# REAL WATER FOOTPRINTS: THE IMPORTANCE OF DEPTH IN VOLUMES

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**ABSTRACT**

Water footprinting is a tool that has generated increasing interest from businesses, academics and governments alike. Fuelled by growing concerns regarding the sustainability of global water resources, it has been seen by many as a method through which water resource issues can be better understood and managed. Water footprinting has also been identified as a tool that could help businesses minimise exposure to operational water risks and exploit an emerging global trade in 'virtual water'.

To date, much of the work undertaken to standardise water footprint methods has centred on quantifying the volumes of water used in product manufacture or to deliver a service. It is however increasingly apparent that this can result in a misleading water footprint that does not fully consider the regional impacts of water abstraction and the local context of water use. The importance of incorporating an assessment of the impacts related to the water used or discharged within the water footprint process is consequently becoming widely acknowledged.

This paper will provide an overview of the water footprint concept and highlight the key drivers towards an impacts-related water footprint. An ongoing Cadbury Plc and ERM project to develop a pilot water footprint method that incorporates an indicative impacts assessment will also be profiled.

**KEYWORDS**

**Water Footprint, Water Sustainability, Indicative Impacts Assessment**

# 1 INTRODUCTION

Global freshwater resources are being placed under increasing pressure by the dual impacts of climate change and population growth. Whilst climate change is most often associated with shifts in mean global temperatures, it has also been linked to increases in the variability and volatility of global precipitation patterns (IPCC, 2007). These changes have meant that extreme weather events such as floods and droughts are not only becoming more widespread, but are also increasing in both severity and frequency (ibid). As a result, freshwater resources are becoming more vulnerable and unstable, characteristics that are making their management increasingly complex.

Whilst climate change impacts are affecting the management of freshwater resources, population growth is changing the quantity of freshwater resources available for use. In the last century, the world population has tripled and it is expected to continue on this path, rising from its current level of around 6.8 billion to over 8 billion by 2030 (US Census Bureau, 2010). The scale of this growth will place greater demands on existing freshwater resource. However, the nature of this growth and the regions in which it will occur is also of considerable concern. Significant growth is, for example, expected in countries such as India and China, which are already 'water stressed' (United Nations Environment Programme (UNEP), 2002). In addition, shifts towards greater urbanisation and development will increase the likelihood that per capita water requirements will also increase.

Both these factors have placed an increasing focus on techniques that can promote more sustainable water resource management both on a corporate level as well as from a public supply perspective. One technique that is receiving significant interest globally is water footprinting.

# 2 WATER FOOTPRINTING

Water footprinting is a term that could be applied to a variety of water management tools available to business, communities and regulatory agencies. These range from high-level water risk mapping exercises on site-by-site bases, such as implementation of the World Business Council for Sustainable Development (WBCSD) Global Water Tool through to more detailed analyses of water flow through product manufacture cycles. It is the latter of these applications that forms the focus of this paper.

This application of the water footprint was first conceptualised by Arjen Hoekstra in 2002 (Hoekstra 2003) as an indicator for freshwater use that incorporates both direct water usage and indirect water usage. The water footprint of an individual, community or business as defined by the Water Footprint Network (WFN) founded by Hoekstra as:

> *...the total volume of freshwater that is used to produce the goods and services consumed by the individual or community or produced by the business.* (WFN, 2010)

## 2.1 GREEN, BLUE AND WASTE WATERS

Within the Hoekstra/WFN water footprint method, water use is separated into two distinct ‘water types’ reflecting the different potential sources of the water used.

- **Green Water** refers to water sourced directly from rainwater, including water stored in the soil as soil moisture and consumed as crop evapo-transpiration.
- **Blue Water** refers to all other water sources, such as ground and surface waters.

The separation of green water sources and blue water sources is a central point of difference between water footprinting and more tradition engineering approaches to water resource management which are usually focused on blue water resources alone (Falkenmark, 2003; Rockström, 2001). The separation also reflects the differing characteristics, availability and opportunity costs of the water types (Hoekstra, Chapagain, Aldaya and Mekonnen, 2009).

Wastewater created during the production process is also incorporated within the water footprint calculation. However, the manner in which this component of the water footprint is incorporated remains the subject of significant discussion. Within the WFN water footprint method, waste water is incorporated as ‘grey water’, which is defined as “volume of freshwater that is required to assimilate the load of pollutants based on existing ambient water quality standards” (Hoekstra et al, 2009). Whilst this approach has its limitations, and is sometimes referred to as a ‘dilution water’ rather than waste water stream (Ridoutt and Pfister, 2010) there is a clear need to incorporate the wastewater stream within a water footprint if it is to be an effective aid to sustainable water resource management.

## 2.2 INDIRECT WATER USE

In addition to the separation of blue and green source water streams, the Hoesktra/WFN water footprint method can be further differentiated from classical measures of ‘water withdrawal’ by allowing the incorporation of ‘indirect’ water use. This indirect water footprint is determined through analysis of aspects such as supply chain water usage and water involved in the use-phase of a product. For example, the indirect water footprint of a meat consumer incorporates the direct water footprint of the retailer, the food processor that prepares the meat for sale, the livestock farm that raises the animal and the crop farm that produces the feed for the animal (Hoekstra et al, 2009). This indirect water footprint allows for a more comprehensive picture of water usage and the overlapping requirements of water streams that must be considered for a robust water management framework.

## 2.3 PRODUCT AND NON-PRODUCT WATER FOOTPRINTS

To date, the Hoekstra/WFN water footprinting method has been mostly applied to the quantification of water volumes embedded within the manufacture of a product, a ‘product water footprint’ (see WFN 2010). Within product water footprints, water is tracked through all stages of the production life cycle, from the water used to grow base crops or to extract minerals and metals, through manufacturing water use and then the water consumed in the product's use phase.

The principles of the Hoekstra/WFN water footprint method can however also be used to map water flows in non-product situations, such as through the delivery of a service or for catchment-wide studies (ibid). Indeed the approach has been aggregated through to the quantification of 'national water footprints' (Chapagain and Hoekstra, 2004). In undertaking these 'non-product' water footprints, the value of the water footprint method often lies in tracing competing/overlapping direct and indirect water use footprints to facilitate water resource management as recognised, resulting in initiatives such as the UNEP International Environmental Technology Centre (IETC)'s Water Footprint, Neutrality and Efficiency (WaFNE) programme (see UNEP-IETC 2010).

### 2.4 IMPACTS-RELATED WATER FOOTPRINTING

Whilst the Hoekstra/WFN water footprinting method has further developed the measurement of water use by incorporating aspects such as blue and green water differentiation and indirect water streams, there remain a number of limitations to the method. For example, and as previously highlighted, the method through which the waste water stream is incorporated within the footprint has been the subject of significant discussion.

However, the key limitation that forms the focus of this paper centres on the Hoekstra/WFN method's aggregation of different water streams on a purely volumetric basis. Within the Hoekstra/WFN method, one litre of water within the water footprint is equivalent to another litre of water, regardless of factors such as the geographical source of the water, or the water type (e.g. blue/green). Thus water abstracted from an extremely water stressed zone, or from a water source of high socio-cultural value such as the Ganges in India is considered the same as a litre of water from a plentiful water resource, or a water resource with limited social or ecological value. Whilst this approach allows for a single water footprint value to be generated, it does not take into consideration the different values of the water sources and associated impacts of water withdrawal, a central consideration for comparative water use decision making and water resource management more generally.

To overcome this limitation, attention has turned to the concept of *impacts-related* water footprinting. In this extension to the water footprinting concept, characteristics related to the impacts of the water abstracted, such as local water stress (see for example Ridoutt and Pfister, 2010), are incorporated within the footprint calculation.

## 3 THE CADBURY PROJECT

The Cadbury Project has been initiated by Cadbury Plc and ERM in order to further progress the concept of an impacts-related water footprint. The overall goal of the project is to develop a pilot water footprint calculation method that incorporates a simple impacts-related component. An Excel tool based on the impacts-related water footprint calculation would also be developed alongside the method and the tool and the method are to be demonstrated through a practical case study. Whilst the Cadbury Project is still ongoing, an overview of the approach being developed is provided below.

### 3.1 THE INDICATIVE IMPACTS ASSESSMENT APPROACH

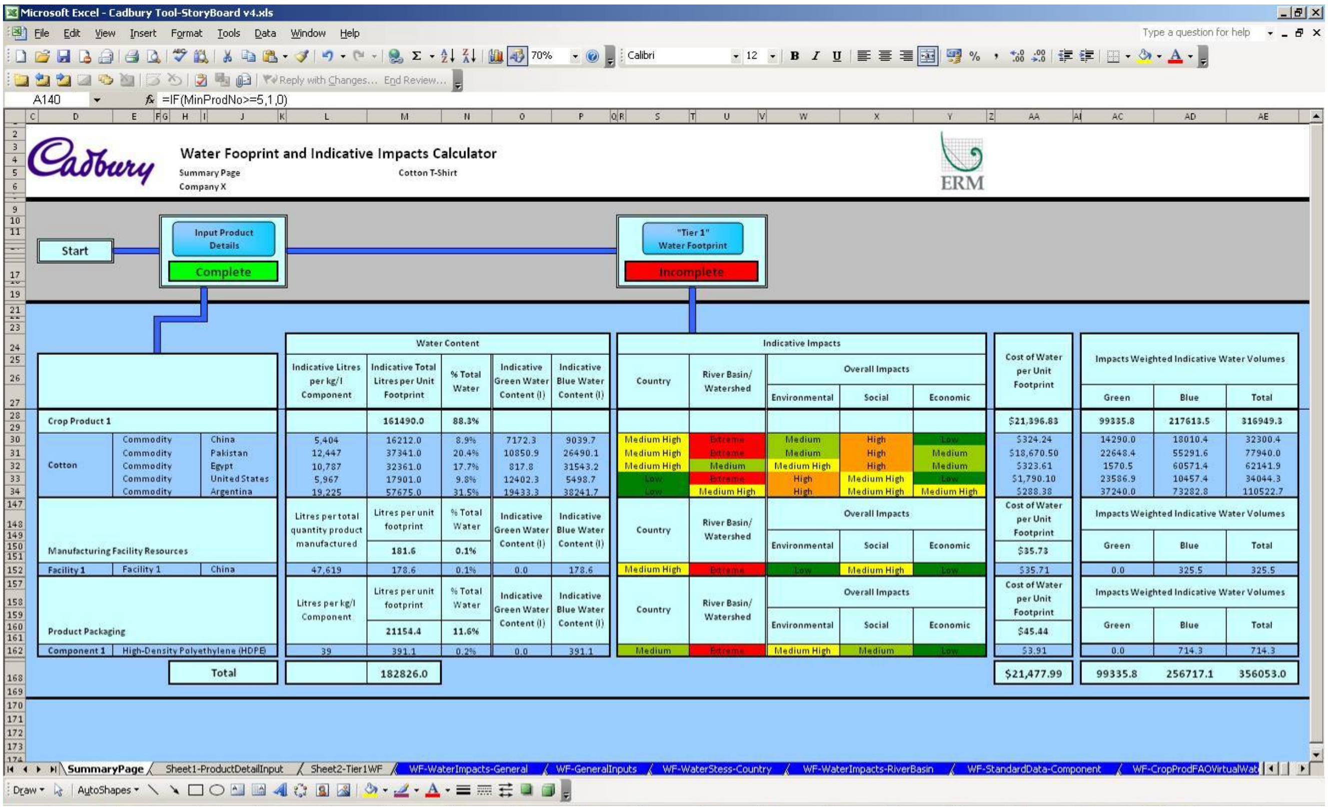
A key requirement of the Cadbury pilot impacts-related water footprint method was the development of a simple impact assessment approach. This requirement reflected both the prohibitive time and resource costs associated with undertaking a detailed impact assessment for each water source in a water footprint and a desire to place the end-user ease-of-use at the heart of the water footprint calculation tool. The foundation of the Cadbury impacts-related water footprint method therefore centred on the assumption that the impacts of water abstraction could be inferred from the general characteristics of the water withdrawn and the environment from which the water is withdrawn. Thus if the water catchment from which the water is abstracted has a high ecological or socio-cultural value, then the impacts of water abstracted from the catchment could also be inferred to be high. Similarly, if the water catchment is of high environmental or social value, then the impacts of waste waters discharged into the catchment will also be high, to a level that is equally dependent on the nature and degree of contamination within the waste water.

In ascribing environmental, social and economic value to the water catchments, published data on the environmental, social and economic characteristics of the catchment from recognised data sources would be used in order to minimise the subjectivity of value judgements. These data sources included: the World Resources Institute (WRI) Watersheds of the World database (WRI, 2003), the World Health Organisation (WHO) and UNICEF Joint Monitoring Programme for Water Supply and Sanitation Country Data (WHO/UNICEF 2010) and the Food and Agriculture Organisation (FAO) Aquastat database (FAO, 2010). For example, catchment biodiversity data, such as numbers of fish, bird and amphibian species (endemic or otherwise) drawn from the WRI Watersheds of the World Application was combined with data on natural land cover types and relative proportions as well as indicators such as RAMSAR site numbers to give an aggregated catchment environmental value rating. From this environmental value, the impacts of water abstracted from the catchment can be inferred as either ‘extreme’, ‘high’, ‘medium high’, ‘medium’ or ‘low’ and overlain onto the volumetric water footprint.

## 3.2 THE CADBURY WATER FOOTPRINT TOOL

To facilitate the demonstration and refinement of the pilot indicative impacts assessment water footprint method, a framework Excel tool is being built alongside the method. The key goal of the tool, as presented as Figure 1, is to allow the user to easily and visually assess the volume of water embedded within each component of the water footprint alongside the inferred environmental and socio-economic impacts of the water abstracted.

*Figure 1: Screenshot of the Cadbury water footprint tool*




# 4 CONCLUSIONS

Water footprinting presents a valuable tool through which the water flows associated with the delivery of a service or the manufacture of a product can be characterised and used to better manage water resources on a product, catchment or global scale. However the method remains in its infancy with a number of limitations associated with aspects such as the incorporation of waste water streams and the aggregation of differing water source types. These limitations have been and continue to be the subject of much interest and the initiator of various innovative modifications.

The Cadbury indicative impacts water footprint method presents one such innovation that seeks to move forward the incorporation of an impacts-related component within the water footprint method. Whilst it is recognised that the approach also has various limitations, specifically relating to the subjective manner in which value is attributed and impact inferred, it provides a framework through which the concept can be further developed. The impacts-related water footprint method developed through the Cadbury project continues to be refined and is currently the subject of a case study trial in South Africa.

## REFERENCES


Chapagain, A.K. and Hoekstra, A.Y. (2004) *Water Footprints of Nations*, Value of Water Research Report Series No. 16, UNESCO-IHE, Delft.

Falkenmark, M. (2008) 'Water and sustainability: a reappraisal' *Environment*, 50, 2, 4–16.

FAO (2010) *Aquastat*, available: www.fao.org/nr/water/aquastat/main/index.stm, last accessed 1 August 2010.

Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M. and Mekonnen, M.M. (2009) *Water Footprint Manual: State of the Art 2009*, WFN, Enschede.

IPCC (2007) *IPCC Fourth Assessment Report: Climate Change Synthesis Report*, IPCC, Geneva.

Ridoutt, B.G. and Pfister, S. (2010) 'A revised approach to water footprinting to make transparent the impacts of consumption and production on global freshwater scarcity' *Global Environmental Change*, 20, 1, 13-120

Rockström, J. (2003) 'Water for food and nature in drought-prone tropics: vapour shift in rain-fed agriculture. Philosophical Transactions of the Royal Society B', 358, 1440, 1997–2009.

UNEP (2002) *Vital Water Graphics*, available: www.unep.org/dewa/assessments/ecosystems/water/vitalwater/, last accessed 1 August 2010

UNEP-IETC (2010) *Water Footprint, Neutrality and Efficiency*, available: http://www.unep.or.jp/ietc/ws/activities/activity_water-footprint.asp, last accessed 1 August 2010

US Census (2010) *International Data Base, World Population Summary*, available: www.census.gov/ipc/www/idb/worldpopinfo.php on 30 July 2010, last accessed 1 August 2010

WFN (2010). *Water Footprint Network*, available: www.waterfootprinting.org, last accessed 1 August 2010

WHO/UNICEF (2010) *WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation*, available: www.wssinfo.org/en/welcome.html, last accessed 1 August 2010

WRI (2003) *Watersheds of the World*, available: www.wri.org/publication/watersheds-world-cd, last accessed 1 August 2010