“What should a responsible food retailer look like in terms of water use and what are the implications for UK government policy?”

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ABSTRACT

A rapidly growing global population and the associated industrial development have long been cited in the literature as Malthusian threats to fresh water supplies. But it is now increasingly clear that the additional problems of climate change and peak oil (the carbon cost of water) are worsening the situation. Climate change is making weather patterns more unpredictable and farming more precarious. Peak oil is making pumped and irrigated water more expensive. The combination of demographics and climate change is creating a perfect storm for fresh water supplies that threatens increasingly fragile food supply chains.

NGOs like WWF and Waterwise in the UK have warned of the unsustainable amounts of virtual or embedded water needed to grow our food – 3,400 litres for the average UK citizen's daily food requirement – and argued that when countries like Kenya, Egypt or Australia, who are using more water than they have, export water-intensive food to the UK we are exporting drought to them and creating future instability.

Food retailers, who sit at the apex of the food supply power structure in the UK, are only at the start of their thinking about water although most are aware of the issues. All are installing water efficiency measures in new stores for financial and environmental reasons. However the majority do not consider they have a responsibility to act beyond their immediate operations. Only two are working on water footprinting their supply chain. Only one is seriously thinking about water use by customers. A wide range of missing drivers were cited to explain the lack of action: the focus on carbon, the lack of a functioning price mechanism, the absence of customer concern, the complexity of methodologies and low government interest.

The range of responses about future risks goes from those who see it as a clear threat to their business in the medium term that will have to be addressed, all the way to

those who believe it will not be a threat and who say that anyway the price mechanism will sort it out if a problem does occur.

There is little or no coordinated UK government policy in this domain and no real sense of urgency about water in relation to food supply, although there are signs that thinking may be changing on this. More research is needed by government to help all stakeholders understand the problem and to allow food retailers and their suppliers and customers to take the appropriate action. More negotiations are needed at the inter-governmental level to agree an international framework for pricing and/or water allocation.

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DEFINITIONS AND ABBREVIATIONS

Virtual, embedded or embodied water: The water needed to produce a product.

A water footprint: The amount of fresh water used directly or indirectly by a person or entity or area or country.

Blue water: Ground water (aquifers) or surface water (rivers).

Green water: Rainwater and soil moisture.

Grey water: Polluted water.

Drought: A temporary decrease in water availability due for instance to rainfall deficiency

Water scarcity: When water demand exceeds the water resources exploitable under sustainable conditions.

Evapotranspiration: Transpiration is what plants need to do. Evaporation is what happens when water is left lying on the surrounding land. The two concepts are merged because nobody has yet found a sensible way to measure them separately.

CHAPTER 1: HYPOTHESIS AND UNDERLYING ASSUMPTIONS

The central hypothesis of this dissertation is that climate change and peak oil are combining with traditional stresses on fresh water supply to create a perfect storm that represents a serious threat to UK food supply. The assumptions underlying that hypothesis are as follows:

Huge amounts of water are needed for growing food

Everything begins with water and water sustains us all. We have to drink it to stay alive and we eat it in the sense that most of our food intake is actually water. But we use far more than we drink or eat to grow our food. The daily food intake of the average UK citizen requires 3,400 litres of virtual or embedded water as it goes from farm to plate (Chapagain & Orr 2008). A cup of coffee requires 140 litres of water to grow, produce, package and ship the beans, roughly the same amount of water used by an average person daily in England for drinking and household needs. The average hamburger contains 1,400 litres of embedded water (Chapagain & Hoekstra 2007). Per capita, Americans consume around 6,800 litres of virtual water every day, twice as much as Britons and over three times as much as a Chinese person (Hoekstra et al 2002).

An estimated 70% of abstracted ground water (blue water) worldwide – 2,664 cubic kilometres - is used to irrigate agriculture. But irrigation only accounts for 30% of the total water used in farming; the rest comes from soil moisture and is dependent upon rainfall (green water). Only 40% of this green water reaches rivers and aquifers because of evapotranspiration, which is partly necessary transpiration by growing plants and partly wasted water that is evaporated from the surrounding land. Evapotranspiration from agricultural land is estimated at more than 7,000 cubic kilometres ie nearly three times the amount of water abstracted for agricultural purposes (Molden et al 2007).

Trading virtual water solves some problems but creates others

Professor Tony Allan came up with the term virtual water in 1993. He defined it as the water needed to produce agricultural commodities. The concept has been criticised in the same way as 'food miles' have for being too simplistic (Merrett 2003, MacGregor & Vorley 2006) and for needing an additional overlay of comparative advantage and opportunity cost (Wichelns 2004), which is partly now addressed by the use of green water (free) and blue water (costs). But despite the criticisms the term virtual or embedded water has survived and is now widely used. Two UK NGOs – Worldwide Wildlife Fund-UK and the water efficiency lobby group, Waterwise - wrote reports on virtual water and water footprinting in 2008 which served to highlight to wider audiences just how much water is used to grow our food.

The London Water Research Group, of which Allan is a founder member, argues that it make sense to "import" embedded water in crop commodities into water short political economies. The Middle East and North Africa (MENA) imports 50 million tons of grain annually. That requires 50 cubic kilometres (billion litres) of water to grow ie roughly the volume of fresh water that flow into Egypt each year down the Nile and about 30% of the fresh water resources of the MENA region (Allan 2003b). In other words there is no way the region can produce all its grain because it just does not have enough water. So the LWRG argue that a country like Egypt is doing the right thing by importing water-hungry staples like wheat.

Egypt is also exporting water-intensive strawberries to the UK. This is Wichelns' point about opportunity cost and comparative advantage. Egypt earns valuable foreign currency from growing a cash crop like strawberries. Egypt also has a comparative advantage over the UK because it is sun blessed and the cost of production is, for the moment, lower than the UK.

However water is not really factored into the equation because its price to Egyptian farmers does not reflect its true value in terms of scarcity and other externalities. The reverse of this coin is that UK food retailers are ordering water-hungry fruit from Egypt despite the fact that they are effectively importing drought to a water-scarce region and despite the fact that there is considerable fragility building up in this particular supply chain.

The problem of water-scarce countries exporting water-intensive products is not a new issue; it predates the concept of virtual water. As Allan himself readily admits virtual water was more a new way to express something rather than a new concept or even a call for action. In the 1980s, for example, Israeli economists had expressed concern about exporting water-intensive products like oranges and avocados from water-scarce Israel (Allen 2003b). Exporting dates and olives which are less water-intensive would make more sense.

Australia is another increasingly water scarce country. Approximately 30% of its water is used to grow food for domestic consumption. Almost 50% of an Australian urban household's water use is through their food consumption, compared to 11% directly in showers, gardens and cleaning. Approximately 40% of the state of Victoria's harvested water is exported in food products. In the words of a recent University of Melbourne report: "Growth in exports will require a changed export mix, or would require all of our water by 2050" (Larsen et al 2008).

UK food retailers are presumably importing water-hungry fruit from water-scarce countries like Australia and Egypt because it makes short-term financial sense. For Australia and Egypt it presumably makes short-term political sense in terms of jobs and national income. It may make less sense in the long term.

It is perhaps worth pointing out here that the solution is not necessarily to go back to growing apples in Kent. Most people think of the UK as a wet country and some of it is,

but the south east of England has less available water per person in terms of rainfall, ground water and river water than Sudan or Syria, and is a designated water-stressed area (DEFRA 2008). At some point it is fair to say that a question mark may need to be raised over growing food in the south-east of England.

A growing population requires more water

Demographics, development and pollution have traditionally been the concerns in relation to stresses on fresh water supply. The world population is growing rapidly. From six billion today it is predicted to reach nine billion by 2050. This implies a need for more food and water. More of the world's population is moving to cities, especially near coastal regions which are often the most water stressed. According to the UN, 29% of the global population lived in urban regions in 1950 and an estimated 60% - 5 billion people - will be in cities by 2030 (UNFPA 2008).

Richer populations use more water

As populations grow richer they demand more water. US water demand has tripled in 30 years whereas the population has increased by 50% (Goldman Sachs 2008). They also demand more meat and dairy which requires more water (Steinfeld et al 2006). Between 1997/99 and 2030, annual meat consumption in developing countries is projected to increase from 25.5 to 37 kg per person, compared with an increase from 88 to 100 kg in industrial countries (FAO 2003). To provide 500 calories in the form of corn requires 130 litres of water, while the same number of calories produced as beef requires 4,900 litres because first the grain to feed the cows has to be grown, then the cows have to be given water to drink throughout their lifetimes (Renault & Wallender 2000).

Desalination is not a solution for agriculture

The cost of desalination is falling fast, but it is still expensive and energy-intensive (Downward 2008). It may be the answer for some, but probably not for agriculture, as Fred Pearce made clear in his 2006 book "When The Rivers Run Dry":

> *"It is hard to see desalination penetrating the agricultural market, where most of the world's water is used. The costs are at least an order of magnitude too high. For the foreseeable future it will be cheaper to import food than to go to the trouble of desalinating seawater for irrigating crops."*

Climate change is changing the rules

Three quarters of the world's population already lives in regions affected by earthquake, tropical cyclone, flood or drought at least once between 1980 and 2000 (UNESCO 2003). Climate change is predicted to dramatically worsen the situation, making some areas more water stressed and less able to produce food. The recent Intergovernmental Panel on Climate Change technical report on climate change and water says: "Many semi-arid and arid areas (e.g., the Mediterranean basin, western USA, southern Africa and north-eastern Brazil) are particularly exposed to the impacts of climate change and are projected to suffer a decrease of water resources due to climate change [high confidence]" (IPCC 2008). These are all areas that export food to the UK.

In other parts of the world rainfall is set to increase with hurricanes and flooding making farming less predictable. "The frequency of heavy precipitation events (or proportion of total rainfall from heavy falls) will be very likely to increase over most areas during the 21st century, with consequences for the risk of rain-generated floods" (IPCC 2008).

Sea levels are rising and causing salination of coastal farms especially where aquifers are exhausted or rivers are running dry. Over abstraction further inland is causing dryland salinity. There may well come a point when food supply lines break down because of a catastrophic reduction in available water (drought, over abstraction, pollution, increased demand) or because of excessive water (flooding, hurricanes) or the wrong kind of water (salinated, polluted).

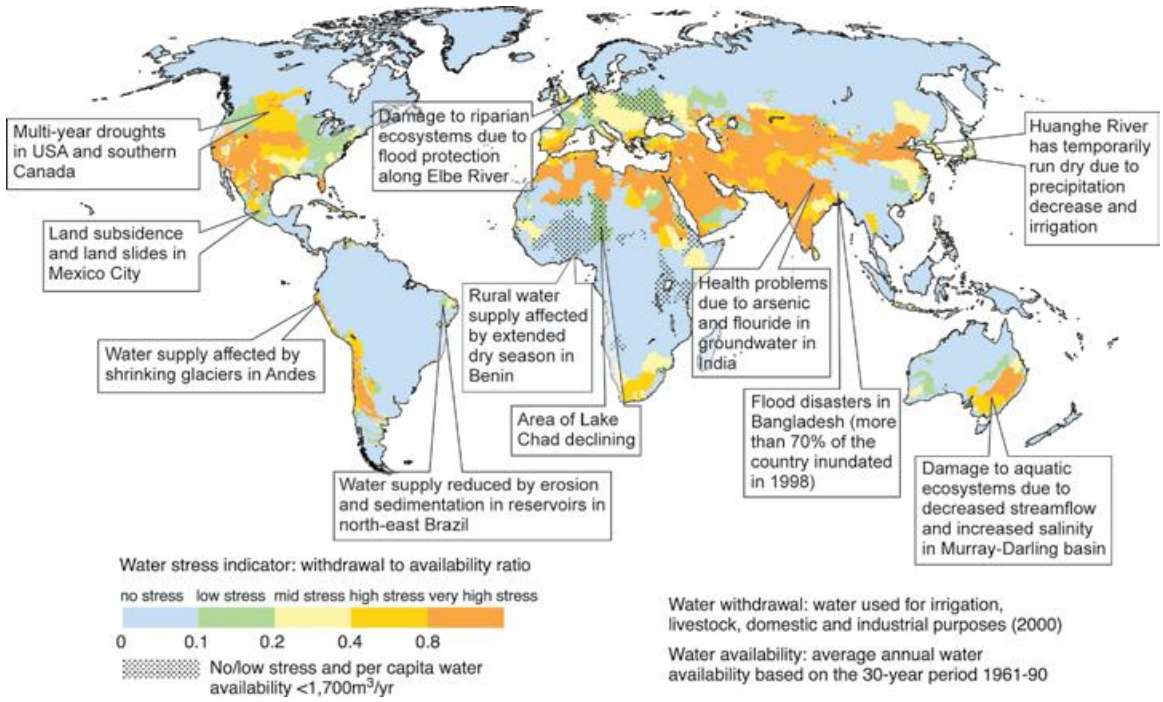

Figure 1: Fresh water issues superimposed on a water stress map. Source: IPCC 2008.

> *"Higher water temperatures and changes in extremes, including floods and droughts, are projected to affect water quality and exacerbate many forms of water pollution – from sediments, nutrients, dissolved organic carbon, pathogens, pesticides and salt, as well as thermal pollution, with possible negative impacts on ecosystems, human health, and water system reliability and operating costs (high confidence). In addition, sea-level rise is projected to extend areas of salinisation of groundwater and estuaries, resulting in a decrease*

of freshwater availability for humans and ecosystems in coastal areas" (IPCC 2008 – see figure 1).

The water used in Egypt in 2000 was estimated at about 70 km3 which is already far in excess of the available resources (Gueye et al 2005). The IPCC expects climate change to worsen the situation dramatically: precipitation is predicted to decline; rising sea levels are expected to impact heavily on the Nile delta; and temperature rises are likely to reduce the productivity of crops and increase their requirement for water leading to an increase in irrigation demand (IPCC 2008).

Ireland may not seem like a country that has a water shortage problem but in actual fact it is expected to experience prolonged periods without rain leading to a need for irrigation for the first time. It is also expected to experience rising sea levels and therefore salination of coastal farms, increasingly fierce storms, and more common 100 year floods (IPCC 2008). In short, farming is set to become far more precarious in Ireland.

The way climate change is adding to traditional stresses on fresh water supply is filtering through to the investment community:

"The demand for water continues to escalate globally from population growth and industrial expansion. At the same time, the world's fresh water supply is shrinking due to pollution, draining of underground aquifers, and climate change… Climate change is adding further tension to the water equation, triggering changes in hydrological systems in many regions of the world. The effect varies by region, from additional rainfall increasing water runoff in tropical zones, to receding glaciers and snowpacks reducing snowmelt and freshwater supplies" (Goldman Sachs 2008).

Peak oil – the increasing carbon cost of water

Cheap oil has given us an industrialised and globalised food supply chain. (Tudge 2003, Lang & Heasman 2004). We appear to be at or near the peak of global oil production although we will only be sure when it has been reached some time after the event. All agree it will happen though and most predict it will be soon. Supply is set to fall while demand continues to increase. The price of oil is expected to rise significantly (Strahan 2007, Hirsch 2005).

Water that is stored, pumped or cleaned has both a financial cost and increasingly a carbon cost as well. Building reservoirs, pumping water around countries, cleaning water, treating water, irrigating fields, washing agricultural products – these require fossil fuels or electricity derived from fossil fuels. As the price of oil rises the underlying cost of supplying water will increase as well.

The price mechanism is an ineffective driver for water

Most fresh water is either free (rainfall/green water) or virtually free because it is often subsidised (abstracted water/blue water) or its price does not account for externalities like scarcity, pollution, soil erosion and resulting flood damage, or salinity (Le Quesne et al 2007, Pearce 2006).

> *"Water has never been priced efficiently, leaving little incentive for conservation. Water has historically been consumed as if it were a permanently abundant commodity. As the lowest-cost utility, water has been systemically under-priced in nearly all countries, which limits the ability of governments and municipalities to fund necessary upgrades" (Goldman Sachs 2008).*

There are no clear agreements on how to assign ownership of water

It would be much easier to price scarcity if the issue of ownership was settled. In the UK the Environment Agency is responsible for licensing the extraction of ground water and the return of waste water to the environment, but not rain water and certainly not virtual water. In Germany some municipalities tax households and businesses if they allow rainwater to flow off their sites – so-called water run-off taxes to prevent flooding. In other words they are enforcing ownership of rainwater. In California the system is "first in last out" so the earliest settlers have a prior claim whatever they are doing with the water. In Australia's Murray River basin, which is in the grips of a multi-year drought, the government allocates water (Pearce 2006).

> *"The most effective means of allocating water will always be determined by local circumstances: there is no 'correct' approach that can simply be replicated globally… A plurality of water rights systems eg state administration, traditional law, internation treaties) may be relevant within a particular situation… Water trading may provide an efficient water allocation mechanism, but, as with other mechanisms, only under particular conditions." (Le Quesne et al 2007)*

CHAPTER 2: RESEARCH QUESTION

Food companies lead the way

In July 2007 Coca Cola announced it was going water neutral. "Our goal is to replace every drop of water we use in our beverages and their production," said their Chief Executive Neville Isdell (ENS 2007). Specifically Coca Cola pledged to:

- Reduce the water used to produce its beverages;
- Recycle water used in manufacturing processes – returning all water used for global manufacturing processes to the environment at a level that supports aquatic life and agriculture by the end of 2010; and,
- Replenish water in communities and nature – balancing the water used in its finished beverages.

Arguably this was not about water as a climate change or carbon issue - this stemmed from negative brand image risk related to accusations that Coca Cola plants were exhausting drinking and farming water resources as well as producing a toxic sludge as waste (The Guardian, 25 July 2003).

Whatever the reason for Coca Cola's move they have arguably succeeded in persuading others to use less water. In early 2008 some of the UK's largest soft drinks companies, acting under the umbrellas of the British Soft Drinks Association, agreed to reduce water consumption in their operations by 20% by 2020 compared to 2007 levels. One of the conclusions of the UK Food Industry Sustainability Strategy Champions Group, which discussed water in 2008, was: "Both retailers and manufacturers should aim to reduce the 'embedded water' in the products they source, the associated carbon, and the potential environmental impact these factors may have, particularly on the products' countries of origin."

A 2007 report from South African Breweries said: "water scarcity and quality are becoming increasingly urgent and politically sensitive issues and are of immediate relevance to SAB-Miller, given the water-intensive nature of the beverage industry, our reliance on water-intensive raw materials and the fact that some of our companies operate in water-stressed regions and countries" (SAB-Miller, 2007). Southern Africa is of course one of the areas of the world predicted to suffer significant water scarcity because of climate change (IPPC 2008).

Food retailers lag behind

By contrast, the food retailers – the supermarkets - announced very little except water efficiency measures in new stores and, in some cases, sourcing of bottled water from the UK rather than abroad.

The supermarkets are usually considered to have the most power in both the UK food retail market and the UK food supply chain. In 1950 supermarkets controlled 20% of the UK grocery market (Blythman 2004). By the end of 2007 the figure was 93%. The largest supermarket – Tesco – now has more than 30% of the grocery market (Taylor Nelson Sofres, 2008).

Supermarket	Share of groceries market end 2007
Tesco	31.4%
Asda	16.7%
Sainsbury's	16.4%
Morrisons	11.4%

Figure 2 – UK supermarkets and grocery market share. Source: TNS 2008.

In 2003 there were 100 supermarket buying desks in Europe (see graphic 1). It has been argued that this is a supply chain bottleneck where the power is concentrated (Grievink 2003, Vorley 2003). In this model farmers, food processing companies and food services companies have less power than the supermarkets.

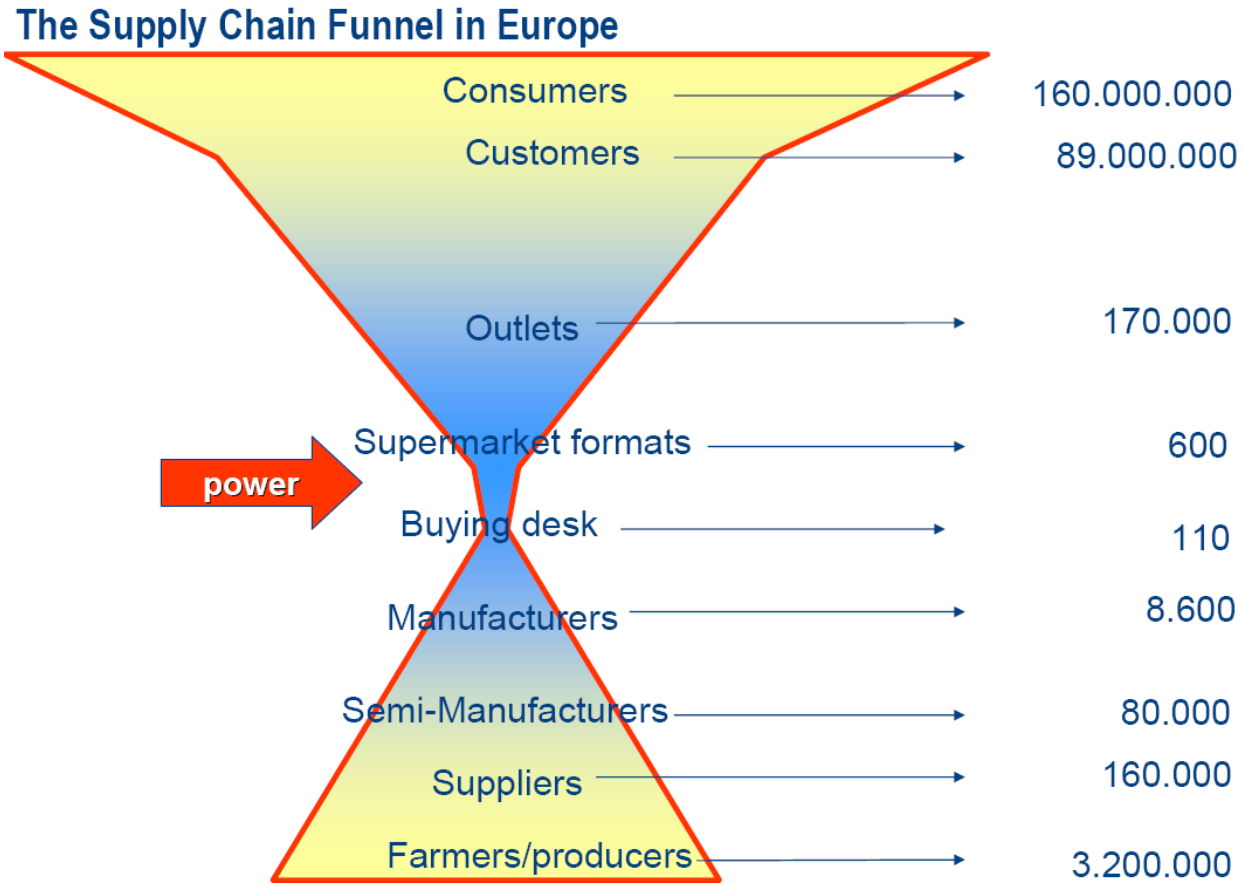

Figure 3: The Supply Chain Funnel in Europe. Source: Grievink/Cap Gemini 2003.

The research question then became to try to find out how much the principal power holders in the UK food supply chain – the supermarkets - understood about water issues and the growing potential threats to food supply, what were the obstacles to action or missing drivers as they understood them, and whether the government could do anything to help with the problems.

CHAPTER 3: CONCEPTUAL/METHODOLOGICAL APPROACH

Literature review

1. Peer-reviewed literature on "food retail" and "water"
2. Government or government-sponsored studies
3. Grey literature

Qualitative research - interviews with UK food retailers.

Eight of the UK's leading food retailers gave time either face to face or by telephone.

My starting point was to ask an unprompted question, which was my dissertation theme: "What should a responsible food retailer look like in terms of water use?" I wanted to see whether respondents were aware of the various discussions in the literature and where they would fix the limits of their responsibility ie direct business operations versus supply chain versus customers.

I then presented a list of problems derived from the literature and asked the following question: "Please look at these problems derived from the literature – do you think any of these issues are currently a problem for your business or could be in the future?"

Perceived problems in the literature

a. Water scarcity due to over-abstraction, population growth, climate change etc
b. Increased efficiency of farming practices eg collection of rainwater, drip irrigation techniques
c. Growing population becoming richer and demanding more meat and dairy
d. Pricing and ownership of water

e. Cost of water use in business operations
f. Risks for a business associated with water eg reputational, regulatory, financial, physical and customer awareness-related?
g. Lack of knowledge about water trends in product sourcing regions eg climate change and demographics
h. Carbon cost of water in terms of collection, storage, pumping, cleaning, desalinating
i. Excessive use of water for making leather and cotton products
j. Food security (in the sense of purchasing availability) due to problems with water supply

This allowed respondents to re-answer question 1 in more detail but also to pick up on things they had missed and comment on things they would not have thought of.

I then presented a possible company action plan and asked for comments with reference to their own actions or planned actions.

A possible company action plan

a. Calculate company water footprint, including supply chain and customers
b. Review sourcing to eliminate provision from water stressed areas except in exceptional circumstances ie temporary alleviation of poverty.
c. Work with producers to make agriculture more efficient eg drip methods of irrigation and collection of rainwater wherever possible and where this does not cause problems further downstream.
d. Work with supply chain and internally to reduce water consumption in operations.
e. Work with supply chain and internally to make sure grey water is returned to the water table clean.
f. Work with customers to reduce water wastage.

I then finished by posing the following questions:

a. Do you think there are there any additional problems associated with water use for a business like yours that I have missed out?
b. Can you tell me what sort of thinking your business has done on any of these issues and whether any clear priorities have emerged?
c. What do see as being the primary obstacles for your company to taking action to solve the problems outlined?
d. How do you think the UK government, or indeed other governments or stakeholders, can help to solve the problems of water use by UK food retailers and their suppliers?

Quantification of the interviews was less easy than it could have been because the respondents were asked open ended questions rather than given a questionnaire inviting yes/no responses. I eventually scored the interviews by creating a grid of questions or issues and awarding 1 point for a definite "yes" or "a serious issue for us", 0 points for a definite "no" or "not an issue for us" and 0.5 points for a "maybe" or "some action taken" or "some thinking done".

In the end, given the small size of the sample, it made more sense to say how many of the interviewees responded "yes" or "maybe" to a particular question rather than using the scoring directly. The scoring was helpful however insofar as it made it easy to see the trends. See Appendix 1 for the grid.

CHAPTER 4: LITERATURE REVIEW

Peer-reviewed literature via City Library and Google Scholar

Online sources searched via City Library e-catalogue: Business Source Complete; International Bibliography of Social Sciences; Green File; Econlit; Web of Science; Science Direct.

Keyword combinations used: "food retail" and "water"; "food retail" and "virtual water"; "food retail" and "embedded water"

The one relevant reference was in Econlit but it dated from 2000 and treated water as merely a waste issue for retailers (Davies & Konisky 2000).

Google Scholar initially threw up too many references to be useful (1,740) using "food retail" and "water" as keywords and a search using those keywords in the title produced just one article which was not relevant. However using "food retail" and "virtual water" as keywords did produce a number of useful references notably the Fresh Insights series published jointly by the IIED and DFID, and a study by the University of Melbourne (Larsen et al 2008).

Changing the keywords to "food retail" and "embedded water" brought up a report by the UK Food Industry Sustainability Strategy Champions, the Sustainable Development Commission's report "Green, Healthy & Fair", and an article on food security by Prof. Tim Lang in The Grocer. However these should more correctly come under government-sponsored reports or grey literature.

Government published or supported studies

The UK government's traditional view of food security is reflected in a DEFRA discussion paper released in July 2008 called "Ensuring the UK's Food Security in a Changing World". It said: "By any objective measure, and despite the recent price increases, the UK currently enjoys a high level of food security. This is reflected by the relatively small proportion of household expenditure on food and the diverse and abundant foods available in our shops, supermarkets and farmers markets."

However in the same month the Strategy Unit of the Cabinet Office released a report called "Food Matters" which included these the following paragraphs which suggest that thinking may be changing:

> *"In many parts of the world, food production is based on unsustainable patterns of water use. Under-pricing and mismanagement of water resources are widespread. On a global basis, the amount of fresh water available per person is falling rapidly. Worldwide, soils are similarly under pressure as a result of poor land management (over-grazing, over-irrigation, run-off, etc). There is a clear need for countries, industries and communities to address these issues.*
>
> *"The increasing scarcity of water, land and other resources means that in 2050 a world population of 7.8 to 10.8 billion people will need to use a different mix of production methods and, quite possibly, see diets change.*
>
> *"Climate change adds two additional compelling dimensions to the future global food challenge: agricultural systems will need to be adapted to the impacts of climate change, which include higher average temperatures, changes in the distribution of rainfall and increased frequency of extreme weather events.*

DEFRA has in the past done good work on analysing UK trends and incorporating climate change predictions for the UK made by the Hadley Centre and the IPCC ("Long-term Farming Trends" – 2005; "Ensuring food security in a changing world" – 2008; "Future Water" - 2008). "Water on the farm", the joint guidance published in 2007 by DEFRA, the Environment Agency, the NFU (National Farmers Union) and LEAF (Linking Environment and Farming) was packed with water efficiency advice for UK farmers. And "Future Water" (DEFRA 2008) accepts that pricing is not working: "Water charges do not reflect the full environmental cost of water usage." However there is nothing in any of these documents on virtual/embedded water or on the implications of the growing stress on fresh water supply for UK food security for global food supply or companies with overseas supply chains.

The Sustainable Development Commission – the government's independent advisory body on sustainable development - talked about embedded water in its 2008 report on supermarkets entitled "Green, Healthy & Fair." It argued that the methodology needed developing and recommended that the government supports "the development of audit methodologies, similar to the life-cycle assessment now used for embedded carbon. Once the methodology is developed government could identify hotspots of embedded water consumption and use the product roadmap approach to explore policy options for reducing levels of embedded water."

Grey literature

In September 2008 The Economist ran an article arguing the world had a water shortage not a food shortage. This followed reports on water earlier in the year from two key investment banks - Goldman Sachs and JP Morgan. Goldman Sachs highlighted the opportunities for investors given the problems of fresh water supply. JP Morgan highlighted the risks to investors from threats to fresh water supply:

"Exposure to water scarcity and pollution is not limited to onsite production processes, and may actually be greater in companies' supply chains than in their own operations. The power-generation, mining, semiconductor manufacturing, and food and beverage sectors are particularly exposed to water-related risks, in our view… In our opinion, corporate disclosure of water-related risks is seriously inadequate and is typically included in environmental statements prepared for public relations purposes rather than in the regulatory filings on which most investors rely. We recommend that investors assess the reliance of their portfolios on water resources and their vulnerability to problems of water availability and pollution."

Waterwise, a water efficiency lobbying group funded primarily by the UK water industry, produced a report in 2007 called "Hidden Waters", which was probably the first widely circulated paper on virtual water and water footprinting. It was based on the work of Ashok Chapagain and Arjen Hoekstra's water group at the University of Twente, which is probably the academic world's leading research body for virtual water and water footprinting.

Chapagain has since left Twente and joined another key figure in the water footprinting debate, Stuart Orr, at WWF-UK. WWF's "UK Water Footprint 2008" has a general section on risks for UK businesses:

"If water security is a risk to your supply chain or your investments, measure the WF [water footprint] of your company. Focusing on where the impacts are most harmful, ask your suppliers to be more water-efficient wherever possible, and invest in their efforts. As well as achieving efficiencies in your company's WF, you may be able to liaise with water managers and encourage and support them to manage water well, so that the poor and the environment get enough and that the water supply on which your business depends is more secure. As a last resort, if all avenues for influence and management have been exhausted and

your WF is still having a harmful impact, you may need to think about shifting the source of your raw materials to regions."

Prof Tim Lang of City University's Food Policy Dept has not written any books or peer-reviewed academic articles on this subject directly, but he has highlighted the problem extensively. In March 2008 Lang gave a presentation to British Members of Parliament entitled "Food Security, Peak Oil & Climate Change: the policy context" in which water was described as having a "huge impact," particularly in terms of embedded water in grain-fed meat and dairy. Furthermore his membership of the Sustainable Development Commission and the Chatham House research project, 'UK Food Supply in the 21st Century: The New Dynamic,' is presumably one of the reasons why those bodies have written reports in 2008 discussing the issue.

GRAIN, an international NGO which promotes the sustainable management and use of agricultural biodiversity, published an interview with Lang in July 2008 in which he said:

"Globally, of all drinkable fresh water, households use 10 per cent, industry 20 per cent and agriculture 70 per cent. Today 92 per cent of humanity has a relative sufficiency of drinkable water, but by 2025 this will be 62 per cent. The notion of how much water it takes to produce an item is likely to become as important as the amount of greenhouse gas emissions it causes. To produce one kilo of grain-fed beef requires 15 cubic metres of water. One kilo of cereals needs between 0.4 and 3 cubic metres. Many of us, alarmed about the importance of water, have been pushing for the auditing of food supply chains for their "embedded water". Labelling foods for their water might help, but the key thing is to reduce profligate water use, since all forecasts see big water crises ahead. The UK is water-rich, but if we are importing others' water, where is the social justice?"

CHAPTER 5: ORIGINAL DATA – INTERVIEWS WITH FOOD RETAILERS

Edited out for reasons of commercial confidentiality

CHAPTER 6: ORIGINAL DATA - HEADLINES

Quantification of the interviews was less easy than it could have been because the respondents were asked open ended questions rather than given a questionnaire inviting yes/no responses. For a fuller discussion of the scoring of interviews see Chapter 3 and for a fuller discussion of the weaknesses of the approach used see Chapter 9.

Responsibility

All eight of the food retailers interviewed accepted that they were responsible for their direct water use ie business operations, and seven said they were working to reduce water use.

Six of the eight interviewees accepted that they had some responsibility for water in their supply chains, but only three said they were actually doing any work with their supply chains.

Only two accepted that they had any responsibility for the water footprint of customers beyond providing information and choice. Half said they could nevertheless work with customers to reduce water wastage. Only two said they had actually taken any action in this regard.

Problems arising from the literature

Six of the eight said that climate change-related water issues are or could be a problem for their business. Five said that they lacked knowledge about climate change, demographics and other water stress issues in their product sourcing regions.

Five could see some or serious risk issues in the future, notably reputational but also physical or customer pressure. None said they are at the moment.

Five said the cost of water either was already or would become an issue.

Almost no one considered the other issues to be a red light either now or in the future. Most notably, given the underlying hypothesis of this dissertation, only three could see any future risk to UK food security due to water issues and only one of them saw it as a definite or serious risk.

Taking action

All except one of the interviewees said they could fully calculate the water footprint of their direct operations; the eighth said it would only ever be a partial measurement. However only two said they actually had the complete figures whilst four said they had partial figures. All except one said they would have problems calculating the water footprint of their supply chains. Only one thought they could calculate the water footprint of their customers and was trying to do so.

All except one said they could work with their supply chains to a greater or lesser extent to make them more water-efficient but only half said they were actually doing something and none said they were doing this in a comprehensive manner.

Only three said they could imagine putting an end to sourcing from water-stressed regions and all of them said it would be tough and would depend on other trade-offs eg social factors or alternative sources of supply. To date none have switched supply from a particular region because of water stress.

Obstacles and drivers

Many obstacles or missing drivers were cited to explain inaction. All said it was primarily a supply chain issue. All said there was a lack of clear methodology or that the methodology was extremely complex to apply. All except one said facts and figures, and knowing what exactly to do, were an issue.

Only three mentioned the key problem of site specificity although the concern by all about the lack of a clear methodology or complexity of applying the methodology could be seen as another way to pick this point up. It was also interesting that only three mentioned the fragmented or extensive nature of their supply chains as an obstacle, although again, this could be to some extent a question of interpretation of the issue raised about applying water footprinting methodology.

Three quarters of those interviewed said there were no civil society drivers ie customers were not complaining about water issues and NGOs were not complaining loudly enough.

Six of them cited the lack of a strong price signal as an obstacle to action. One went so far as to predict that there would be no threat to UK food supply because UK food retailers pay top prices and will therefore always be able to guarantee supply.

Five said the current focus on carbon was their primary concern or was constraining their ability to act on water. Six of the interviewees said the focus on other sustainability measures or understanding the trade-offs with other sustainability measures was an obstacle.

Government policy

There were not many suggestions for government action and several interviewees were adamant that government action, in the form of additional regulations, would be unacceptable. Four of those interviewed said the government should coordinate the use of standard methodology and promote joined up thinking in the context of general sustainability issues. Three felt the government should raise awareness and put out clear messages.

Conclusions

The state-civil society-supply chain competing forces model is of some use for analysing this, although mostly to illustrate who is not doing what (see figure 3).

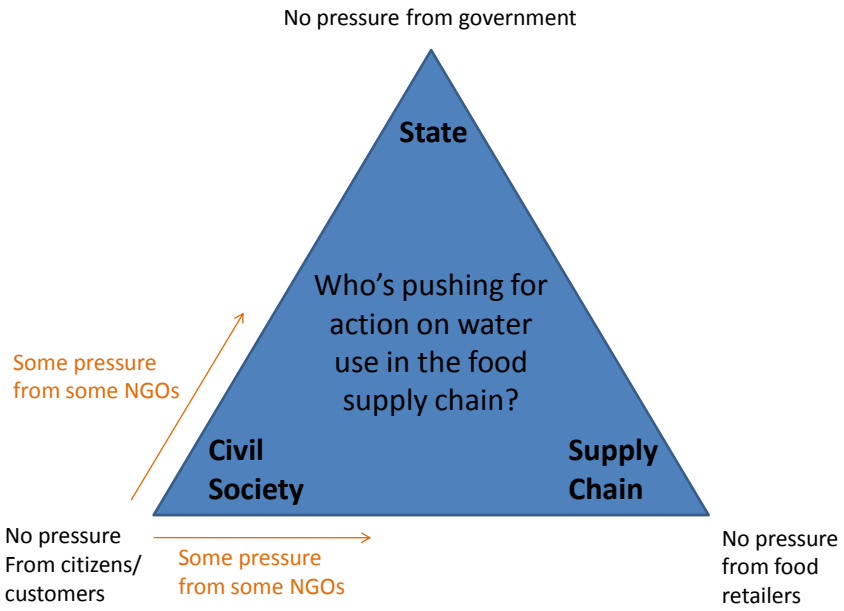

Figure 4: No pressure for action on water use in the food supply chain

The state - the UK government - is doing little because it does not believe there is currently a problem and expects the market to solve any problems if they emerge,

although there are some signs that parts of the government are starting to change their thinking.

The supply chain – in this sense taken to mean the primarily the food retailers because of their control over it – is not doing much because there are no urgent drivers for action. Food retailers claim they do not have enough information, the methodology is too complicated, there is no cost/price driver for the moment, it is not their problem, they are focused on carbon and other sustainability issues, civil society – primarily their customers - is not asking for action, and the government is not issuing guidance or setting regulations in this area.

Some parts of civil society - NGOs like WWF and Waterwise, and academics like Allan, Hoekstra, Molden et al – have done considerable work on different parts of the problem, but do not seem to have persuaded the majority of the food retailers or the government of the need to take action. Nor does their work appear to have filtered down to the public, possibly because of other sustainability issues that are easier to understand or are perceived to be more important. Arguably nobody has comprehensively pulled together the traditional and new stresses on fresh water supply and made the case for action strongly enough.

CHAPTER 7: IMPLICATIONS FOR FOOD RETAILERS

The easy stuff

1. Calculate company the water footprint of direct operations. Do a cost benefit analysis of retrofitting water efficiency measures. Require water efficiency measures in new build.

2. Map water efficiency actions being taken by supply chain. Share best practice among suppliers and farms. Work with farms wherever feasible to make agriculture more efficient eg drip methods of irrigation, repair of leaks, collection of rainwater where this does not cause problems further downstream.

3. Work with government and customers to reduce water wastage wherever possible.

4. Lobby government for standard methodology, clear messages and joined up thinking.

The hard stuff

1. Lobby government to review traditional global water risks by region eg demographics (growing population), richer population (more meat and dairy), development (urbanisation, pollution), lack of agreement on how to price of water and how to define ownership, and then overlay climate change predictions with regard to water eg too little water (lack of rainfall, long term end of glacier water supply), too much water (flooding, hurricanes), the wrong water (salinity due to sea level rises, overflowing sewers).

2. Commission product water footprints for water risky areas based on 1). The methodology exists (www.waterfootprint.org). There is no need to measure every product water footprint; only the risky ones. Make sure your supply chain understands the risks. Where possible try to help them prepare for more variability and more intensity in weather patterns eg hurricanes, flooding or drought. Prepare a contingency plan for breakdown of supply.

3. Prepare a strategy for permanent withdrawal from water stressed regions if local stakeholders are clearly pursuing an unsustainable path. The assumption should be that civil society will push on this eventually implying brand risk for you.

CHAPTER 8: IMPLICATIONS FOR GOVERNMENT POLICY

Doing nothing is not an option

Competition for water resources is likely to increase as the global population grows and as climate change makes some areas drier and other areas unable to support crops because of the intensification of rainfall over shorter and less frequent periods. In 1995, 41 per cent of the world's population - 2.3 billion people - lived in water-stressed river basins. Under current consumption patterns this number will rise to 3.5 billion (48 per cent of the world's population) by 2025. Of these, 2.4 billion will live in highly stressed water basins (World Resources Institute 2000). It is hard to see how an estimated global population of 9 billion by 2050 can be fed under a business as usual scenario. And it is hard to see how the globalised UK food supply will not be affected.

Help UK businesses with facts and figures

1. Commission research of traditional global water risks by region, then overlay climate change predictions with regard to water (see Chapter 7).

2. Coordinate the use of standardised water footprint methodology.

The combination of the above should allow businesses to be able to overlay their own product water footprints in water risky regions, to draw the necessary conclusions and to take action.

Work for proper pricing or allocation of water in the UK and abroad

Nowhere in the world is water is priced or allocated coherently. Every study says so. The literature on water pricing often confuses costs, opportunity costs, value, and price

(Goldman Sachs 2008). Externalities like scarcity, climate change risks, salinity and pollution are rarely included (Le Quesne et al 2007). Green water and blue water have different values at different times on different sites (Hoekstra et al 2005). Benefits realised from water quality and treatment services are very site specific and difficult to quantify (Bann et al 2008). Pricing water at its true value ie including all externalities is likely to lead to increased poverty unless a progressive tariff structure is used, which leads some to say that pricing cannot work and that water needs to be allocated (Le Quesne 2007).

And/or negotiate international rules on water use

There exists a multitude of confusing ways to allocate water rights. Governments need to work together to produce a coherent framework or agree to build on one already in existence. Most of the world's major rivers cross international borders, but are not covered by treaties. In the words of Fred Pearce: "This is a recipe for conflict and for upstream users to hold downstream users to ransom."

Some argue that the reason there have not been significant water wars in the Middle East, an area which is no longer self-sufficient in water, is because countries have cooperated on this issue (Allan 2002). Under this scenario nations see negotiated settlements over water rights as preferable to war and should be amenable to arbitration by an International Water Court or perhaps a beefed up World Water Council, which is already an international multi stakeholder platform. Its stated mission is "to promote awareness, build political commitment and trigger action on critical water issues at all levels, including the highest decision-making level, to facilitate the efficient conservation, protection, development, planning, management, and use of water in all its dimensions on an environmentally sustainable basis for the benefit of all life on earth."

Water aid as a key plank of foreign policy

Western discussion of Pakistan focuses on Islamist militancy, and dictatorship versus democracy. In the long term however, by far the greatest threat to Pakistan's survival as a state comes from water shortages stemming from demographics, development and climate change. Global warming is melting the glaciers that feed Pakistan's irrigation system. First the country will flood, and then it will dry up (Rowell & Lieven 2008).

Pakistan and other endangered countries need massive help and encouragement to improve their water conservation systems and reduce the present appalling level of waste. British international aid should be restructured to make addressing climate change and improving water conservation its central priority.

CHAPTER 9: WEAKNESS OF APPROACH AND GAPS IN KNOWLEDGE

Literature review

My literature review was not as exhaustive as it could have been. I restricted my search to the City Library online resource and Google Scholar. I also restricted it to food retailing and virtual water rather than a larger interpretation of water issues which was probably a mistake. I also did not explicitly search for peer-reviewed work that matched up food retailing and water issues with climate change.

The list of problems derived from the literature was probably in the wrong order and some of the problems were wrong. For example, this was a dissertation about food retailing so the issue of cotton and leather was a red herring, albeit an interesting one in terms of seeing who is aware of the problem.

The question about climate change was not clear enough about the problems other than water scarcity eg flooding or hurricanes or sewer overflows. Some of the early interviewees mentioned this and the later ones were prompted by directive questioning which meant that the interview process was not quite the same for all. Water scarcity and knowledge about sourcing region should perhaps have been merged as issues, but then again sourcing region implies more than just water scarcity. It probably would have been better to say "water issues" which could have included flooding for example.

The efficiency of farming question was the wrong way round; it should have talked about inefficiency.

Social issues were arguably missing. One of the interviewees mentioned this and said that health should also be included. This is a fair point; for example, there is a large body of literature on arsenic and fluoride poisoning in water supplies (Pearce 2006).

With hindsight the key issues are probably as follows:

- Demographics and development - including urbanisation, migration to coastal cities, pollution, increasing salinity
- Virtual water in agricultural products and water inefficiency of agriculture
- Population becoming richer and demanding more meat and dairy
- Pricing and ownership of water
- Health and social issues
- Climate change – variability of weather patterns, water scarcity, flooding, hurricanes
- Peak oil – carbon cost of water
- Risk – reputational, customer awareness
- Food security given the above

Interviews with food retailers

Quantification of the interviews was less easy than it could have been because the respondents were asked open ended questions rather than given a questionnaire inviting yes/no responses. I ended up shoehorning the answers into a data analysis structure which is more helpful than simply using quotations but not terribly scientific. That said a sample size of eight is never going to be very scientific.

The company action plan I put forward had many of the right elements but was in the wrong order. A number of the interviewees said that it made more sense to work on the lowest hanging fruit and use the '80:20 rule'. Grey water return to the environment should have been part of water efficiency measures.

Further Work

It is clear that more research is needed to quantify the increased risks to the fresh water supply of newly emerging issues like climate change when considered in tandem with the more traditional problems of demographics and development. I have suggested one approach in Chapter 8 which is for the UK government to take the lead with some general scenario planning so that UK food retailers can then overlay their own product water footprints for particularly risky regions. However if the UK government will not act, then NGOs with deep pockets could fill the gap. And at least one of the food retailers may decide to go it alone because of their ethical brand image. There is also the issue of the lack of pressure bubbling up from civil society which certainly needs further exploration.

I hope my dissertation is another brick in the wall of trying to understand what will affect UK food security in the coming decades. There is a lot of work on the traditional pressures on fresh water supply – demographics and development. There is a growing body of research on virtual water and water footprinting. There is a lot of material on climate change and peak oil. But there is not much that draws these all together. And there is nothing that links it all to food retailers in the UK and precious little on the implications for government policy.

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