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Managing our water footprint

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Summary

By 2030 two-thirds of the world's inhabitants may experience moderate to high water stress. Between 1953 and 1986 around half of the increase in agricultural production came from irrigated land but with the associated problems of groundwater and water quality reduction and waterlogging. Water footprints, whether determined in terms of nations, organisations or individuals are governed by consumption, particularly of animal derived food products, climate variations and food production practices. Individuals in the US have an average footprint of 2480m^3/capita/yr, whereas the average footprint in China is 700m^3/capita/yr. Long term, water security will only be addressed by facilitating change at all levels using a structured, measured approach.

With an increasing global population more and more attention is being given to the growing pressure on water as a natural resource. Research by the Organisation for Economic Co-operation and Development (OECD) suggested that by 2025, global water use is estimated to rise by up to 30% in developing countries and over 10% in the developed world. The research also concluded that the global population which is living in water-stressed areas is set to double over the period 1995-2025, and predictions suggest that by 2030 some two-thirds of the world's inhabitants may experience moderate to high water stress in parts of Africa and Asia. The global population has been predicted to rise from 2.56 billion in 1950 to 9.40 billion in 2050.

The earth's surface is predominantly covered in water with only 23.9% of the surface as land comprising 3.9% of the surface cultivated to arable and 1.4% as permanent crops with irrigated agriculture playing a key role in food production now and in the future. Irrigation has significantly increased food production efficiency. Estimates suggest that between 1953 and 1986 about half of the increase in agricultural production had come from irrigated land. However, this increase in global food production has led to an environmental impact in many regions of the world including:

- groundwater overdraft - removing volumes of water from groundwater that cannot be replaced naturally by the water cycle thus lowering the water table;
- water quality reduction – as water is re-used for irrigation at many points in a water shed the biological, and chemical quality can deteriorate including increased salinity; and,
- water logging – as a result of excess irrigation in soils where there is poor drainage. This can lead to a rise in the water table bring salts to the upper levels of the soil.

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[1] Louise Manning PhD, MIFST, NSch was awarded a 2007 Nuffield Farming Scholarship Trust award to study water availability and its impact on food production. She visited the US, Canada and Europe. The study entitled "Water: Managing a vital resource" has now been published and is available from the Nuffield farming Scholarship Trust. For more details about this and a fully referenced version of this paper contact: Louise by email at l.manning@btinternet.com or visit The Human Imprint http://thehumanimprint.typepad.com for full contact details.

Food production, especially irrigated food production, has to co-exist with the natural hydrological balance within a river basin as a result of rainfall, stream flows, groundwater, evaporation and transpiration. Food production is the major user of fresh water, with a world's average of 71% of the water available being used although the proportion of abstracted water that is used for agriculture varies from region to region and depends largely on natural rainfall. This figure is reversed in the UK where published figures would suggest that only 2% of water is used for national food production. The Food and Agricultural Organisation (FAO) has collected data on the volumes of water abstracted for agriculture in four regions and the data is collated in Table 1. In Latin America, water withdrawal for food production compared to available resources is 1% and this compares to 36% in South Asia and 51% in the Near East and North Africa.

Table 1: Comparison of water resources and water requirements in four regions of the world

	Total renewable water resources (km^3)	**Water withdrawal for agriculture (km^3)**	**Water withdrawal as percentage of renewable water resources**
Latin America	13409	187	1%
Near East and North Africa	541	274	51%
East Asia	8609	693	8%
South Asia	2469	895	36%

The water footprint of a country has been described as "*the volume of water needed for the production of the goods and services consumed by the inhabitants of the country*". The key drivers of a country' water footprint are:

- The degree of consumption of goods and services;
- Food consumption patterns, especially the proportion of animal derived products in the diet (dairy, meat);
- Climatic factors such as rainfall, growing conditions and the requirements for irrigation; and
- Food production practices and the degree of water use efficiency.

As supply chains are increasingly more global a particular country's water footprint can be described as a combination of its "internal water footprint" i.e. within national boundaries or "external" based on the level of imported goods and products. Water footprint can be calculated on a national, regional, family or a personal basis. Personal water footprints vary significantly from country to country based on personal demand, for example, an individual in the US has an average footprint of 2480m^3/capita/yr - this is three and a half times the average footprint of a person living in China at 700m^3/capita/yr.

Another term that is used in the debate on water security is "virtual water". Virtual water can be defined as the amount of water that has been used in the production and manufacturing of a specific product or food item. It has been suggested that the virtual water content of wheat is about 1 m^3/kg whereas the virtual water associated with meat production can vary between 5 and 13.5 m^3/kg[9]. Individual diets will have a major impact on personal water footprint and it has been calculated that for food and drink consumption alone whilst the average per capita consumption of drinking water is between 0.05 and 0.15 m^3/capita/day the per capita consumption of virtual water varies between 1 m^3/capita/day for a survival diet; 2.6 m^3/capita/day for a vegetarian diet and over 5 m^3/capita/day for a US style meat based diet. The predicted changes in global food consumption have been analysed and suggest that there has been a rise in average calorific intake from 1964 – 2030 from 2358 kcal/capita/day to 3050 kcal/capita/day. The increase in calories is one element that is driving demand for fresh water to support food production the other is the transition in many regions of the world towards a meat and dairy product based diet as shown in Table 2.

Table 2: Virtual water content of food products

Product	Virtual water content (litres)
1 hamburger (150g)	2400
Cheese (100g)	500
Chicken (100g)	390
Rice (100g)	340
1 cup of coffee (250ml)	280
1 glass of milk (250ml)	250
1 bag of potato crisps (200g)	170
Wheat (100g)	130
1 apple (100g)	70
1 slice of bread (30g)	40
1 cup of tea (250ml)	35
1 potato (100g)	25
1 tomato (70g)	13

Water security is therefore being affected by a number of drivers including increasing population, increasing calorie intake, a transition to deriving those calories from meat and animal products, and, in some societies, an increase in food waste. In order to meet these supply chain drivers we need to push more efficient water use through technological advances as well as reducing demand especially through waste reduction. The Waste & Resources Action Programme (WRAP) “Love Food Hate Waste Campaign” concluded that in the UK we throw away around one third of the food that we purchase. Analysis of the virtual water contained in just the top three fruit and vegetables that were thrown away (Table 3) shows this is equivalent to nearly 1 million m^3 per annum. If you suppose the average person uses 150 litres of water per day in their house in the UK – this equates to the water used by 18,000 people per year. This is the tip of the “iceberg” because the data analysed only represents around 5% of the food that we throw away. As meat and dairy products have a much higher virtual water content this begins to demonstrate the impact of waste food on sustaining water resources.

Table 3: Top three fruit & vegetable league table by estimated tonnage of waste per annum

Top three fruit & vegetables wasted in UK[12]	Estimated tonnage of waste per annum[12]	Numbers of avoidable fruit & vegetables wasted per day[12]	Average virtual water content[11] (l per item)	Virtual water (m^3 per annum)
Apples	179000	4,400,000	70	308,000
Potatoes	177000	5,100,000	25	130,050
Tomatoes	46000	2,800,000	184	515,200
Total				953,250

Global food supply chains provide the mechanism for countries to undertake “virtual water trade”. This means that a water-scarce region or country can import virtual water within food products and thus relieve pressure on its own water resources. They also provide a driver for regions with high rainfall where the water is accessible, and the land is suitable for agriculture, to utilise this resource for producing food for export.

Water footprint is a subject that will gain increasing focus for individuals, organisations and indeed nations. The key is to firstly recognise the issues surrounding fresh water security, and ascertain the steps required to utilise water more efficiently at all levels. However, this process is of limited value if the information derived cannot be effectively communicated so that change actually occurs. Having said this, the most difficult hurdle still remains and that is to mediate in the demand cycle by creating awareness and ownership of individual actions and decisions that lead to water wastage. This focus could ultimately be externally driven by price, but a pricing policy is a blunt instrument and will not impact on all players equally. It has been suggested that social tariffs can be embedded to offset this, but the cost of implementation of such a complex policy may well outweigh any of the potential benefits that were originally determined.

Water security will only be addressed by facilitating change at all levels. Implementing change requires a structured, measured approach so that the transition actually takes place from where you are to where you intend to be. This requires the engagement and assistance of people. People are often seen as the "problem", but they are also the solution. We must not fail to recognise this nor fail to understand the impact on their lives of the journey we are asking them to take. If, instead, we understand their perceptions and sometimes the fear of change itself, then we will succeed in meeting this challenge. Managing water as a natural resource will ultimately be achieved by awareness, empowerment and then the myriad of individual steps taken by individual people.

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RuSource briefings provide concise information on current farming and rural issues for rural professionals. They are circulated weekly by email and produced by Alan Spedding in association with the Arthur Rank Centre, the national focus for the rural church. Previous briefings can be accessed on the Arthur Rank Centre website at http://www.arthurrankcentre.org.uk/projects/rusource_briefings/index.html

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