Institutional Challenges, p3. CSIRO Publishing, Victoria Australia.

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the best allocation of Australia's scarce water resources'.[3] Whilst it may be possible to argue, based on a couple of selective examples, that virtual water considerations are of little or no value in making water allocation decisions, in the examples cited by the NWC the assumptions they have made invalidate such a conclusion. Numerous alternative examples could be cited that would lead to the opposite conclusion. Apart from this, the NWC's position is open to challenge on several grounds.

Firstly, the NWC's illustrative examples contend that the 'virtual water measure ……. takes no notice of the many other considerations [which the NWC identifies as the cost of other inputs and the different values of selling two alternative crops] that should be factored in if the best allocation is to be made' to just one of the two crops. There is nothing in the virtual water concept that claims a virtual water measure is or should be a benchmark or the sole deciding factor in making water allocation decisions, or that other decision criteria ought not be considered. Secondly, the NWC's reference to costs and values of the crops seems to suggest that the production of a crop must be costed and the crop valued only in $ terms. A crop can be valued in other ways, as I have pointed out, by its calorific value or its nutritional value. Thirdly, the making of water allocation decisions is by no means the only or even the primary application of virtual water concepts and water footprints and a cursory dismissal of them will not improve things.

That having been said, there are important differences between the virtual water content of a product and its water footprint, differences that would place practical limitations on the scope of Clothier's suggestion (of which he is no doubt aware) but not detract from it. While virtual water is a measure of the total water volume required across the supply chain to produce goods, services or commodities it has no spatial or temporal dimension, meaning that it takes no account of where or when the water was used in production processes. Further, virtual water does not concern itself with the different types of water that can be attributed to the production of something.

Water footprints

The concept of water footprints was originated in 2002 by Arjen Y Hoekstra who is currently Professor in Multidisciplinary Water Management in the Twente Water Centre at the University of Twente in the Netherlands and Scientific Director of the Water Footprint Network.

A water footprint is the total volume of fresh water required to produce a product, or which is used directly and indirectly by a business, industry, region, town, household, state, nation, etc and specifically considers the three types of water used (blue, green and grey) and where and when each is used. However, the water footprint of a product or service in volume is identical to its virtual water content. Anyone, anything, any place that uses water, has a water footprint and it can be calculated, or at least reliably approximated.

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[3] eNewsletter *Distilled* Edition 30, July 2008. National Water Commission, Canberra.

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For explanatory purposes, a water footprint is often compared to the better understood ideas of carbon footprints and ecological footprints. Carbon footprints measure (in tonnes) energy use in terms of carbon dioxide volumes and greenhouse gas emissions produced. Ecological footprints measure (in hectares) the use of bio-productive space.

Because it takes account of three different type of water, the aggregate water footprint of something is the total of its blue, green and grey water footprints. The blue water footprint is the net volume of surface or ground water used. The green water footprint is the volume of rainwater stored in soil that is used. The grey water footprint is the volume of water required to dilute any polluted water that results from production processes so that it can again satisfy some minimum water quality standard.

Because of its temporal and spatial dimension, a water footprint shows the immediate impact on the local water system where water is used to produce something as well as the impact on the total water cycle resulting from consumption of the end product, the consumption site often being located a large distance from the production site(s). In Australia, the consumptive availability and direct use of water is a simple concept and relatively easy to account for because it is systematically monitored, metered, reported, reviewed, benchmarked and/or otherwise controlled at many levels (e.g. catchment, business, household, industry, etc). Consequently, more and more organisations, agencies and individuals are collecting and documenting more and more data about less and less, which has resulted in a quite comprehensive understanding of direct water use, who gets the water, who uses it and in what volumes. Unfortunately, there has been no real improvement or interest in the availability and quality of information about the considerably greater indirect water use that occurs and, more importantly, no consideration of the policy and total water cycle management implications of its consumption.

In the overall management of the water resource and the consumptive pool the exclusive focus on direct water use would seem to indicate that, in a total water cycle management context, the strategic management of water is lacking. The attributes of the supply chain can have substantial impacts on the volumes and temporal and spatial distribution of water consumed when products goods and services are produced. Water is used directly (and indirectly) in production and manufacturing processes to produce the goods organisations need to deliver a unit of output or provide a service. Water footprints make the connection between direct and indirect physical water use per unit of product, and consumption.

As a simple example, government agencies are notorious purchasers and consumers of large quantities of copy/printer paper so they can write letters, print documents, photocopy information, etc (the paperless office never happened). The volume of water used in the production and supply chain to provide the paper is ultimately 'used' by agencies because they are the consumers of the paper in which the water is embodied. It ought to be of

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some interest to government agencies, or for that matter any business consumer of such paper, that the volume of water required (summed across the production and supply chain) to produce a single sheet of 80gram A4 paper is around 10 litres. The volume of water this represents is just one input to an agency's water footprint.

Numerous other products and facilities are required by government agencies to provide services and these too require water to produce (such as cars, furniture, buildings, lighting and power, glass, field equipment, telephones and office equipment). For example, there are ongoing needs for computers and peripheral devices and these are subject to periodic replacement. These devices contain scores of microchips which, summed across the production and supply chain, require about 32 litres of water per chip to produce. An agency's water footprint is therefore the sum of the water footprints of products such as these which it consumes in order to provide its business outputs. A bureaucracy's total water footprint is the sum of the individual water footprints of each of its agencies.

The water footprint of a business is equal to the sum of the water footprints of its business output products. The supply chain water footprint is equal to the sum of the water footprints of the business input products. Direct water use (the visible component or operational footprint) is generally much smaller than the indirect (supply chain) footprint and the impact of a water footprint depends on the vulnerability of the place where the water footprint is located, which is usually not where the product that incurred the footprint is actually consumed. This is also why the scope of Clothier's proposal is practically limited.

If a consumer product were to be comprehensively labelled with its water footprint it ought to specify not just how much water went into making it, but also where and when the water was consumed in the production process as well as the blue, green and grey water components of the total water footprint. Without knowing where, when and how the footprint was incurred, there would be no way of knowing if it took place in a water stressed or vulnerable location at a particular time and therefore whether there were any local impacts (this of course assumes that one has access to the spatial and temporal information as well as the related temperature and rainfall data necessary to make this determination). Similarly, without knowing the proportion of each of the three component footprints, there would be no way of knowing with any certainty just exactly what the local impacts were. In broad terms, the sorts of impacts that would normally be considered are economic, environmental and social, the core sustainability dimensions.

Notwithstanding the obvious practical limitations of labelling products with comprehensive water footprint information (or there even being any point in doing it) and then accessing the information required to evaluate the local effects of the footprints there is no doubt that, from a consumer's perspective at least, Clothier's proposal is worthwhile. This is so despite the fact that it almost certainly means the products he has in mind would be labelled solely with the volumetric quantum of water required to produce them (ie the equivalent of their virtual water content). Relative to the progress made with similar

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initiatives in other countries, Clothier's suggestion and a positive response to it is therefore well overdue in Australia. But apart from what Clothier himself has said, why is it a good idea?

Initiatives to improve the efficient use of water concentrate mainly on domestic and small business direct freshwater use. Typically, these initiatives relate to waterwise gardens, flow reduction devices, WELS appliance water efficiency rating labels, domestic grey water reuse systems and water recycling together with some financial incentives and other demand management measures. Considerable associated efforts seek to inform and educate consumers on how to save water by minimising their reliance on its direct use. However, since the volume of freshwater used directly in domestic and small business situations represents only about 11% of total direct freshwater use, the prospect of national and state-based initiatives making any significant contribution to either water use efficiency or water conservation overall is minimal. As local, regional, national, or global water cycles are considered in turn, any such contribution reduces to the irrelevant.

On the other hand, a water footprint takes account of not just direct water use but indirect water use, the latter being, in general, many times greater than the former. Where products are derived from primary production and agriculture, knowing the water footprints of those products (for example, foodstuffs) will enable a consumer to make a choice about buying and consuming a particular product or choosing an alternative product that has a smaller water footprint or which, if the necessary information is included in the footprint labelling, is sourced from somewhere that is not water stressed. Since agriculture uses about 70% of the world's total fresh water resources, this provides an opportunity for a domestic consumer to make a significant contribution, in a total water cycle management sense, to the sustainability of fresh water resources globally and even at local, regional, state and national levels where the comprehensiveness of water footprint labelling enables this to be done. It simply isn't possible for a consumer to make anywhere near the same impact with the small scale and magnitude of domestic water saving initiatives that can only reduce direct water use at the local level to reduce local water shortages when thought necessary by water governance authorities from time to time.

A consumer who chooses a product with a smaller water footprint than another or a product which was manufactured in a place not subject to water stress, can exert pressure on producers and manufacturers to minimise their use of fresh water to make the product, or to make alternative or comparable products that have smaller water footprints, or to make the product in locations that, across the supply chain, are less subject to water stress. Consumers who make informed and conscious diet or lifestyle choices about the purchase and consumption of any product based on the size of its water footprint can also stimulate competition between manufacturers and suppliers to further reduce the water footprint profiles of their products in order to maintain or improve their market share.

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Conclusion

Water footprints show the impact of consumption on the total water cycle. Compared with current initiatives that seek solely to reduce direct 'operational' water use (such as demand management) and mainly in domestic/residential settings, initiatives to reduce the supply-chain water footprint of any business, industry sector, region, town, community or household can offer significantly greater scope to improve overall water use efficiency and water resource conservation. Is reduction of direct operational use enough to maintain the sustainability of our very limited fresh water resources, or is time to look at our water footprints, which include the water use of the supply chain? A diverse range of climate resilient, sustainability initiatives in urban integrated water management settings should include the use of water footprints.

The use of consumer product labelling in Australia is one important water footprint initiative that can and should be undertaken for the reasons advanced in this article. With the publication of "The Water Footprint Assessment Manual"[4] the perennial excuse that there are no standards or guidelines available to provide a consistent methodological and measurement approach to calculating water footprints is no longer valid. Further, global averages for the water footprints of most products are available. What is now required is the cooperation and goodwill of industry organisations together with the political will and government policies necessary to get something done.

[4] Hoekstra, Chapagain, Aldaya and Mekonnen (2011), The Water Footprint Assessment Manual : Setting the Global Standard", Earthscan, UK

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Water Footprint Network (WFN)
http://www.waterfootprint.org
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UNESCO-IHE Institute for Water Education
Netherlands Water Partnership
Water Neutral Foundation
World Business Council for Sustainable Development
World Wildlife Fund
World Bank
Current Partners include Australia's **CSIRO**

WFN Mission:
To promote the transition towards sustainable, fair and efficient use of fresh water resources worldwide by:

- advancing the concept of the 'water footprint', a spatially and temporally explicit indicator of direct and indirect water use of consumers and producers;
- increasing the water footprint awareness of communities, government bodies and businesses and their understanding of how consumption of goods and services and production chains relate to water use and impacts on fresh-water systems; and
- encouraging forms of water governance that reduce the negative ecological and social impacts of the water footprints of communities, countries and businesses.