Water Footprint of Nestlé's 'Bitesize Shredded Wheat'

A pilot study to account and analyse the water footprints of Bitesize Shredded Wheat in the context of water availability along its supply chain

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WWF (for WFN)

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Project timeline

This pilot project is first proposed at a meeting of Water Footprint Working group (WFWG) held on the 8th July 2008 with interest from Nestlé. The project proposal was jointly prepared by WWF-UK and University of Twente. The quotation for the project was then sent to Nestlé on the 7th of August 08 by UT (University of Twente) followed by a formal contract signed by both the parties. WWF-UK agreed to lead the project and prepare the final report.

WWF-UK prepared the preliminary data acquisition sheet and sent that to the Nestlé on the 17th Oct 2008 in a workshop organised at the Cereal Partners factory in the UK. The participants of this first meet were John Gavin (Quality & Regulatory Affairs Dir CPUK), John O'Callaghan (Energy Mgr CPUK), Clive Smith (SHE Mgr Stav), Marianela Jimenez (CO-SH&E), and Ashok Chapagain (WWF-UK). The visit was useful in collecting the first set of data on production of various kinds of Shredded Wheat varieties from the factory. A more detailed data set was prepared and sent by John O'Callaghan on the 7th Nov 2008. John Gavin has been persistently filling any data voids during the entire calculation phase of the project.

An interim presentation of the first cut of the results was made in the WFWG's meeting hosted by SABMiller at Woking, UK on the 18th Dec 2008. The first draft report was sent to Nestlé on the 19th March 2009. John O'Callaghan and Marianela Jimenez provided refinement and clarifications on data used in the calculations in April 2009.

A second draft of the report was prepared and sent back to Nestlé and a feedback to that was sent by Marianela Jimenez on 22 July 2009. WWF-UK provided necessary materials to Marianela Jimenez for the preparation of the presentation by Nestlé at World Water Week event in Sweden held in August 2009.

A meeting has been arranged between Arjen Hoekstra (WFN) and Ashok Chapagain (WWF-UK) at Enschede to discuss and finalise the report in August 2009. Based on the outcome of the meeting and feedbacks from Nestlé, the report is finalised in April 2010.

Contents

1   Introduction

Recent interest in Water Footprint (WF) accounting for business has led to the formation of the Water Footprint Network (WFN) in 2009. As part of Nestlé's engagement in Water initiatives, Nestlé has joined the Water Footprint Network (WFN).

As the concept and methods for accounting WF are still at the development stage, there are not yet established standards for businesses to adopt. In this context, WWF International commissioned a study on the subject to the University of Twente. With subsequent discussions in the meetings of the WFN at Zeist (2007) and Delft (2008), a report on the framework to account the WF of a business (Gerbens-Leenes and Hoekstra 2008) was published. To further the accounting methods outlined in this report along with expertise housed in the University of Twente and WWF-UK on WF accounting methods, numerous pilot projects have been suggested as a way to road-test the methods and help advance the process of establishing a WF 'Tool' for estimating water in supply chains. This study therefore contributes to methodological learning for the tool towards standards for water footprint accounting.

In this context, WWF-UK and Nestlé proposed to undertake the pilot Water footprint Assessment study. This begins with an analysis of the wheat supply chain within the UK to the Staverton factory for the production of Shredded Wheat brands. The factory and Shredded Wheat brand belongs to Cereal Partners Worldwide, a 50:50 Joint Venture between Nestlé and General Mills International. Nestlé's interest in this is to test the methodology covering all steps along the product life cycle, from suppliers to consumers, in order to develop a better knowledge on assessing the water footprint of a product, and prepare a basis to improve the product's environmental impact.

The project has two stages (Figure 1). In stage 1, volumetric assessment of the water footprint is made at three levels which are: the supply chain WF, the direct water footprint of wheat to the final Nestlé product originating from its factory, and the end-use water footprint of consumption. In stage 2: the WF is then analysed with the impacts in the corresponding locations with respect to the local hydrological characteristics.
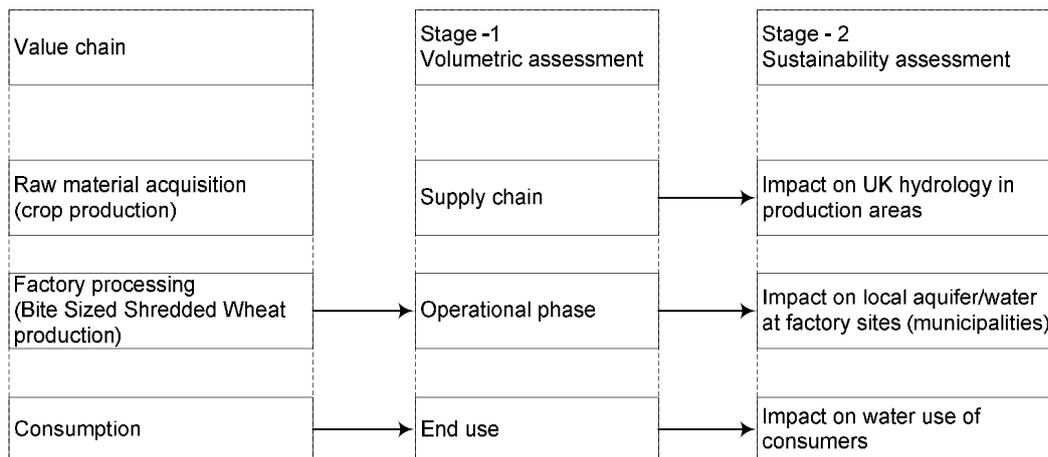

Figure 1. Framework for the assessment of WF of 'Bitesize Shredded Wheat' from a factory perspective.

WWF-UK (Ashok Chapagain) and WWF-International (Stuart Orr) have undertaken this study with input and guidance from A.Y. Hoekstra (University of Twente/WFN). An active coordination with the wider work programme of the WFN has been provided by Derk Kuiper. The work is conducted with a field visit to the concerned factory in the UK with experts from Nestlé (M. Jimenez and J. Gavin).   A group discussion was held among the key technical and

management personnel at the site to understand the in-situ use of water at various production steps.

1.1 PROJECT DELIVERABLES

The report includes volumetric amounts, source maps, impacts study and breakdown of water content along the various stages of the supply chain and a narrative section. Once the report is finally agreed and accepted, a subsequent mode of publication and dissemination of the results will be discussed with WFN.

1.2 PRODUCT DESCRIPTION

The pilot is designed to estimate the water footprint of one simple product from Nestlé, Bitesize Shredded Wheat. This product is produced in a single factory in the UK located at Staverton. Nestlé has different varieties of this product (Figure 2). As the purpose of this project is to establish a practical framework on accounting methodology and impact assessment, the study focuses on 'Bitesize Shredded Wheat' as it is the simplest example among the different varieties of Shredded Wheat from Nestlé. The method can be replicated for any other varieties using product specific data for each individual product.

Figure 2. Different varieties of Shredded Wheat and Shreddies produced in the Staverton factory

The common ingredient for the most common varieties of Shredded Wheat brand has 3 flankers:

1. Bitesize Shredded Wheat – ingredients (whole grain wheat = 100%)
2. Honey Nut Shredded Wheat – ingredients (whole grain wheat = 82%, honey = 2.8%, sugar, peanuts, coconut, hazelnuts, molasses, flavouring agents)
3. Fruitful Shredded wheat – ingredients (whole grain wheat = 73%, different dried fruit & nuts, sugar, and flavouring agents.

1.3 STAVERTON FACTORY

The factory is located at Trowbridge (51° 20' 50" N 2° 12' 30" W) along the banks of river Avon near Bath (Figure 3). It is a relatively a new factory (< 10 yrs old) in a rural location with 8.5 hectares of areal coverage. It has 100% UK wheat as a main ingredient, and is a sole supplier of all Shredded products. It was formerly a shared Nestlé site.

Figure 3. Staverton factory of Nestlé in the UK

At full capacity, the factory is estimated to produce 21,717 tons of Shredded Wheat and 17,676 tons of Shreddies in 2008. Table 1 presents the future production estimation from the factory for the years 2008-10.

Table 1. Estimated Shredded wheat production from the Staverton factory (tons).

	Year 2008	Year 2009	Year 2010
Shredded wheat	8,212	8,554	8,556
Shredded biscuits	13,505	13,381	13,531
Shreddies	17,676	18,740	18,969
Total factory	39,393	40,675	41,056

This factory sources mainly two varieties of wheat, Clare and Alchemy. The farms are located at a 50 km radius of Northants, NN6 7QA. The farmers do not irrigate their farm for wheat production. Wheat is harvested and/or dried to maintain a moisture content of <14.5% for storage. It has two heat suppliers which add approximately ~1% of water during cleaning to condition the grain, approximately 48hrs prior to the cooking stage at Staverton. The factory is located at 180 km away from the collection hub at Northants. Staverton receives its water supply from Wessex Water Ltd from 2 reservoir feeds with a separate water meter with sub-meters for different units. These are read manually. Effluent from the factory goes to a local treatment works run by Wessex Water and nothing is discharged to the nearby river. The plant has an agreement with Wessex Water to treat the waste based on the volume of polluted return flows from the factory.

2 Method

2.1 WF OF A PRODUCT ALONG THE SUPPLY CHAIN

The total water footprint (WF) of a product/supplier is made up of two components; the direct WF and indirect WF. The direct WF of a supplier is calculated as the sum of volume of water either evaporated or polluted at the point of operation. The indirect WF is equal to the sum of

total WFs of the predecessor suppliers in the product supply chain. The schematic to calculate the total WF of a supplier is presented in Figure 4.

$$WF[i] = WF_d[i] + WF_{sc}[i]$$

where $WF[i]$ is the total water footprint of supplier i, $WF_d[i]$ is the direct water footprint of the supplier i, and $WF_{sc}[i]$ is the indirect water footprint of the supplier i.

The indirect water footprint of the supplier i, $WF_{sc}[i]$, is equal to the total water footprint of its immediate supplier $WF[i-1]$. The direct water footprint of the supplier i for product m from its operation, $WF_d[i,m]$ is calculated as:

$$WF_d[i,m] = \frac{WU[i,m]}{Q[i,m]} \times \frac{v_f[i,m]}{p_f[i,m]}$$

$$= \frac{\{Water\ evaporated[i,m] + Water\ polluted[i,m]\}}{Q[i,m]} \times \frac{v_f[i,m]}{p_f[i,m]}$$

$$= \frac{\{Water\ evaporated_{blue}[i,m] + Water\ evaporated_{green}[i,m] + Water\ polluted[i,m]\}}{Q[i,m]} \times \frac{v_f[i,m]}{p_f[i,m]}$$

$$= \left\{ \frac{BWevaporated}{Q[i,m]} \times \frac{v_f[i,m]}{p_f[i,m]} \right\} + \left\{ \frac{GWevaporated}{Q[i,m]} \times \frac{v_f[i,m]}{p_f[i,m]} \right\} + \left\{ \frac{Water\ polluted}{Q[i,m]} \times \frac{v_f[i,m]}{p_f[i,m]} \right\}$$

$$= WF_{blue}[i,m] + WF_{green}[i,m] + WF_{grey}[i,m]$$

where WF $[i,m]$, expressed in m³/ton, is the water footprint of output m and $Q[i,m]$ is the quantity of the product m in ton produced from the supplier i. The WF $[i,m]$ is calculated based on the method given in Chapagain and Hoekstra (2008). $WU[i,m]$ is the volume of water use in the operation of the supplier which is made up of the volume of water evaporated and equivalent volume of water polluted. The volume of water evaporated is further separated into two based on the source of water use, blue (*BWevaporated,* evaporation from the use of surface and ground water) and green (*GWevaporated,* evaporation from the use of rain water).

The p_f [i,m] is the product fraction (dimensionless) and v_f [i,m] is the value fraction (dimensionless) of the product m and are calculated using the methods presented in Chapagain and Hoekstra (2008). Thus, the WF of each product is composed of three separate WFs, namely blue WF$_{blue}$), green (WF$_{green}$) and grey (WF$_{grey}$). The volume of water polluted is estimated based on agreed water quality standards in the recipient water bodies and the pollution load in the return flows from the factory (Hoekstra and Chapagain 2008; Chapagain and Orr 2009). The total volume of water evaporated in the stage of crop growth is calculated using the maximum daily crop water requirement and the available effective rainfall calculated using the model CROPWAT (FAO 1992). Using the outcomes of the CROPWAT, the volume of blue and green water evaporated are separated following the methodology presented in Chapagain and Orr (2009). The various steps involved in the calculation of the WF of a business is recently published in the form of a manual by the WFN (Hoekstra, Chapagain et al.

2009). Figure 4 presents a detailed schematic for the calculation of a WF along the supply chain.
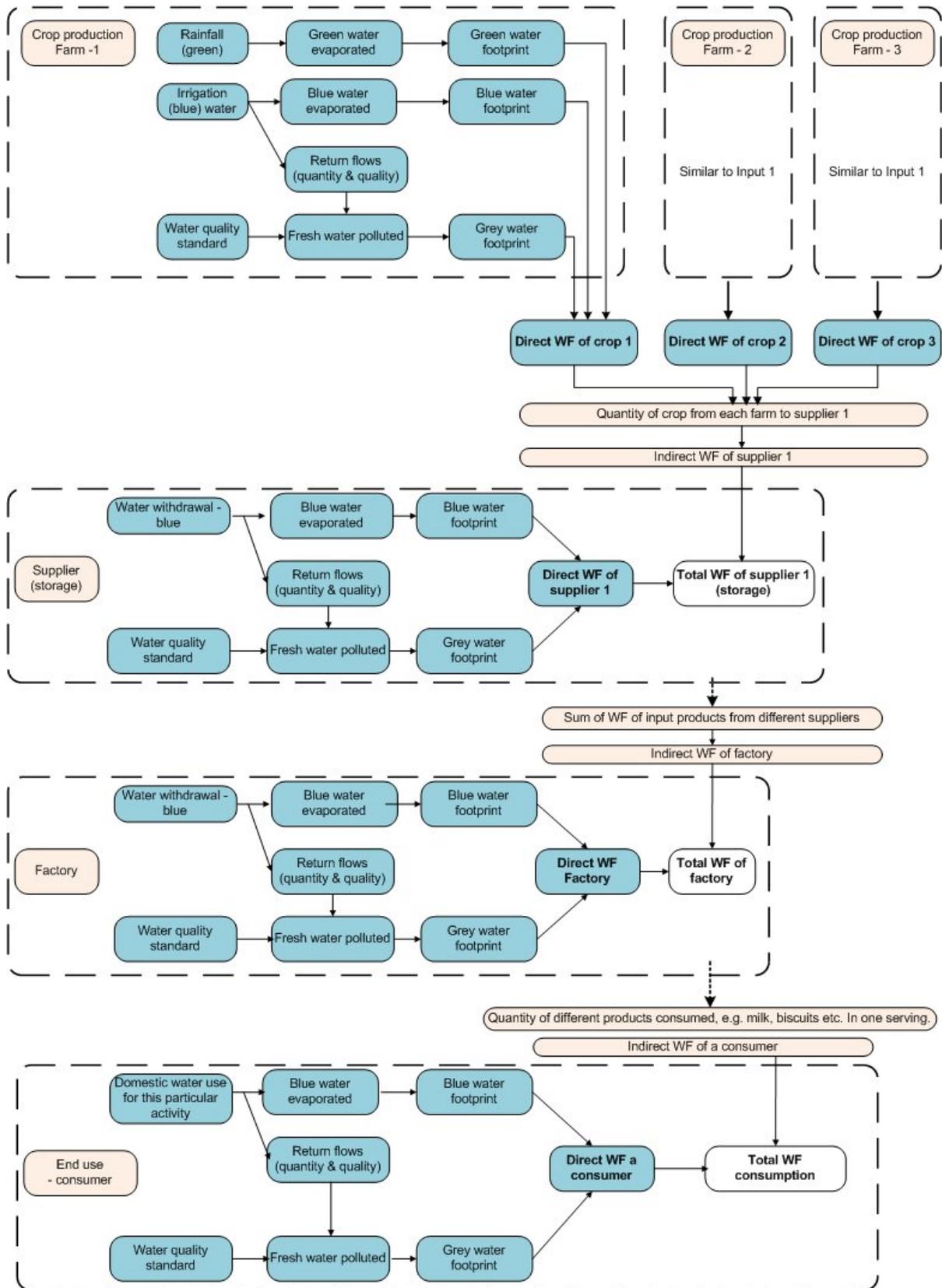

Figure 4. Layers of calculating WF of different actors along the product supply chain.

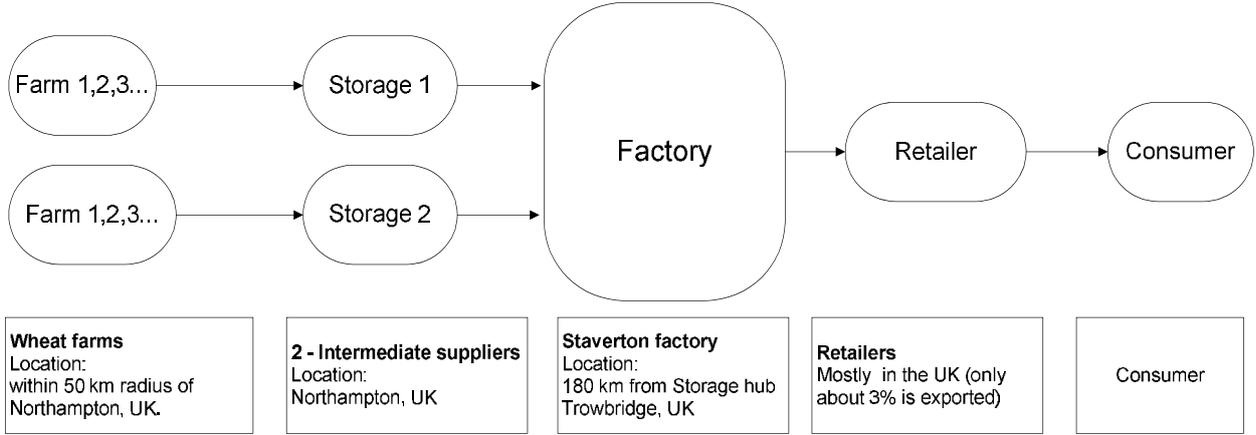A simplified supply chain of Bitesize Shredded Wheat from Nestlé's Staverton factory is presented in Figure 5.

Figure 5. Simplified supply chain of Shredded Wheat.

2.2 PRODUCT TREE OF THE BITESIZE SHREDDED WHEAT

If a supplier has more than one output product, the total WF of the supplier should be attributed to each product in a rational way such that there is no double counting of WFs. The distribution of a WF among different output products is made on the concept of product fraction and value fraction. Chapagain and Hoekstra (2003) first introduced this concept to estimate the virtual water content (volume of water used per unit of a product) of processed products. Later on, the concept is embedded in the methodological frame work of estimating virtual water content of any processed products (Chapagain, Hoekstra et al. 2006; Chapagain and Hoekstra 2007; Hoekstra and Chapagain 2008; Chapagain and Orr 2009).

For this purpose, the different stages of production are hierarchically presented in a product tree (Figure 6). A product tree has product fraction (ratio of the weight of the individual output products to the weight of the input product) and value fraction (ratio of the market value of individual output product to the total market value of all the output products combined) at each stage of production. For example, after stage of 'Storage', the only change is moisture content, thus the value fraction is 1.0, whereas the only the product fraction changes. For a detailed explanation of product fraction and value fraction please refer Hoekstra et al (2009).
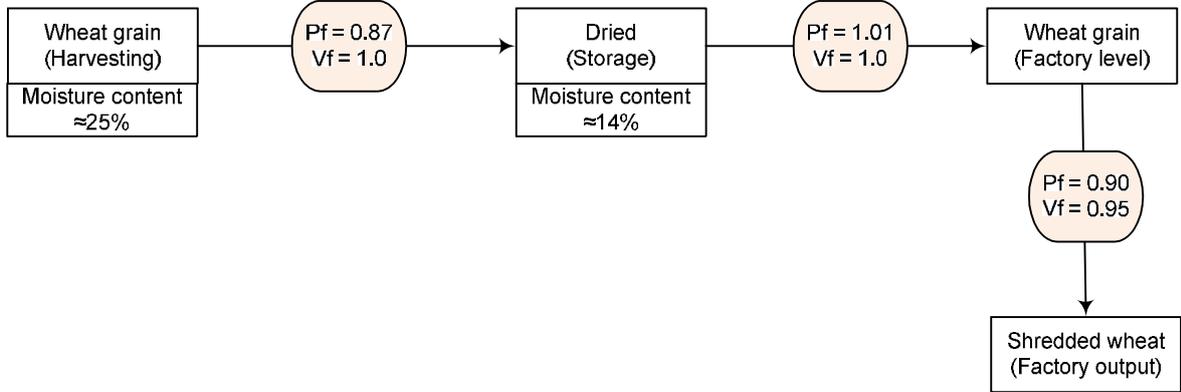

Figure 6. Product tree of Bitesize Shredded Wheat.

3 Data

The various sets of data used in this analysis can be broadly grouped into three different levels. These are 'Farm level (crop production)', 'Factory level (storage and factory)', and 'end use level (consumer)'. The different data used in each group is discussed in the following sections. In the absence of data, a reasonable assumption is made based on existing literature and expert opinion. It is taken care that any such assumptions do not undermine the usefulness of the result.

3.1 CROP PRODUCTION

Three sets of data have been compiled at farm level as detailed in the following paragraphs. The wheat used in the factory is entirely grown in the UK around 50 km radius of Northants (Longitude = 52^0 18' N, Longitude = 1^0 5' W).

The total quantity of wheat import per farm is back calculated from Staverton import data provided by Nestlé. The crop yield (ton per hectare), crop length, crop parameters are collected from field data from Nestlé and FAO (Allen, Pereira et al. 1998). The fertiliser use data at farm level is gathered and supplied by Nestlé field offices. As the pesticide use in winter wheat in the UK is nominal (FAO and Defra), and there is no data readily available on the type and quantity of any pesticide and insecticide used in the farm, it is neglected in quantifying the WF of crop production. There is no irrigation water used (source: Nestlé) in the crop fields. The climate data for the regions where wheat is sourced from is collected from FAOCLIM (FAO 2001).

More than 95% of the wheat used by Nestlé is winter wheat of varieties: Clare, Alchemy, Consort and Riband. According to the BSFP (British Survey of Fertiliser Practice), 98% of the crop area received nitrogen dressing for winter wheat in the UK during 2007 (Thomas 2008). The total fertiliser application rates for N, P_2O_5 and K_2O were, 190, 31 and 39 kg/ha respectively. The efficiency of use of nitrogen fertiliser by winter wheat and winter barley varies depending on the soil type. For light sand soils the efficiency is 70%, whereas for medium, clay, silty, organic and peaty soils, it is 60%. For shallow soils over chalk and limestone it is only 55% (The Stationary Office 2000). Hence, there is inevitably some fertiliser leaching into the local surface water sources. For this study, we have assumed a 60% recovery of inorganic nitrogen and 100% recovery for organic nitrogen fertiliser. However, as there is very little organic manure applied to the field, the nitrogen applied is assumed to be 100% inorganic. Out of the total loss, we have assumed a nitrate-nitrogen loss as leachate as only 10%. Though there can possibly be at least 2-3 crops in rotation in the same field in a year, we have attributed only half of the total fertiliser application to the winter wheat and consequently only half of the total leachate to the wheat production.

Nitrate-nitrogen is highly mobile in the soil and will be lost with any drainage water. We have calculated the grey water footprint of wheat farming based on the methodology presented by Chapagain et al (2006). Nitrate in human diets was thought to be a contributory factor to methaemoglobinaemia in infants and to gastric cancer (Richards 2007). The 'Drinking Water Directive' (80/778/EEC) of 1980 set a limit of 50 mg nitrate/litre in drinking water and this limit was extended to water sources in the 'Nitrates Directive' (91/676/EC) of 1991. Since 1980, the association between nitrate concentration in water and human health has been largely dismissed, at least in Europe, but the limits remain (Richards 2007). Hence, we have used this limit as the standard to estimate the volume of water necessary to dilute the leachate (polluted return flows) to the drinking water standards.

3.2 SHREDDED WHEAT PRODUCTION

There is an intermediate storage before the wheat grain reaches the factory. There is negligible amount of water used in this storage and there is no pollution released to fresh water bodies at storage level.

At the factory level, all the relevant data are collected from the factory inventory by Nestlé e.g. wheat entering the system (ton/yr), Bitesize Shredded Wheat produced (ton), wastage of wheat (in % or in ton), water used in the factory (m^3), and waste water discharged (quantity and quality). There is no immediately available data on the supply chain of the packaging material and other water intensive products used in the factory for these products.

3.3 BITESIZE SHREDDED WHEAT CONSUMPTION

Normally, once the product is dispatched from the factory, it reaches the shelves of the retailer and then ultimately to the consumer. One might like to refine the total water footprint of the product that finally reaches the hands of a consumer by adding the direct water footprints incurred at the retailer level. However this is a relatively small amount and very complex to estimate as a retailer might have thousands of products in store that varies both in time and quantity. Therefore we have omitted this phase in the pilot.

A further additional water footprint is created when the product reaches the consumer, in the process of consumption and waste disposal. Based on a Life-Cycle Analysis (LCA) approach, one can estimate the end use WF of the product. As this is very complex and invites rather complex boundary issues, we have not done a complete estimation of the end use WF. However, as Nestlé has recommended that consumers take the Bitesize Shredded Wheat with milk in a certain combination for a variety of reasons, we have included this at the end use WF estimation. Nestlé recommends using 125 ml of low fat milk per 2 biscuits of Shredded Wheat at 21.5 gram of each. We have used the same recommendation for 43gm of Bitesize Shredded Wheat consumption.

Though one can imagine that a variety of other sources of water use can be attributed to this consumption such as:

- What are the other ingredients needed, for a different composition that might be suggested by Nestlé?
- What percentage of the daily water use can be attributed to this individual consumption? Is cleaning of utensils an additional burden or not?

In the absence of the detailed data at this level, we have not included all these actions in estimating the end use WF of the Bitesize Shredded Wheat. As it is almost impossible for a factory to trace out the source of other ingredients that a consumer buys, it is suggested to use the national average water footprint (m^3/ton) of these ingredients in the UK from Chapagain and Hoekstra (Chapagain and Hoekstra 2004). However, this national average should be calculated based on the weighted production inside the UK and the imported volume of products with their respective virtual water contents at the producing countries (Hoekstra, Chapagain et al. 2009).

4 Result

4.1 WF OF CROP PRODUCTION

The crop water requirement of wheat is 397 mm/season in the farms where Nestlé sources its wheat from for the Staverton factory production. The effective rainfall used by the crop is 184

mm /season, called green water use (evaporation of soil moisture maintained by rainfall). Since there is no irrigation to the concerned wheat fields, there is no blue water evaporation in the fields. Using the crop yield (ton of wheat per hectare of land), we get the green WF of what at farm level equal to 239 m^3/ton.

The average fertiliser use in the winter wheat farms in the UK is 190 kg N/ha, 31 kg P_2O_5/ha and 39 kg K_2O/ha. Based on nitrogen as the critical element in determining the dilution requirement, the equivalent volume of fresh water affected is 380 m^3/ha. With an average wheat yield of 7700 kg/ha, the grey water footprint of wheat (WF_{grey}) is calculated.

The total weight of wheat at farm level is 5951 ton/yr. The total WF at farm level (direct WF at farm level for Nestlé's Bitesize Shredded Wheat) is calculated to be equal to 1.7 million cubic meters per year.

Table 1. WF at 'Farm level' for the quantity of wheat sourced by Nestlé.

	Green	Blue	Grey	Total
Water use, evaporated or polluted (m^3/ha)	1838	0	380	2218
WF of wheat in m^3/ton	239	0	49	288
Total WF of wheat at farm level in m^3/yr	1,422,378	0	294,088	1,716,466

Note: As there is no irrigation water supplied, the blue water requirement is not included in the total water use at field level.

As there is a slight reduction in weight as a result of change in moisture content, the total weight of the wheat at the storage phase becomes 5229 ton/yr. Based on the total water used to clean the storage house, the direct WF at storage level is calculated. This direct WF is added to the total WF at farm level to get the total WF at storage level (Table 2).

Table 2. WF at 'Storage level' for the quantity of wheat sourced by Nestlé.

	Green	Blue	Grey	Total
Indirect WF in m^3/yr	1,422,378	-	294,088	1,716,466
Direct WF in m^3/ton	0	0.005	0.005	0.01
Direct WF in m^3/yr	-	26	26	52
Total WF at storage level in m^3/yr	1,422,378	26	294,114	1,716,518

4.2   WF OF BITESIZE SHREDDED WHEAT AT FACTORY GATE

4.2.1 Direct WF at Staverton

There are a number of other output products besides Bitesize Shredded Wheat from gross activities at the factory. As there are no independent data for water usages for one single product in the plant, a logical water accounting is made to estimate the evaporated and waste flow for each of the individual products from the factory based on the share of each weight of each product to the total weight of all the output products.

The water use inventory is compiled from the factory for the period of Apr-Sep 2008. The total use of water from the return of the condensation for the 6 months is measured as 2,047 m^3. The total deficit water, after deducting the re-use of the condensed water, is measured as 16,533 m^3 for the same period. Total water intake for the same period is 66,865 m^3. The gross return flow from the factory is 37,557 m^3. Thus the total outflow from the factory (steam loss + return flow)

is equal to 54,090 m^3. The total evaporation in factory is the calculated as the difference between total intake (66,865 m^3) and total outflow (54,090 m^3) which is equal to 12,775 m^3.

The deficit steam (water) and total water intake is attributed to each product category based on the share of evaporation for each product category to the total evaporation from the factory. The volume of waste water is estimated by subtracting the volume total evaporation (steam loss plus other evaporation from the system) from the total water intake.

The total volume of water evaporated attributed to the Bitesize Shredded Wheat is calculated to be 2,172 m3 per six months period. As the production is 2,353 t/six month, the evaporation per ton of product is 923 litres. Hence, the direct blue water footprint of the factory in the production of Bitesize Shredded Wheat is 923 l/t.

The return flow per unit of finished product is 2,714 l/t. However, as all the waste water is treated by a separate unit as per the existing set up, there is no grey WF of the factory. It is still debatable whether the blue WF should include the return flows or not, as the treated water is released to a different point (downstream of the river) other than to the point where it is abstracted from. For the sake of present calculation and to be consistent with the existing methods on estimating a WF (Hoekstra, Chapagain et al. 2009), we have excluded this from the total blue WF of the factory.

As there is a reduction in the total weight of the wheat as result of the factory operation, the weight of the half yearly production of the Bitesize Shredded Wheat is 2,353 ton. Thus the direct water footprint of the Bitesize Shredded Wheat at factory level is equal to 2,172 m^3/six month. Assuming that the annual production is double of that for the six months (4,706 t/yr), the resulting direct WF at this stage is calculated to be 4,344 m^3/yr, which is a 100% blue water footprint.

4.2.2 Total WF at Staverton

The total WF of the Bitesize Shredded Wheat at the Staverton factory level is the sum of its indirect WF and direct WF. The indirect WF at this level is equal to the total WF at storage level which is 1,716,518 m^3/yr (calculated in section 4.1). The direct WF is equal to 4,344 m3/yr (calculated in section 4.2.1). The total WF (m^3/yr) of the Staverton factory related to the Bitesize Shredded Wheat production is calculated to be 1,720,862 m^3/yr (Table 3). The blue WF is created by the operations at factory level and storage, whereas the green and the grey are from the activities at farm level (crop production).

Table 3. The WF of Staverton Bitesize Shredded Wheat at Staverton factory gate.

	Indirect WF				Direct WF				Total WF			
	Green	Grey	Blue	Total	Green	Grey	Blue	Total	Green	Grey	Blue	Total
WF* (m³/ton)	302	62	0.006	365	0	0	0.923	0.923	302	62	0.929	366
Total WF (m³/yr)	1,422,378	294,114	26	1,716,518	-	-	4,344	4,344	1,422,378	294,114	4,370	1,720,862
Locations	Farm and storage locations				Factory site				-			

4.3   WF OF CONSUMPTION OF BITESIZE SHREDDED WHEAT

Assuming that there is no significant direct WF in the retailer stage, the total WF of the Shredded Wheat at the level of the consumer is estimated by adding the WF of other ingredients needed to make a serving based on the recommendations by Nestlé for desired taste and nutritional value. As per Nestlé's recommendation, one serving of Shredded Wheat

Biscuits is best taken with 125 ml of milk; 2 biscuits of 21.5gm each. There are no other additives recommended such as sugar or fruits etc. We have taken same serving composition for the Bitesize Shredded Wheat in calculating the water footprint per serving of the product. Assuming cleaning of utensils and the related pollution per servings to be negligible, the total water footprint per serving of Nestlé's Bitesize Shredded Wheat is calculated and presented in table 4.

Table 4. Total WF of Bitesize Shredded Wheat consumed according to Nestlé's recommendation.

	Blue WF	Green WF	Grey WF	Total WF
WF (m^3/ton)				
• *Biscuits*	0.929	302	62	365.674
• *Milk***	0	722	0	722.000
WF (m^3/yr)				
• *Biscuits*	4,370	1,422,378	294,114	1,720,862
• *Milk*	0	9,877,128	0	9,877,128
• *Total WF*	4,370	11,299,506	294,114	11,597,990

Note: * Water use in preparation and cleaning utensils etc is assumed to be zero.
** The WF of milk is taken from (Chapagain and Hoekstra 2004). Here, it is assumed that this to be 100% green WF, as the report doesn't separate these two WFs categorically.

The total WF of a typical packet (750gm) of the Bitesize Shredded Wheat equates to 274 litres/packet, out of which 226 litres are green, 47 grey and 1 litre is blue (Table 5). Here, the WF is related to the biscuits only. However, as it is consumed with milk, the WF of a typical Bitesize Shredded Wheat breakfast is 106 litres per serving (16 litres for biscuits and 90 litres for milk).

Table 5. WF per serving of a typical Bitesize Shredded Wheat breakfast.

	Blue WF (litre)	Green WF (litre)	Grey WF (litre)	Total WF (litre)
Bitesize Shredded Wheat (43 gm/serving)	0.04	13.00	2.69	16
125 ml of low fat milk per serving	0.00	90.25	0.00	91
Total WF (litre/serving)	0.04	103.25	2.69	106

A flow diagram showing the distribution of the WF along the supply chain of the Bitesize Shredded Wheat is presented in Figure 7.
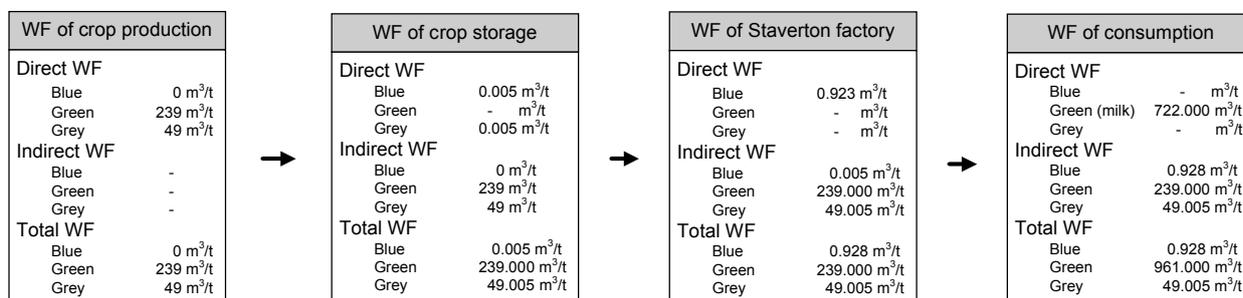

Figure 7. Water footprint of Bitesize Shredded Wheat (l/ton) along the supply chain.

WF pilot project

5   Sustainability assessment and conclusion

At the farm level, impacts are minimal with respect to blue water use as no irrigation water is used. However, as a result of fertiliser use there are pollution impacts to the local surface water resources which can be addressed with a proper fertiliser management practice in place. The risk of loss of nitrates by leaching can be reduced by ensuring that the amounts of nitrogen applied are lesser than, or just equal to that the crop uptake.

At the storage level, there is a moisture enhancement of 10%, about 24 hours before the grain is supplied to the factory. This only adds a very small (direct blue) amount of water at the storage point. The size of the direct blue water footprint is very small compared to the total water available in these locations, and hence the impact on the local hydrology is also minimal. However, an analysis of UK water resources is useful to highlight potential issues and proactivity with regard to trends and changes.

Average annual rainfall over England and Wales is 890 mm/yr and nearly half of this evaporates leaving an average of 465 mm to recharge surface water resources (Environment Agency 2008). However there is a large variation in the recharge rates over England and Wales ranging from more than 2500 mm in parts of Wales and the English Lake district to less than 200 mm/yr in parts of Eastern England. Figure 8 presents the recharge rate during summer and winter in England and Wales. The farms supplying wheat to Nestlé are located on regions with moderately lower recharge rates to the surface water bodies (100-200 mm/yr), whereas the factory is located in a region with a relatively higher recharge rate (200-500 mm/yr).
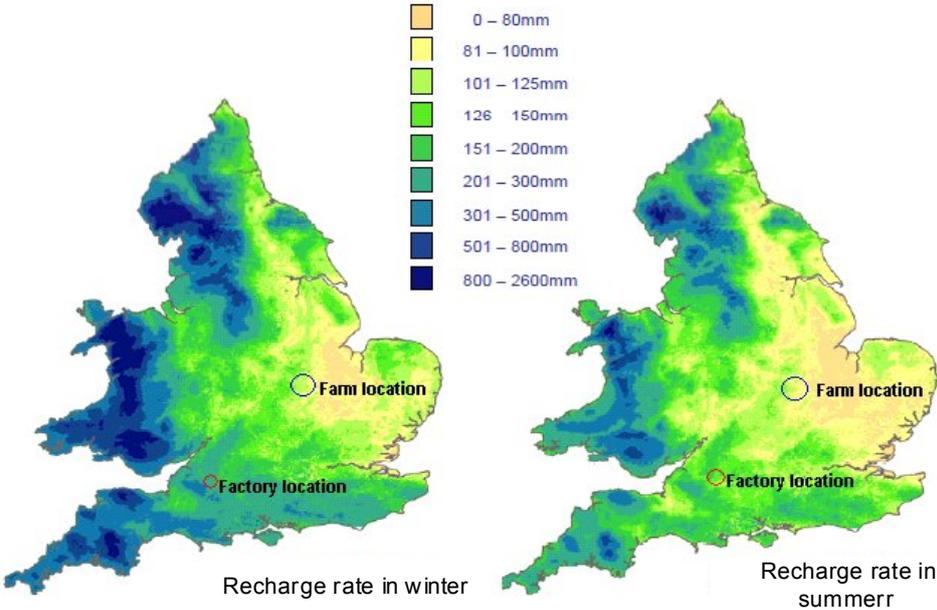

Figure 8. Annual recharge rate of surface water in England and Wales during winter (October to March) and summer (April to September). Source: (Environment Agency 2008).

A measure of scarcity can be effectively expressed in terms of WEI (water exploitation index) which is the ratio of actual blue water abstraction to the total recharge rate in a region. On average, over England and Wales, only about 10 per cent of the freshwater resources are used for abstraction, excluding abstraction to support power production, which is often returned directly to the environment (Environment Agency 2008). Water resources are considered to be under stress or over stretched if this index is more than 20 per cent. South East and Eastern England can be classified as an area 'under stress from water abstraction', with more than 22 per cent of freshwater resources abstracted (Figure 9). Compared to the rest of Europe, water

resources are under greater stress only in drier countries such as Cyprus, Malta, Spain and Italy (Environment Agency 2008).
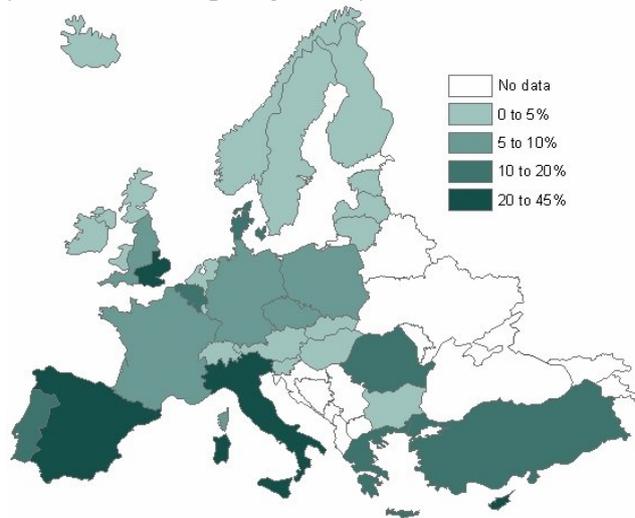

Figure 9. Water Exploitation Index in regions of the UK and the rest of the Europe. Source (Environment Agency 2008).

Based on the CAMS (Catchment Abstraction Management Strategies) assessment of the Environment Agency (2008), there are considerable pressures on water resources throughout England and Wales, not just in the drier South East and Eastern England. The CAMS considers how much freshwater resource is reliably available, how much water the environment needs and the amount of water already licensed for abstraction. This shows the locations where water is potentially available for abstraction.

The water resources availability map (Figure 10) shows that there are many catchments where there is no water available for abstraction at low flows (Environment Agency 2008). The figure shows that the Nestlé factory is located in a region with risk to future blue water availability. The farms are located in areas with severe blue water availability issue. Hence, a timely WF analysis of all its products originating from this region would be strategically important for the business to grow in these regions.
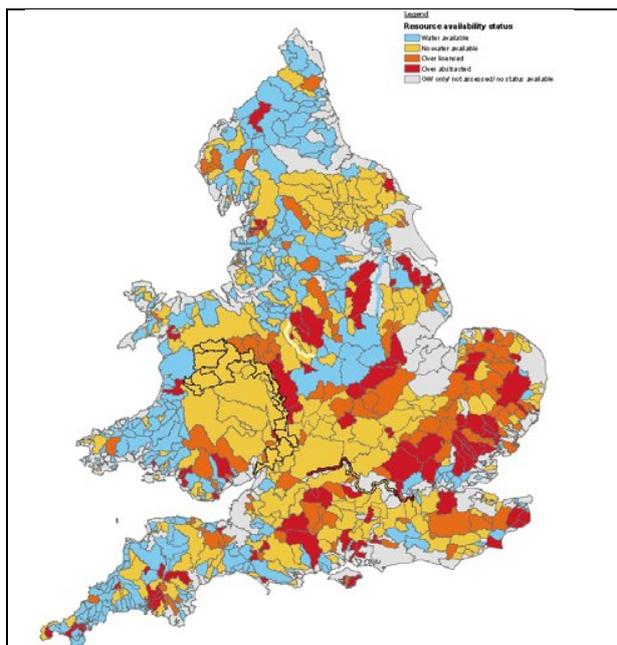

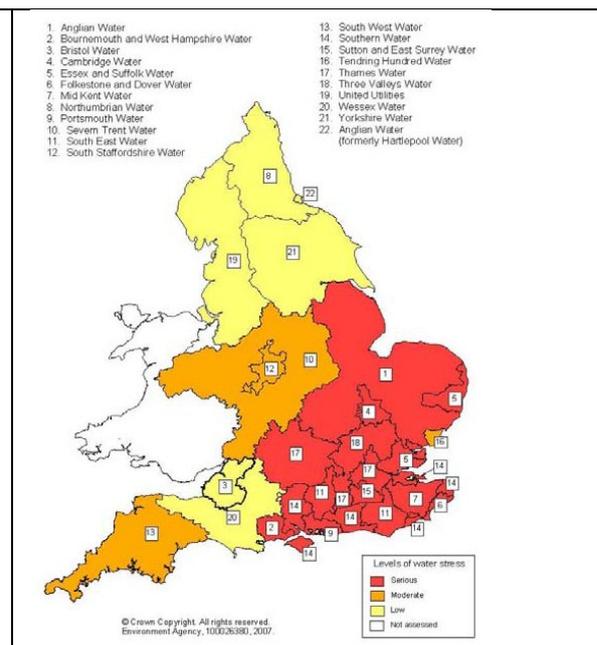| **Figure 10. Blue water availability for abstraction in England and Wales. Source (Environment Agency 2008).** | **Figure 11. Levels of water stress in England and Wales. Source (Environment Agency 2008).** |

The most critical competitor for water uses is the domestic water sector. The analysis of the EA (Environment Agency 2008) shows that both the locations of Nestlé's supply chain lie at severe water stress zones (Figure 11). The figure shows which areas of England are considered to be seriously water stressed by assessing where current and future household demand for water is a high proportion of the available freshwater resources.

Based on projected population growth in England and Wales, it is seen that both the farm and factory locations are going to witness a 20-30% rise in the population (Environment Agency 2008; ONS 2009). Hence, any reduction of blue and grey water footprint of the supply of Nestlé's Bitesized Shredded wheat would always result in a better position for Nestlé's water related risks in the future.

The inclusion of impact categories into the WF measure is an on-going evolution, drawing on experiences from both LCA and water regulation practices. There are, depending on the boundaries set and the problem to be solved, impact categories which can help the management aspect of water use. In this case study the impacts are low, as the system from a water abundant area with minimal social and environmental impacts deriving from production techniques. While this is essential for companies to realise, not all factories and production sites are impact free.

Acknowledgements

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