FACT SHEET 4:

SUSTAINABLE WATER AND PUBLIC HEALTH

AUGUST 2009

INTRODUCTION

Sam Lister, Health Editor for *The Times* wrote in an article entitled *Climate change is bad for your health*[1]

"As an island nation with a temperate climate and regular rainfall, Britain has never much wanted for water. Our summers are occasionally hot, mostly mild and invariably thought to be disappointing. The south of England may get hit with the odd hosepipe ban, but the popular pastimes of excessive car washing and patio cleaning are never lost for long. That we do not suffer from severe "water stress", when demand outstrips supply, is a reason the urgency of global warming goes relatively unnoticed. With water stress come crises in public health, including disease, poor sanitation and malnutrition, and climate change takes on a very human dimension.

Britain will not lack this human dimension for long. Of all the climatic shifts, water-related problems are arguably the most imminent and most personal; as the country's temperature rises and weather patterns become more extreme, health will be compromised by a lack of clean water and diseases spread by polluted floodwater. Health professionals — until now noticeable only by their absence in the climate change debate — will become increasingly important in helping us to understand and adapt to problems and in promoting behavioural changes that might avert the greatest threats."

The water cycle is a perfect example of natural recycling. Water falls as precipitation from the sky onto the land, runs towards the sea via watercourses and permeable underground strata, and then is available once more for evaporation from the seas and oceans back into the atmosphere where clouds may form. The water is available for use by man and even when contaminated by our activities will usually be restored by natural degradation processes and dilution so that the cycle is uninterrupted. At the global level, the mass of water in the system remains constant and the cycle is driven by the energy of the sun, a truly sustainable system. However, local problems occur when demand outstrips either supply or the distribution arrangements; contamination is widespread; or the water body cannot be contained in a convenient storage basin, river system or aquifer.

Water is an essential component of human life; for drinking, cooking, preparation of food, personal hygiene and domestic cleaning. In most developed nations, the arrangement for excreta disposal is also a water carriage system requiring large volumes of water for its efficient operation. Outside the home, water is also essential for agriculture and almost all industrial production.

DEMANDS FOR WATER

In England and Wales the typical domestic demand for potable water outside of emergencies is currently 148 litres/head/day.[2] Customers with meters, about one third of the population of England and Wales, typically use 8 - 20 litres/head/day less water than unmetered customers.[3] There are some uncertainties in calculating unmeasured supplies, although overall confidence in the data, which have been collected routinely for several years, is high.

In most regions, and particularly in East Anglia and the South East, total domestic demand for water continued to increase until 1995/96 and then declined. This overall trend masks increased demand in some regions caused by demographic changes. Water efficiency measures promoted by suppliers are starting to bring down the average per capita consumption to the levels of the mid-1990s. Increased use of water-saving appliances also reduces demand. However, trends towards lower levels of household occupancy may increase overall demand in the future. Savings from conservation measures average 3.6 litres/head/day, with extremes ranging from no savings at all up to 11 litres/head/day.[4]

After the major flooding which affected many parts of the UK in the summer of 2007, the Pitt Review[5] recommended that Defra (Department for Environment, Food and Rural Affairs) amends emergency regulations to increase the minimum amount of water to be provided in an emergency, in order to reflect reasonable needs during a longer-term loss of mains supply. In accordance with existing regulations,[6] at least 10 litres of water were supplied to each affected person. However, while 10 litres of water may have been acceptable in meeting the immediate and essential needs in the first few days of the emergency, it was insufficient to meet the longer term needs of the public. There were particular problems for vulnerable groups such as the chronically sick and those with young children.

Internationally, and based on estimates of requirements of lactating women who engage in moderate physical activity in above-average temperatures, the consensus is that a minimum of 7.5 litres per head per day will meet the requirements of most people under most conditions. This water needs to be of a quality that represents a tolerable level of risk. This volume does not account for health and well-being-related demands outside normal domestic use such as water use in health care facilities, food production, economic activity or amenity use.[7] The SPHERE project suggested that 15 litres of water used per head per day was the minimum standard for disaster relief.[8]

CLIMATE CHANGE

Most research to date has focused on environmental impacts rather than health impacts. Models are currently available which measure the potential impacts of climate change on water resources, agriculture, coastal zones and other sectors, but there is no well-developed tool for health.[9]

Climate change is already impacting on the UK water industry with respect to its operations (both water and wastewater), asset serviceability and maintenance, and its long-term strategic planning and investment decisions.

Key impacts include:

- An increase in the intensity, severity and frequency of extreme weather events such as droughts, storms and floods
- Reduced availability of water in rivers, reservoirs and aquifers, which also means lower quality in some cases due to reduced dilution of pollutants
- More treatment of water supplies due to lower quality of water in the environment, which costs more money and uses more energy
- Effects on existing sewerage systems, which were not designed to cope with the extremes of weather caused by climate change; more intense rainfall is likely to exceed the capacity of parts of the network and cause local flooding
- Water quality problems caused by run-off taking nutrients and pesticides from agricultural land, for example, and transferring them into rivers and lakes
- Effects on the structure and operation of dams and reservoirs, for example from increased siltation and slippage

- Pipe systems for both drinking water supply and sewerage becoming more prone to cracking as climate changes lead to greater soil movement caused by more severe wetting and drying cycles
- Increased risk to assets on the coast or in flood plains from flooding, storm damage, coastal erosion and a rise in sea level
- Discolouration and odour problems resulting from higher temperatures and more intense rainfall events
- Likely increased demand for water, particularly at times of reduced availability, exacerbating supply issues[10]

Disruptions of the water and wastewater infrastructures clearly have the potential to impact adversely on public health.

DEPARTMENT OF HEALTH APPROACH

The Department of Health's Environmental Strategy for the National Health Service[11] has identified a number of "Environmental Priority Areas" in relation to water:

1) Produce water policy and strategy
2) Water audit
3) Install meters as appropriate
4) Identify and rectify leaks
5) Ensure correct water tariff
6) Discuss potential need with local water company
7) Set objectives/benchmarks
8) Review performance

These priorities are largely directed at cost saving rather than health-driven interventions

In 2008 the Department of Health and the Health Protection Agency published their updated report on the Health Effects of Climate Change in the UK.[12] They identified three drinking-water related problems: increased rainfall (over short periods) leading to increased numbers of bacteria in surface water; increased water temperature leading to an increase in algal blooms in reservoirs; and a decrease in the efficiency of chemical coagulation: a major method of removal of microbes from drinking water. The report acknowledges that these potential impacts of climate change are unlikely to pose a threat to well-managed water treatment plants, but could cause problems for private water supplies, surface water supplies without filtration and groundwater supplies under the influence of surface water, unless they are adequately filtered.

In relation to flooding, the authors noted that there is good evidence to expect an increase in the frequency of heavy precipitation, with the greatest increases in frequency occurring for short-duration, high-intensity events. Hence an increased risk of flooding may accompany no change, or even a decrease in mean rainfall or in the duration of wet spells. The report recommends implementation of flood health risk assessments, improved implementation of interventions to reduce health impacts associated with flood events, including the better use of current measures, such as guidelines for dealing with chemical contamination of flood waters, and post-flood support and counselling, and strengthening emergency planning and preparedness.

ENVIRONMENT AGENCY VIEW

Vision: Enough water for people and the environment[13]

"Management and use of water that is environmentally, socially and economically sustainable, providing the right amount of water for people, agriculture, commerce and industry, and an improved water-related environment."

Objectives:

Adapting to and mitigating climate change

- Ecology is more resilient to climate change because abstraction pressures have been reduced and a diverse network of habitats has been allowed to develop.
- The resilience of supplies and critical infrastructure is increased to reduce the impacts of climate change.
- Flexible and incremental solutions in water resources management allow adaptation to climate change as it happens.
- Everyone is able to make more informed decisions and choices about managing water resources, protecting the environment and choosing options to avoid security of supply problems.
- Greenhouse gas emissions from using water resources are minimised and properly considered in future decisions.

A better water environment

- Measures will be in place to make sure that water bodies achieve Water Framework Directive objectives.
- Abstraction is sustainable, the environment is protected and improved and supplies remain secure.
- Environmental problems caused by historic unsustainable abstractions are resolved.
- Catchment management is integrated so that impacts on water resources and the water environment are managed together.

Sustainable planning and management of water resources

- The twin track approach of resource development with demand management is adopted in all sectors of water use.
- In England, the average amount of water used per person in the home is reduced to 130 litres each day by 2030.
- The Environment Agency targets and adapts its approach to reflect the location and timing of pressures on water resources.
- In England, water companies implement near universal metering of households, starting in areas of serious water stress.
- Leakage from mains and supply pipes is reduced.
- New and existing homes and buildings are more water efficient.
- Water resources are allocated efficiently and are shared within regions where there are areas of surplus.

Water and the water environment are valued

- Water pricing for the abstraction and use of water acts as an incentive for the sustainable use of water resources.
- Abstractors and users make informed choices to use water more efficiently.
- Innovative tariffs are adopted by water companies to maximise savings and minimise issues of affordability.
- The needs of wildlife, fisheries, navigation and recreation, as well as the environment and abstractors, are fully taken into account when allocating water resources.
- Innovative technology is developed to improve water efficiency by all water users.

WATER UK VIEW

Water UK is the trade body which represents water and wastewater service suppliers for England, Scotland, Wales and Northern Ireland. Over the last five years, significant change has come from within the industry and sustainability is now recognised as delivering business value, rather than simply being a response to regulatory requirements or philanthropy. Many companies recognise that acting in a sustainable way can attract employees, build customer trust, drive innovation, improve efficiency and save money.

In England and Wales, approximately 19 billion litres of water per day are provided from 2,100 licensed surface and groundwater abstractions. Over half of this (an average of 148 litres per head per day) is consumed by households. The level of household consumption is influenced by demographic changes and the ways in which water is used, but has not changed significantly over the last five years. In contrast, consumption by industrial and commercial sectors has been declining, reflecting in part the changing nature of UK industry.

However, a key issue for the industry is the rising cost of treating water, as raw water quality deteriorates (levels of colour, nitrate and pesticides are increasing). With climate change anticipated to exacerbate some of these problems, the industry has been investigating options and techniques across the whole of the water supply chain, from source to tap. For example, United Utilities is trialling techniques to improve raw water quality. Its Sustainable Catchment Management Programme (SCaMP) centres on land management changes to improve the condition of two upland Sites of Special Scientific Interest and improve raw water quality, while providing a sustainable income for their tenant farmers.[14]

In the UK, water and sewerage services cost, on average, less than £1 per day for domestic customers. Over the last five years, the average price of water per household in the UK has increased by approximately 20%. The challenge for the sector is to manage the cost of the provision and treatment of water and wastewater to ensure it can deliver affordable services. The price of water, or what people pay for water through bills, is regulated by Ofwat in England and Wales. The water companies in England and Wales are financed by customer bills and by private investment such as long-term loans to meet the costs of infrastructure development beyond those which are met through customer bills.

In the last five years, average household bills have risen by approximately 20% but the proportion of households who pay more than 3% of their income on water and sewerage has remained constant (approximately 9% of households). Affordability for low income and vulnerable households will continue to remain an issue.[15]

The water industry was one of the first to report its energy use and greenhouse gas emissions on a sector basis in 2005. From 2007/08 onwards, the industry regulator Ofwat has required each company in England and Wales to report emissions annually, and to consider the cost of carbon in future business planning. The water industry is responsible for about five million tonnes of greenhouse gas emissions (CO_2 equivalent) every year. Whilst this represents less than 1% of total UK emissions, it is rising. Despite improved efficiency in abstracting, treating and supplying water, population demographics and consumption growth, along with more stringent treatment standards, are driving energy use up. On average, across the UK, each megalitre (thousand tonnes) of drinking water takes 559 kWh to produce and deliver and gives rise to 0.271 tonnes of CO_2 equivalent in emissions. Again on average, each megalitre of sewage takes 756 kWh to collect and treat and produces 0.476 CO_2 equivalent in emissions. United Utilities has developed the Carbon And Sustainability Tool (CAST) to assist in making its capital investment more sustainable and carbon efficient. CAST allows the company to compare different solutions in terms of their lifetime contribution to carbon emissions and their overall sustainability. The tool was fine-tuned using the real-life example of the company's sludge strategy, highlighting the option of maximising the use of an existing sludge incinerator, rather than constructing an additional one.

LJMU / UU STUDY ON SHOWERS

If current trends continue, the quantity of water used in showers in the UK will rise from about 650 Ml/d (megalitres per day) in 2000 to over 1200 Ml/d by 2020. For comparison purposes, United Utilities supplies around 2000 Ml/d to meet the total demand for treated water across the whole of the north west of England. Showering is more complicated than a simple water volume flow process; droplet size, temperature and skin pressure are also important factors in delivering an effective shower. It is possible to design showers that operate at flow rates as low as 4 l/min. However, many pumped showers can operate at flow rates in excess of 12 l/min, though there is a requirement in the Water Supply (Water Fittings) Regulations 1999 that the water supplier must give consent prior to installation of a pump or booster that is connected directly or indirectly to a supply pipe and draws more than 12 l/min.[16]

United Utilities commissioned Liverpool John Moores University to carry out a research study of factors affecting water use in domestic showering and looked at both key physical performance criteria and customer satisfaction.[17]

The study confirmed the major challenge for the UK to implement actions that will influence water use in showers in order to minimise the potential for major increases in water and energy use in the future. The current trend is for a rapidly increasing number of customers to own showers that provide high flow-rate which, together with high frequency of use, results in water and energy use by showers often being greater than for baths. Water use for showers is currently projected to double over the next 20 years. This study estimated the volume used in filling a bath as 73 litres. Electric showers (46% of installed showers) have typical flow-rates of 3 to 8 l/min. Mixer showers without pumps (38% of installed showers) have typical flow-rates of 5 to 15 l/min. Pumped showers (16% of installed showers) have typical flow-rates of 10 to over 20 l/min. The fitting of a flow restrictor or regulator, or change of showerhead can be used to reduce the flow of a mixer or pumped shower.

The water and energy use of showers was evaluated and compared with washing using a bath. The estimated average usage rates per washing event are tabulated as follows:

	Flow-rate	Duration	Volume per event	Energy per event	Cost to customer
Electric shower	3.9 l/min	5.8 min	22.6 litres	0.95 kWh	20 p
Mixer shower (short duration)	8.0 l/min	5.8 min	46.4 litres	2.80 kWh	26 p
Mixer shower (long duration)	8.0 l/min	9.0 min	72.0 litres	4.30 kWh	40 p
Pumped shower	12.0 l/min	9.0 min	108.0 litres	6.50 kWh	60 p
Bath	n/a	n/a	73.0 litres	4.90 kWh	43 p

Note: Short and long duration alternatives are presented for mixer showers to represent the range of average values reported.

Method of washing	Water use per event	Energy use per event	Water use per household per year	Energy use per household per year	Total carbon use per household per year
Electric shower	22.6 litres	0.95 kWh	14,000 litres	580 kWh	249 kg
Mixer shower (short duration)	46.4 litres	2.80 kWh	28,000 litres	1720 kWh	327 kg
Mixer shower (long duration)	72.0 litres	4.30 kWh	44,000 litres	2650 kWh	503 kg
Pumped shower	108.0 litres	6.50 kWh	66,000 litres	3980 kWh	756 kg
Bath	73.0 litres	4.90 kWh	35,000 litres	2330 kWh	443 kg

It is difficult to determine accurately the relative use of baths and showers for personal washing. The available data have been used to estimate average annual water, energy and carbon use in the home for each method of personal washing, as in the table above. The findings from this study therefore suggest that many mixer and pumped showers may consume more water, electricity and carbon than washing by bath. This is owing to a combination of factors: water flow-rates of mixer and pumped showers can be significant, and the frequency and duration of showering are much greater than for bathing, particularly because of the ease of taking a shower.

A further finding is that the energy use in homes to heat (and pump) water for personal washing is about 70 times that used by a water company to supply the water and dispose of the wastewater. Therefore actions to reduce water use, and associated energy consumption, by showers do not only reduce water abstraction from the environment but also, very importantly, have a significant effect on the energy and carbon consumption in the home.

Water saving devices were tested by LJMU in 18 homes in order to investigate the extent to which customers were willing to accept a shower water saving device. Flow regulators were fitted in 9 homes and aerated showerheads were fitted in 9 homes. Flow regulators are effective in reducing flow-rate but can adversely impact on customer satisfaction with the shower performance, whereas aerated showerheads achieved similar savings and were more favourably viewed by users. The study has shown that showerheads are available that restrict the flow-rate of mixer or pumped showers to below 8 l/min but continue to give acceptable shower performance.

REUSING GREYWATER AND HARVESTING RAINWATER

Greywater, also known as sullage, is non-industrial wastewater generated from domestic processes such as dish washing, laundry and bathing. Wastewater from toilets is known as black water. The apparent wastefulness of using fresh drinking water to flush the toilet or water the garden partly explains the appeal of reusing bath and shower water or rain from the roof for these purposes. However, for UK homes, it is more cost effective to save water than to reuse rainwater or greywater. Also, efficiency measures save energy and CO_2 emissions, whereas greywater and rainwater systems often increase the total amount of energy used and CO_2 emitted as a result of extra treatment and pumping.[18] Even from a purely environmental point of view, cost effective measures should be prioritised as they allow greater benefits for a given outlay. For large communal domestic or commercial developments the economics may be better. Where gardens need a lot of watering, simple, low cost greywater diversion systems can save considerable quantities of water at a time of peak demand. Similarly, the humble water butt is able to capture rain from summer showers, allowing gardeners to apply the water where it is needed most.

GREYWATER RE-USE

Greywater comprises 50-80% of residential wastewater. The treatment and re-use of wastewater has to be undertaken on a relatively large scale if it is to stand any chance of being economically viable and these systems are generally more appropriate for hotels, public buildings or estate-sized schemes. Such a system is used in Melbourne, where the municipal "Council House 2" (municipal offices) development recycles sewage from the building through a membrane filtration process in the basement. Moreover, the system can extract sewage from a mains sewer running in the street adjacent to the building and treat the sewage for re-use.[19]

Although "sewer mining" does not seem to be necessary at the present time in England and Wales, there are two distinct options that do merit further consideration: the local recycling of greywater, and the local recycling of both greywater and blackwater. In addition, recycled wastewater can be mixed with harvested rainwater. The resulting water can in principle be used for garden irrigation, car-washing and for non-potable internal uses, such as toilet-flushing, via separate plumbing. This can save significant amounts of mains water.

There are several problems with these systems, however. The most obvious is the health risk associated with pathogens, in particular, in water that has not been treated to a potable standard. For example, if storage is required, the quality of the water can deteriorate rapidly as the bacteria multiply - a particular risk with greywater that has been subjected to minimal treatment. Concerns have been raised if such water is to be used for internal purposes such as toilet-flushing, that there is a risk of children and pets ingesting it or aerosol contamination of surfaces. Cross connections between the potable system and the greywater system are an additional and more realistic risk.

Problems can arise when warm, nutrient-rich greywater is stored, as it supports bacterial growth. There are currently three approaches for dealing with this problem. The first is to limit the time that the greywater is stored. These systems might incorporate an electronically controlled dump valve to empty the storage tank after a period of inactivity before refilling with mains water. The second approach is to use chemical disinfectants such as chlorine or bromine compounds that inhibit biological activity and extend possible storage time. The third approach is to treat the greywater in a small sewage treatment plant, either by using traditional biological methods or newer membrane filtration technology. The treated water is clear and free of unpleasant odours and contains little organic matter, allowing it to be stored and reused. However, this uses a significant amount of energy and is very expensive. Untreated greywater can be used for watering the garden if it is used immediately after it is produced, but in general it should not be used on edible crops. The wastewater from kitchen sinks and dishwashers is often not collected as it is too heavily contaminated.

Even if proper greywater systems are installed, there is a risk of cross-connecting the recycled water to the potable water system, in spite of the fact that the plumbing fixings are very different. Clearly, therefore, tradesmen and professional designers will need to be properly trained in installation. Strict and well-defined standards and guidelines will be needed if greywater recycling is used on a wider basis. Water recycling in the UK is currently being held back by the lack of any legally enforceable sub-potable water quality standards. If there were a universal statutory standard for sub-potable water, in contrast to the current situation where site-specific standards have to be agreed, this would help to regularise the process of re-use, and thus help to put the minds of developers and residents at rest.

Another point is the importance of ensuring that these systems are properly maintained, since problems can be caused by sediments, fats, oils and greases, discoloration and biofilms or slimes. This was a serious problem during Essex and Suffolk Water's trial of greywater recycling at the Heybridge social housing development, where the experiment was abandoned because the filters became blocked and the pumps failed. Similarly, operation and maintenance difficulties were the main problem behind the ultimate decommissioning of the Living Machine wastewater system at BedZED (the Beddington Zero Energy Development at Wallington, Surrey). Here the activated sludge stage required regular maintenance and operational adjustment, and no financial provision had been made to employ somebody to carry out these tasks. Regular maintenance is absolutely essential, but this in turn brings a cost which can be a deterrent for developers and residents.[20]

A final problem is the public attitude towards water re-use. Primarily, there is the "yuk" factor which applies to the recycling of blackwater but can also be an issue with greywater if people think too much about what may go down the plughole. The public also has very high expectations because of the excellent quality of mains water; any sub-potable quality water is viewed with suspicion.

Therefore a comprehensive programme of public education is needed if such schemes are to become anything more than an occasional novelty. A large development being constructed at Mawson Lakes in Adelaide's northern suburbs (South Australia) that re-uses both greywater and blackwater reflects the Australian public's advanced awareness of water shortage issues. Mawson Lakes features a dual water supply system, supplying drinking water and recycled water to homes via completely separate mains. The recycled water is sourced from the Bolivar Sewage Treatment plant approximately 8 km away and then has stormwater added to it from the Salisbury engineered wetlands. Residents of Mawson Lakes are now using recycled water for toilet flushing, watering the garden and washing the car. The recycled water is also being used for irrigation of public parks and reserves. The local utility company - SA Water, provides a comprehensive audit of homes within the area to ensure that cross connection between the recycled water and drinking water does not occur.[21] Altering public opinion in England and Wales will not be a rapid process. Currently, reclaiming wastewater in this country is seen as a slightly odd thing to do and acceptance will only come about when this direct recycling is seen as a normal thing to do.

HARVESTING RAINWATER

In many drier parts of the world including Australia, Bermuda, and many other small islands in the Caribbean and elsewhere, rainwater is harvested from roofs, stored in above-ground or underground cisterns and then used for all domestic purposes including potable use. Therefore, if it is correctly collected and stored, rainwater can certainly be used in this country for toilets, washing machines and watering gardens without further treatment. In practice, most domestic roof areas are too small to satisfy all this potential demand, regardless of the size of the storage cistern, so it is important to evaluate the potential savings before investing in an expensive installation.

The garden water butt is the simplest way of collecting rainwater. It does not need any treatment or mains backup, and it does not have to supply water when temperatures are below freezing. Household rainwater systems are, however, much more sophisticated and their installation is quite complex. It can be assumed that 60 per cent of the rain falling on the roof is actually collected and used. This is because there may be times when the tank is overflowing and unable to collect additional rainwater or there may be insufficient demand to use all of the water collected. Rainfall can be sporadic and so storage is needed, but the optimum tank size is usually much smaller than one might think. The Environment Agency recommends the tank is sized to hold 18 days worth of demand, or five per cent of annual yield, whichever is lower.[18]

SUMMARY

The British Isles as a whole are often seen as being a water-rich region, but in certain areas there are already difficulties meeting demand at particular times in some years. Climate change and demographic shift will increase these difficulties and force us to be more careful with the resources that we already enjoy. The most cost-effective investments that we can make are in water-saving technologies, which have the added benefit that by saving water we generally save energy too, especially if some of that water has been heated before use. Even cold water, though, needs energy for its treatment and distribution to our homes and workplaces.

Direct reclamation of wastewater is unlikely to see widespread adoption within the UK at the individual domestic level, but new housing schemes and commercial developments could incorporate some elements of greywater recycling and rainwater harvesting if the costs of supplying treated mains water rise sufficiently to alter the cost/benefit balance.

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