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Urban Farm
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"He hangs in shades the orange bright, like golden lamps in a green night."
Andrew Marvell - The Mower to the glow-worms

Virtual Water:

The Burden of an range

By Miina Rautiainen

WHILE ENJOYING A GLASS of orange juice in a café, the origin of this yellow nectar rarely comes to mind. Oranges that we consume in different forms – juices, marmalades, fresh fruits – have travelled a long way, often from the other side of the globe, before reaching us. This is not surprising to most of us, considering that the weather in Ireland isn't the sunniest. But have you ever thought of how much water this small vitamin bomb has needed before arriving here?

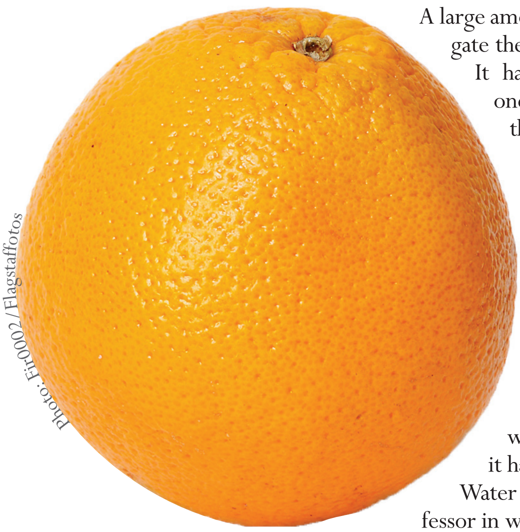


Photo: Fir0002 / Flagstaffotos

Most of the world's oranges are produced in Brazil. A large amount of water is used every day to irrigate the plants and to wash the picked fruits. It has been calculated that to produce one orange 80 litres of water is needed throughout the whole supply chain. This means each orange we buy in a supermarket has a virtual burden of 80 litres of water. This burden is also known as the water footprint.

The idea of water footprint is simple. It looks at the whole supply chain of a product and calculates the volume of water that has been used at each stage. In other words, it calculates virtual water. Water footprint was introduced by Arjen Hoekstra, and it has now been further developed by the Water Footprint Network. Hoekstra is professor in water management at the University of

Twente in the Netherlands.

He developed the water footprint in 2002, while working on the relationship between water use and consumption.

"I realised that national water use statistics, as they are usually presented, tell us very little about how people really use water. All imported products need water as well, in other countries. The water footprint of national consumption has an internal as well as an external component," he says.

The amount of water on the earth has been stable since the beginning of the time. Thanks to the energy from the sun, we have a hydrological cycle. Water evaporates from seas and continents, rains down from the clouds and flows from land to ocean through run-off. However, only a tiny fraction of all water is available for humans to use. About 70 per cent of our 'blue planet' is covered with water, but only 3 per cent of this is fresh water. Furthermore, about two thirds of fresh water resources are captured in glaciers and snow.

It is said that there is enough water for everyone. But the problem is water is not equally distributed. Currently, there are around seven billion inhabitants on the planet, and the United Nations has estimated that nearly half of that number is already living with water scarcity or water stress.

While the total amount of water doesn't change, the amount of drinkable and non-polluted fresh water does change, and it is decreasing at a rapid pace. By 2050, the world population is predicted to be nine billion. This means that increasingly scarce water resources need to be shared between an ever-increasing number of thirsty mouths.

Most of the available fresh water, around two thirds, is used globally in agriculture for food production. One fifth is used by industry, and only eight per cent is used domestically for drinking, cooking and washing. As the standard of living gets higher in developing countries, diets change towards consuming more meat; producing meat requires eight to ten times more water than growing crops.

Scientists and academics have been discussing the upcoming water crisis for years. In the 1990s, Professor Tony Al-

Photo: Wonderwater cafe

lan introduced the term 'virtual water', which was originally called 'embedded water'. He argued that virtual water might help to avoid the imminent water crises in the Middle East.

Since then, the concept of virtual water has produced heated debate in academic circles.

Allan is the co-leader of the London Water Research Group in King's College London. A member of the group, Finnish PhD researcher Suvi Sojamo describes virtual water as a concept that "illustrates the global interdependencies of our water supply and consumption, and the shared nature of water resources".

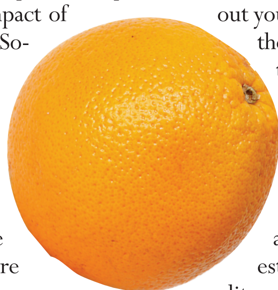
Virtual water is a theoretical approach for examining the movement of water in today's globalised world. For an ordinary person it may feel useless and distant. However, realising the effect of our own water use, and the global impact that it has, is important as water stress increases and the population keeps growing.

Recently, virtual water's practical applications, such as the water footprint, have brought it into the daily lives of many people who would not have heard the term before. Water footprint is used in the same way as the more commonly known 'carbon footprint' and 'ecological footprint'.

"The water footprint is a new measure of water consumption and pollution, a supply-chain based indicator that didn't exist beforehand and already has become an essential element in the discourse about water allocation," says Hoekstra. "It has proven to be instrumental in raising awareness, but is also increasingly used to inform governmental policy and company strategy. Of course, information about water footprints is only one input in decision making."

Naturally, virtual water is only virtual from importers' and consumers' point of view. In places where oranges grow, virtual water is as real and refreshing as the water we see running from the tap. Through the whole supply chain, on each step, real water has been used for irrigation, washing, transport and processing.

The virtual water concept can help people understand the impact of their consumption. Suvi Sojamo says:



"If meant as a concept targeted to people as consumers, it can make them aware of the global impact of their consumption. They are therefore empowered to make more sustainable choices and pressure the companies to shift towards behaving more sustainably. As citizens, virtual water could empower people to demand more sustainable trade and development policies from their governments."

Getting the information to different groups of people across society can, however, be challenging. Questions such as how to communicate it and which target should be prioritised are not easy to answer.

"The way it is currently communicated to consumers, citizens, governments and corporations could be clarified," says Sojamo. "There's still some confusion and disagreement on accounting and assessment methodologies, but it shouldn't undermine the original value of the intent of making us aware of our total water consumption."

There have been many attempts to make these rather theoretical issues more accessible. Numerous online calculators have made it possible to work out your water footprint. But still there is a question of turning the figures into something understandable.

According to Hoekstra, "The water footprint as a concept, and water footprint assessment as a methodology, is firmly established in the scientific literature. The main barrier to

Virtual water glossary

Blue water	Fresh surface and groundwater; water in lakes, rivers etc
Green water	Rain water which is stored temporarily in the soil and used by vegetation
Grey water footprint	Indicator of fresh water pollution; calculated as the volume of water that is required to dilute pollutants to such an extent that the quality of the water remains above agreed water quality standards
Virtual water	Freshwater used through the supply chain and embedded in a product, hence virtual
Water footprint	Volume of freshwater used in production of commodities and goods; can be calculated for individuals, nations, products etc.
Water scarcity	Ratio of freshwater to freshwater availability

Source: *Water Footprint Network*

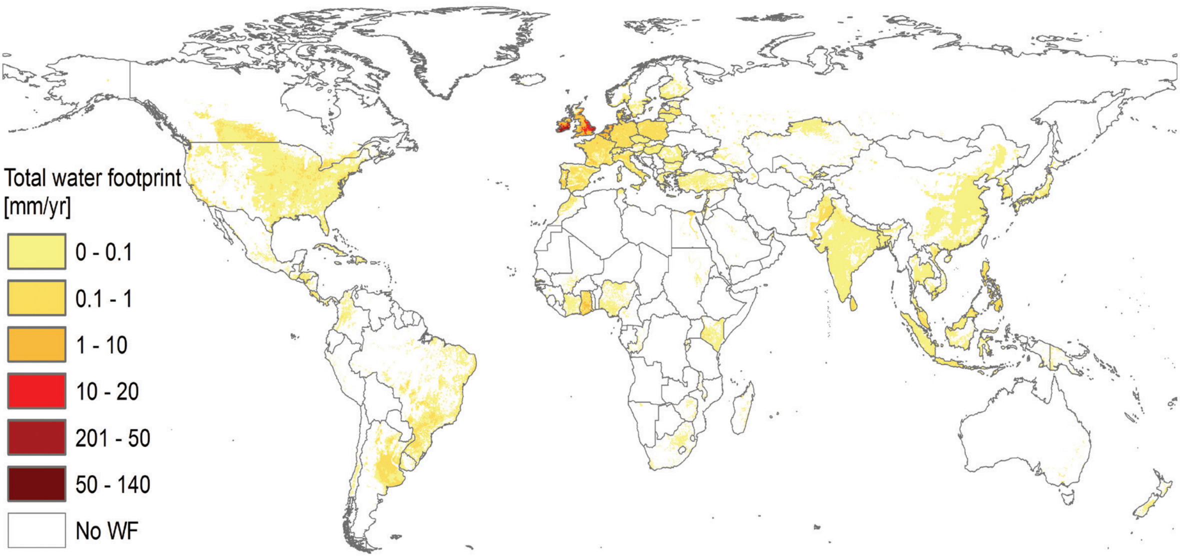


Image: Arjen Hoekstra

The origin of Ireland's water footprint, which is calculated at 1301 cubic metres per capita per year

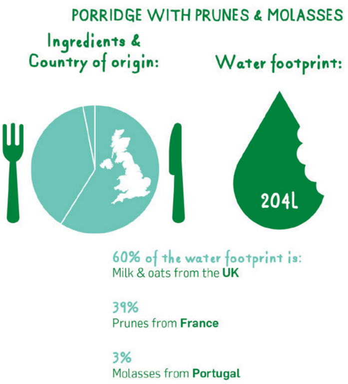
its application in policy making is still a lack of data and experience on how to integrate new insights on water footprints into the daily practice of policy makers. Currently, a lot of pilot projects on water footprint assessment are going on worldwide, in both the public and private sector, which will help to create a portfolio of case studies."

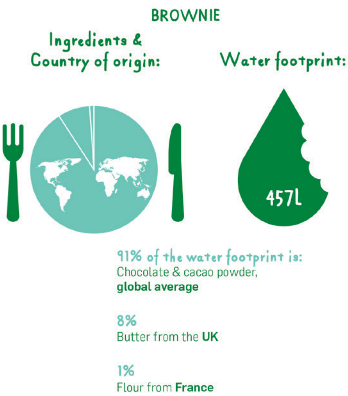
Italian Angela Morelli works on spreading the word about virtual water and tries to bring it closer to people through information design. Her infographic story on water can be read on the website of *The Reed*.

> "The main barrier is still a lack of data and experience on how to integrate water footprints into the daily practice of policy makers
>
> *-Arjen Hoekstra*

LET'S TAKE AN EXAMPLE: according to the Water Footprint Network, an average Irish person's water footprint is 1301 cubic metres annually. This is the total water footprint for Ireland, divided by the population, so it doesn't show differences in individuals' water use. In litres, this totals 1,301,000 which is about half the water of a 50 metre-long Olympic swimming pool. A bit more than two thirds of this water comes from outside the country. This means that only one third of the water in Irish water footprint originates directly from Ireland. The rest stands for indirect use, or, in other words, virtual water. Interestingly, the Irish water footprint is lower than the average global water footprint, which is 1385 cubic metres. This may be down to climate and less reliance on imported agricultural products.

However, a big water footprint is not necessarily a bad thing. The important





Images: Wonderwater cafe

question is: how is water used? Therefore, water footprints are divided into three colours which clarify water use: green, blue and grey. The blue water footprint stands for use of surface and groundwater. The green water footprint means the use of rainwater, as far as it doesn't become run-off. The grey water footprint refers to water that has been polluted during the supply chain. In the Irish example, it is likely that, as the need for irrigation is very small due to the climate, the green part of the footprint is significant.

But can knowing our water footprint really change the way we consume or use water?

"This crude sort of information will create some awareness of hidden water needs in general," says Hoekstra, "and it may also point to the main water consumers in a person's consumption pattern. For many people, this would be meat, dairy and cotton. People may adjust their consumption pattern and reduce waste, but probably even more important is that the increased level of public awareness motivates companies to start working on reducing the water footprint of their products and stimulates politicians to put freshwater concerns higher on the political agenda."

Wonderwater cafe menus illustrate the water footprint and origin of different courses

Hoekstra also says water footprint has had an impact in his own life.

"My perception of meat has changed in particular, and I have been motivated to reduce my meat consumption. Animal products are responsible for 25 to 30 per cent of the water footprint of humanity."

The question of making water footprint easier to understand was also at the core of a project called Wonderwater café. One of the curators, Jane Withers, tells that she had been familiar with the idea of water footprints for several years, and tried to explain the concept to people first in an exhibition. However, she found that this was not the most efficient way.

"This made me realise that it could be more effectively communicated in a live situation, where people were participants confronted with choices rather than observing it through info graphics in a gallery. As agriculture uses by far the largest share of global water, food was the obvious place to begin. Hence I developed the idea for the Wonderwater café," she says.

The Wonderwater café project was launched last year, in cooperation with Arjen Hoekstra himself and academics from Aalto University in Helsinki and King's College London, who were responsible for the calculations. It opened in London, Helsinki and Beijing, with the same concept adapted to fit the host venue, and the menu, space and facilities available.

"At the core of the concept is using the existing menu as a vehicle for explaining the water footprint," Withers says.

The modified Wonderwater menu (*see images on the left*) illustrates the water footprint and the origin of each course. The diner is also informed about how the water has been used. The feedback around the project was positive.

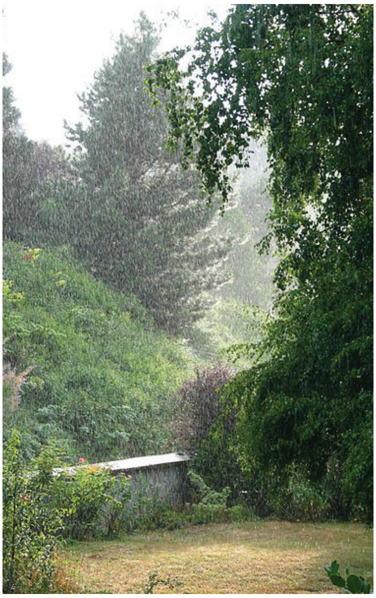
"Most people are amazed and have no idea not only about the water footprint but also how much water is used in food production and where this comes from," Withers says.

"It certainly opened the debate on global water consumption among an audience who were largely unaware of the impact, and helped to raise awareness and debate around global water issues."

Water footprint seems to be a good way of raising consumers' awareness about direct and indirect water use. However, Withers says more work is needed.

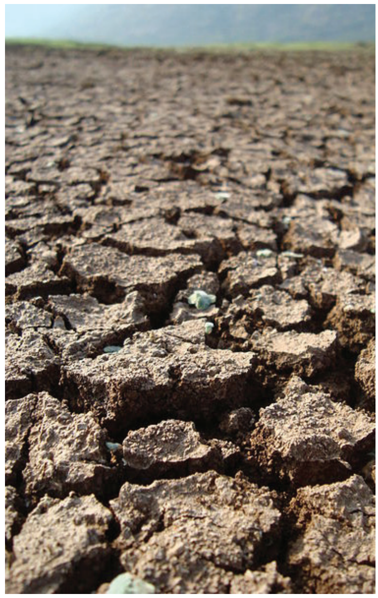
"It is a useful starting point but it is an immensely complex issue. For instance a high water footprint isn't necessarily negative – emphasis should not be on the figures alone but how we interpret them. There needs to be further work on simplifying the messaging around the water footprint and establishing a set of guidelines for a general audience."

WATER IS VITAL FOR life. Therefore, it is no surprise that water might be one of the main causes of future conflicts. Already, Photo: Axel Rouvin



Increasing productivity in the water-rich parts of the world is part of the solution, according to Arjen Hoekstra

Photo: Arivumathi via WikiCommons



changing the flow in rivers and building dams has caused tension between nations, and forced people to move. This kind of conflict of interest is likely to increase when resources get scarcer, but the number of water users grows. Some have even argued that future wars will be over water. Suvi Sojamo says that "the talk about water wars is often misleading".

"Water has been a contributing factor to the escalation of several predominantly local disputes, but has never been the sole reason for a large scale international armed conflict," she says. "Water wars are just not economically, technically nor politically feasible: it's much cheaper to ensure water security via virtual water imports or desalination than via waging an international conflict. However, this doesn't mean there wouldn't be billions of people suffering from inadequate access to water due to political reasons, national and international."

Also Hoekstra doesn't find talking about water wars very relevant.

"Wars are generally political or ethnic. Political or ethnic tensions are often fed or aggravated by economic crisis and conflict over scarce resources. In this sense, severe overexploitation of freshwater resources can surely contribute to the risk of war. But conflicts are generally complex and have a diversity of underlying factors, so talking about 'water wars' is probably a bit simplistic," he says.

Allan suggests virtual water as a one part of the solution to crisis in the Middle-East. However, it is not a magic cure that would bring peace on Earth.

"It would be difficult to prove that the concept itself had prevented any specific wars or crises," Sojamo says, "though in practice especially the Middle Eastern countries have very likely benefited from importing virtual water embedded in food rather than using their scarce resources for water intensive agricultural production."

Alongside the virtual water concept has grown the concept of virtual water trade. By analysing the virtual water streams, it is possible to see which countries are importing and which countries exporting virtual water. Through trading, the streams could become more balanced. This means that water-scarce countries could import water-intensive products, which require lot of water during production, and in this way save their own local water resources. There are already some examples, such as Jordan, of countries importing water-intensive products in order to save their own water resources.

According to Hoekstra, "The most water scarce regions in the world – where water footprints exceed sustainable supplies – include North Africa and the Middle East, South Africa, Mexico, Australia, Southern Europe and parts of the US, India and China. The solution to water scarcity in those regions doesn't lie solely within these regions. An important part of the solution will also be to increase water productivity in the water-abundant parts of the world, for example by increasing the productivity in rain-fed agriculture. International virtual water trade patterns are likely to change in the future."

Suvi Sojamo would divide virtual water trade into two different forms, either "the on-going economically invis-

> "Most people have no idea about how much water is used in food production and where this comes from
>
> *-Jane Withers*

ible and politically silent process, or informed trade policy and practices".

"When it comes to the former, virtual water imports have ameliorated water scarcity in certain arid areas. However, the global agro-food political economy is power-asymmetric, as the global 'West' and 'East' are racing towards securing their food supply internationally, protecting their markets, or subsidising their own export producers at the cost of the underdeveloped agricultural sector in the global 'South'. When it comes to the latter, possibilities vary from more efficient to more equitable water use, both locally and globally."

Sojamo also emphasizes the informing nature of virtual water:

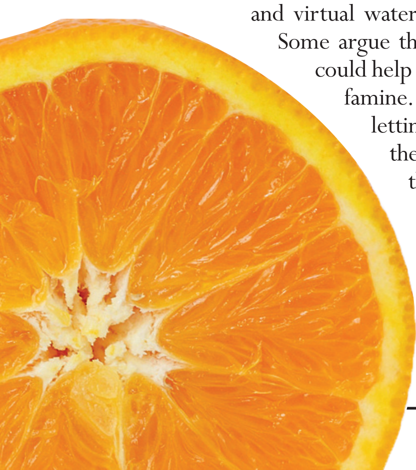
> One glass of orange juice has a water footprint of about 200 litres

"Virtual water can inform production and trade, but volumetric assessments need to take into account the wider environmental and socio-political context in any given location; whether the local context could be improved and developed by contributing to water sustainability and security in the catchment area, or whether it would be better to allocate the water resources for some other use."

Arjen Hoekstra says that "understanding water footprints and virtual water trade is part of the same challenge. The concepts are related. Virtual water flows in the global economy are factual.

"We better understand these flows, because we can never formulate policies towards sustainable, efficient and equitable water use and allocation if we don't understand water footprints and virtual water flows," he continues.

Some argue that virtual water trade could help us to find solutions for famine. Others criticise it for letting countries play with their water resources at the expense of others. Analysing the trade with different products might be the key to understanding the movement of virtual water. However, it is also very difficult as the global trading system has become more complex.



FOR INSTANCE, WE COULD look at the oranges traded to and from Ireland. In 2010 according to the Food and Agriculture Organisation of the United Nations (FAO) Ireland imported 25,500 tonnes of oranges, 28,400 tonnes of concentrated orange juice, 44,600 tonnes of single strength orange juice. The major supplier country was Brazil, from which 15,000 tonnes of single strength orange juice was directly imported. Nearly 4,000 tonnes of fresh oranges were imported directly from South Africa and about 3,000 from Egypt. Large amounts were imported through the United Kingdom, Germany and Netherlands.

However, not all the imports were consumed by Irish people. More than 30,000 tonnes were exported as concentrated or single strength juice, mostly to the UK. The exports mostly stayed within Europe but a small proportion was exported as far as the United States (103 tons single strength juice) and Chile (2 tons of concentrated juice).

On a global level, the biggest importer of oranges is Russia. The Water Footprint Network calculated that one orange has a water footprint of 80 litres. Of this 72 per cent is estimated to be green water, 20 per cent blue water and 9 per cent grey water. In total, orange juice has a water footprint of 1020 litres per one litre of orange juice. Hence, one 200 millilitre glass of orange juice has a water footprint of about 200 litres.

From this, we can draw the simple conclusion that the Russian people eating oranges imported from Brazil are indirectly using the water resources of Brazil. Through fruit trade, the water used in production of oranges is virtually transported abroad. From the Russian point of view, each orange has 80 litres of virtual water in it, and each glass of orange juice is embedded with 200 litres of water. Though, they will never see this water for real. However, from a Brazilian point of view, 80 litres of water was actually used for each growing orange, which reduced the amount of local fresh water resources.

Agriculture is the biggest water user

globally, and water efficiency in agriculture can vary a lot between different countries. Therefore, the first step before attempting to create an intensive virtual water trade, is to take a look at the way water is actually used.

"According to several studies, the virtual water trade is already contributing to global efficiency gains, especially when goods are traded from green water to blue water locations. However, first and foremost there is a lot of room for improvement in agricultural water use all around the world," says Sojamo.

"Currently only some 15 per cent of agricultural produce is traded internationally, but the volumes are growing, mostly fuelled by growing demand and changing diets. Whether this is sustainable depends on the nutritional value provided, for example soy for food or feed, and also on the wider ecological footprints of production and trade flows," she adds.

Virtual water has stirred discussion and criticism within academic circles for years and still there seem to be many unanswered questions. Creating the water footprint concept has brought it closer to the public and helps to illustrate the invisible 'virtual water cycle'. But the work is not finished yet, as new problems around water will arise and cause tensions between nations. According to Sojamo, virtual water is often misunderstood.

"It was not intended as something economically or politically imperative. A lot of caution is needed when making any type of sustainability claims. As with actual water, it is important to consider management and governance interaction and actors: whose behaviour should be changed and how if different outcomes are desired?"

Virtual water and water footprint are essentially tools for raising awareness. They don't tell us what we should do but help us to understand the wider impact of our consumption.

So, next time you are peeling your delicious and juicy orange, think about the long distance this fruit has travelled to you and the 80 litres burden it is carrying. Not so long ago it was still hanging in shades, somewhere in a Brazilian orchid, "like golden lamps in a green night". ○

Water footprints of different products:

1 kg beef	15,400 litres
1 l biodiesel (from soy beans)	11,400 litres
1 kg chicken meat	4,330 litres
1 cotton T-shirt	2,500 litres
1 kg rice	2,497 litres
1 kg potato	287 litres
A glass of milk	255 litres
A baguette	155 litres
A cup of coffee	140 litres
1 egg	200 litres
1 banana	160 litres

Source: *Water Footprint Network*