GEOVATION WATER CHALLENGE

DEEP DIVE OUTPUT

The Challenge: How can we improve water use in Britain, sustainably?

We held the Water Challenge deep dive on 27 October 2015 at the Geovation Hub in London.

From this, 24 people who were familiar with issues to do with water – including water companies, recreational water users and people close to government policy – identified 66 raw problems.

We've summarised these into 41 problems explaining why they matter, and have grouped them into five key themes:

1. TOO LITTLE WATER
2. TOO MUCH WATER
3. POOR WATER QUALITY
4. AGEING INFRASTRUCTURE
5. WATER USE BEHAVIOUR

1. TOO LITTLE WATER

1.1
Rain vs. sunshine

PROBLEM

Striking a balance between sunshine and adequate water availability – needed for plants to grow.

WHY IT MATTERS

70% of land in England is farmed (Parliamentary Office of Science and Technology 2014). UK summer rainfall is due to decrease by 20-40% and more than 50% in southeast regions by the 2080s due to climate change (Bisgrove and Hadley; Centre for Horticultural and Landscape 2002).

1.2
Competing water demands

PROBLEM

70% of land in England is farmed (Parliamentary Office of Science and Technology 2014). UK summer rainfall is due to decrease by 20-40% and more than 50% in southeast regions by the 2080s due to climate change (Bisgrove and Hadley; Centre for Horticultural and Landscape 2002).

WHY IT MATTERS

The UK's population is projected to rise by almost 10 million by 2040 (ONS 2015).

1.3
My dry garden

PROBLEM

Water is distributed unevenly throughout the year. In dry periods, high quality drinkable water is often used to maintain gardens.

WHY IT MATTERS

Since the 21st century gardening has become a leading hobby in Britain: 27 million people are estimated to own or have access to a garden, with gardens contributing to a multi-billion pound industry (Calnan, 2002).

1.4
Taking out salt

PROBLEM

Despite sea water being an almost infinite resource, it's salty and non-potable. However, it is energy intensive and expensive to remove salt from sea water.

WHY IT MATTERS

Only up to 1% of all global water is available as freshwater; 97% is in our oceans (Foundation for Water Research 2015).

THEME I
References

1.1 Rain vs. sunshine

Parliamentary Office of Science and Technology (2014) *Diffuse Pollution of Water by Agriculture*. Postnote Number 478. POST: London.
Bisgrove, R. and Hadley, P. (2002) *Gardening in the Global Greenhouse: The Impacts of Climate Change on Gardens in the UK*. Technical Report, University of Reading: Reading.

1.2 Competing water demands

Office for National Statistics (2015) *What do the 2014-based National Population Projections show?* [Online]. Available at: http://ons.gov.uk/ons/rel/npp/national-population-projections/2014-based-projections/sty-1.html [23 November 2015].

1.3 My dry garden

Calnan, M. (2002) *A Desktop Study of Climate Change Impacts on Gardens*. Presentation at the UKCIP Users' Forum, 8 & 9 May, London.

1.4 Taking out salt
Foundation for Water Research (2015) *Desalination for Water Supply*, FWR: Marlow. [Online]. Available at: http://www.fwr.org/desal.pdf [5 November 2015].

2. TOO MUCH WATER

2.1
What's flooded now?

PROBLEM

Official real-time information about flooding only describes risk in terms of a fixed parcel of land. It doesn't include details about populations on-the-move. There's a growing need for up-to-date, real-time location-based information.

WHY IT MATTERS

A survey following the 2007 Gloucestershire floods found that only around 20% of respondents had sufficient information about flood-related matters that allowed them to prepare effectively for the flooding (British Red Cross 2013).

2.2
Catchment requirements captured

PROBLEM

There's a lack of understanding around spatial relationships and interdependencies in the wider water cycle. This leads water companies to spend more, take longer investigating problems and make sub-optimal decisions.

WHY IT MATTERS

There's a complex interaction between flood management, growing food and biodiversity – one that needs better understanding and consideration. For soil under trees, for example, water infiltrates 67 times faster than in soil under grass. Also, many catchments across the UK have removed trees which causes water to flow downstream to flood settlements (Royal Institute of British Architects 2014).

2.3
Report my flood

PROBLEM

Continuous flood monitoring is currently limited to strategic locations. For example, remote sensing is expensive and often limited to a time and space, yet millions of on-the-ground 'eyes and ears' and mobile sensors provided by the population are not captured and used.

WHY IT MATTERS

Flooding in 2012 cost £3.2 billion to resolve. It costs the Met Office around £48 billion per year to provide flood warning information (Gray, BIS 2015).

2.4
Clear my river

PROBLEM

The Environment Agency and local authorities can't often clear rivers and channels to the extent communities might like, because of competing priorities and finite resources. Also, there's a lack of awareness around who owns channels and guidelines on community responsibilities.

WHY IT MATTERS

Almost 50% of England and Wales' total population live within five miles of watercourses (Canal & River Trust 2014).

2.5
Dredge or not to dredge

PROBLEM

Dredging and channel management is a contentious, political issue. To allow for a fair debate about the practical benefits of dredging, we need a way of mapping how the physical characteristics of a catchment might lend itself to dredging.

WHY IT MATTERS

Farmers in Somerset claim that a lack of river dredging has worsened the impact of flooding in the area, with 42% silted up (Bell 2014, BBC News).

2.6
Finding breach hotspots

PROBLEM

Embankments can fail to protect land from flooding. This tends to occur at embankment transition points, for example where they cross paleo-channels or there's a change of farm or materials. Embankment failures happen with little warning and are difficult to forecast.

WHY IT MATTERS

Storm surges by Hurricane Katrina in 2005 breached many levees which caused 75% of New Orleans' city to flood (Kayen et al 2005).

2.7
SuDS mapping

PROBLEM

Areas with a high potential to benefit from sustainable urban drainage systems (SuDS) are not currently mapped. There needs to be a better way to identify opportunities (new and retrofitting).

WHY IT MATTERS

Around three million properties are at some risk of surface water flooding (Environment Agency 2014).

2.8
Nature needs engineering

PROBLEM

Natural soft and green engineering techniques can be cheaper and more sustainable than traditional engineering solutions, yet uptake of this approach is much slower. To help encourage uptake, we need maps that show suitable areas where geographical, social and economical factors combine.

WHY IT MATTERS

Seven of the UK's 10 wettest years have occurred since 1998, with 2014 being the fourth wettest year on record (Met Office 2015).

2.9
Groundwater flooding

PROBLEM

Groundwater flooding is difficult to map and predict, and therefore difficult to mitigate. It can happen over a very long period of time, having knock-on effects on sewers, drains and rivers. We need to combine and improve various sources of information to help people minimise the impact of high groundwater levels.

WHY IT MATTERS

Around 250,000 properties are at risk from groundwater flooding (DEFRA 2004; UK Groundwater Forum).

THEME 2
References

2.1 What's flooded now?

British Red Cross (2013) The Experience of Flooding in the UK: A research study, British Red Cross: London.

2.2 Catchment requirements captured

Royal Institute of British Architects (2014) *Building a Better Britain: A vision for the next Government.* [Online]. Available at: https://www.architecture.com/Files/BuildingaBetterBritainReport.pdf [5 November 2015].

2.3 Report my flood

Gray, M. (2015) *Public Weather Service Value for Money Review*, Department for Business, Innovation and Skills: London. [Online]. Available at: http://www.metoffice.gov.uk/media/pdf/c/a/PWS_Value_for_Money_Review_-_March_20151.pdf [5 November 2015].

2.4 Clear my river

Canal & River Trust (2014) *Working together for the well-being of our canals, rivers, wildlife and people.* [Online]. Available at: https://canalrivertrust.org.uk/media/library/7747-ka-10-year-strategic-plan.pdf [4 November 2015].

2.5 Dredge or not to dredge?

Bell, S. (2014) *Would river dredging solve floods?*, BBC News. [Online]. Available at: http://www.bbc.co.uk/news/uk-25911391 [10 November 2015].

2.6 Finding breach hotspots

Kayen, R., Collins, B. and Gibbons, H. (2005) *USGS Scientists Investigate New Orleans Levees Broken by Hurricane Katrina*, US Geological Survey. [Online]. Available at: http://soundwaves.usgs.gov/2006/01/ *[16* November 2015].

2.7 SuDS mapping

Environment Agency (2014) *Flood and coastal erosion risk management: Long-term investment scenarios (LTIS) 2014*, Environment Agency: Bristol. [Online]. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/381939/FCRM_Long_term_investment_scenarios.pdf [23 November 2015].

2.8 Nature needs engineering

Met Office (2015) *State of the UK climate 2014*. [Online]. Available at: http://blog.metoffice.gov.uk/tag/wettest/ [Accessed 16 November 2015].

2.9 Groundwater flooding

DEFRA (2004) *Making space for Water*, DEFRA: London. [Online]. Available at: http://www.look-up.org.uk/2013/wp-content/uploads/2014/02/Making-space-for-water.pdf [10 November 2015].

UK Groundwater Forum *What is groundwater flooding?* [Online]. Available at: http://www.groundwateruk.org/faq_groundwater_flooding.aspx [16 November 2015].

3. POOR QUALITY WATER

3.1 Rain-driven pollution

PROBLEM

The quality of bathing water is affected by surface water runoff (caused by heavy rainfall events, for example from highways, drains, sewers, pavements). There's no real-time understanding of where, when and how pollution by this rainfall will deteriorate water quality, meaning it's difficult to prepare a response. Poor bathing water quality has an impact on tourism and aquaculture.

WHY IT MATTERS

2014 was the wettest winter on record (Met Office 2014). Climate change will increase the frequency and intensity of rainfall events across the UK, generally during the winter time (DEFRA 2012).

3.2 Pollution from farms

PROBLEM

Pollution from farming is difficult to address because there are lots of small point sources from individual owners. Runoff from farming operations can pollute water sources with soil and chemicals. This causes reduced water quality, some species to die out and it becomes difficult for aquifers to recharge. It's also expensive to clean up. Poor water quality has an impact on local businesses.

WHY IT MATTERS

Farming is responsible for contaminating up to 40% of rivers with phosphate. In 2005, half of rivers in England and Wales had a high concentration of phosphate. Two-thirds of groundwater is subject to or at risk of diffuse pollution, and one-third of groundwater supplies England's drinking water (Environment Agency 2007).

Water bodies can't achieve the desired water quality and part of the reason for this is that 25% comes from agricultural water pollution (DEFRA 2015). Coastal tourism across England and Wales is worth £7 billion and provides over 210,000 jobs (National Coastal Tourism Academy 2015). The UK water industry spends around £39 million per year removing nitrates from drinking water (DEFRA 2004).

3.3 Working with nature

PROBLEM

Natural processes (for example managing catchments and creating wetlands) can help improve water quality, availability and reduce flooding. However, it's difficult to identify the best places for these processes.

WHY IT MATTERS

Ecosystem services can be more cost-effective than traditional 'grey' engineering solutions. For example in Oregon, the USA, farmers were paid $6 million to plant trees on their land along streams, to help improve water quality. In comparison, $60 million was spent on refrigeration systems to cool water in order to meet temperature standards (Scarlett and Boyd 2011).

3.4
Predicting eutrophication

PROBLEM

Predicting eutrophication which is toxic to fish, is a complex problem to solve. There are many influencing factors as well as being financially and logistically difficult to clean up. Excessive nutrient concentrations (phosphate and nitrates) in watercourses lead to algal blooms. These remove oxygen from water and choke the riverbed which causes problems for fish, invertebrates and other wildlife.

Risk is greater when river flows are low and temperatures are warm. We need to find ways of including citizen science into the Environment Agency's evidence. The amount of phosphate that enters the system needs to be reduced in the first place.

WHY IT MATTERS

Eutrophication costs an estimated at £54-96 million per year in damages (Environment Agency 2012), and the risk to human health can have a heavy impact on tourism – such as outdoor swimming (Wainwright 2010, Guardian).

3.5
Inland swimming locations

PROBLEM

It's difficult to find appropriate locations for inland swimming. Inland locations have different water quality considerations to the coast.

WHY IT MATTERS

Just less than one million people participate in outdoor swimming every month in England alone. This equates to over 10% of the population above 16 years old (Comley and Mackintosh; Liverpool John Moores University).

3.6
Aqua acid

PROBLEM

Acidification is linked to inducing carbon dioxide which destroys sea life.

WHY IT MATTERS

Acidification is lethal to fish. Three billion people worldwide rely on fish for animal protein. Currently the most productive fishing ground hotspots are confined to only 10% of the world's oceans (UNEP 2010).

3.7
Washing away soils

PROBLEM

When farmers apply synthetic fertiliser to their crops it degrades agricultural soil. This has an impact on the water holding capacity; it can cause rapid runoff and exacerbate erosion, pollution and poor water quality. Excessive siltation can block spawning gravels for fish and damage other wildlife habitats such as invertebrates and white clawed crayfish. It also leads to flooding problems downstream and problems around drinking water abstraction sites.

WHY IT MATTERS

75% of sediments and 65% of nitrates that pollute water bodies come from farming. 'Good ecological status' is only met by 24% of water bodies in England, 36% in Wales, 65% in Scotland and 22% in Northern Ireland (Global Food Security).

When large soil particles settle and sediment, this impacts water quality and fisheries. It also causes aquatic vegetation to grow which can increase flood risk (DEFRA 2009). In an intensely monitored agricultural catchment in northwest England, up to 90% of sediment and 75% of phosphate was transferred in high flows and runoff events in the 2011-12 hydrological year (EdenDTC 2013).

3.8
Plastic from pollution

PROBLEM

Various pollutants (for example micro plastics from dumped waste) can wash into rivers, streams, urban drainage and other pipes which can damage local and downstream ecology. Micro plastics can be ingested by wildlife and passed through the food chain, risking wildlife and human health.

WHY IT MATTERS

In 2014 a study was conducted that estimated 5.25 trillion plastic particles present floating on the ocean surface (Environmental Health Perspectives 2015) and around eight million tonnes of plastic into the ocean each year (DEFRA 2015).

Plastic in the ocean pollutes the marine environment, harming sea life. It can affect the bird population and has an impact on human health, causing cancer, reproductive problems, birth defects, infant brain development, diabetes and asthma (WWF 2006).

3.9
Stop sea sickness

PROBLEM

Sample data on the quality of bathing water is only taken during the months of May to September. Readings taken between October and April are not made publicly accessible (DEFRA 2014), despite data for this term being recorded. This means that during this time, recreational water users cannot know the safety of the water.

Also, the quality of water can change suddenly, however shorter-term data isn't recorded because real-time or in-situ monitoring doesn't exist. The Surfers Against Sewage (SAS) real-time water quality information service, the Safer Seas Service, warned users for free and in real-time when almost 1,000 sewer overflow discharges impacted approximately 150 UK beaches during the 2015 bathing season (15 May–30 Sept). There were nine consecutive days of sewer overflow discharges at the end of August (including the bank holiday weekend), at several beaches in the Safer Seas Service.

WHY IT MATTERS

Around 20 million people go to the British coast every year (Pond, Environment Agency 2002). Surfing alone is worth £1.8 billion to the UK (Mills and Cummins 2015) and coastal tourism in England and Wales alone generates more than £7 billion for our economy (NCTA 2015).

The World Health Organisation recommends that people avoid using the sea for 24–48 hours after a sewer overflow discharges (WHO 2003). In England and Wales there are 1.3–2.2 million cases of stomach upsets per year, related to poor bathing water quality (Economics for the Environment Consultancy 2002). There are 25,000-31,000 sewer overflows around the UK that can act as point source polluters (Marine Conservation Society 2011), sometimes discharging untreated human sewage and storm water after periods of heavy rain or during breakdowns in the sewerage system.

If the current testing regime is not robust enough to identify these impacts, coastal communities are denied of their opportunity to make the improvements needed to protect water users and the coast. The majority of recreational water users contacting SAS after they have fallen ill report ear, nose and throat infections and gastrointestinal problems, but there are also more concerning illnesses implicated.

3.10
Polluted dry rivers

PROBLEM

A lack of rain means that river pollutants are not diluted.

WHY IT MATTERS

In the UK in 2012, one in four days were in drought whilst one in five days were in flooding (London Wildlife Trusts 2014).

3.11
Beyond regulation

PROBLEM

Environmental regulators license businesses to dispose of certain volumes of waste products into our rivers and lakes. If we find new ways to remove harmful products at the source and from manufacturing processes, this could enable new win-win restorative options that go ‘beyond regulation’.

WHY IT MATTERS

There’s a role for place-based data. It will help the UK to step beyond regulation and work with businesses and the government to create transparent and restorative manufacturing processes. This would help to eliminate the 20% of contaminants that create 80% of the problem (Suff 2011, The Environmentalist).

By way of example, in the turn of the 21st century an investigation was carried out which found that of the 10 companies that supply both water and sewage services in England and Wales: 7/10 reported their work is against DEFRA’s UK guidelines only; 3/7 reported using other guidelines combined with UK standards, for example Water UK sustainability indicators; and only 2/7 considered international reporting guidelines. In total, only 4/10 officially published reports on sustainability, the environment, quality and conservation, and social responsibility (Bichta 2003, Bath University).

THEME 3
References

3.1 Rain-driven pollution

Met Office (2014) *Wettest winter for England and Wales since 1766*. [Online]. Available at: http://www.metoffice.gov.uk/news/releases/archive/2014/early-winter-stats [23 November 2015].

DEFRA (2014) *UK Climate Change Risk Assessment: Government Report*, The Stationary Office: London. [Online]. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69487/pb13698-climate-risk-assessment.pdf [23 November 2015].

3.2 Pollution from farms

Environment Agency (2007) *The unseen threat to water quality: Diffuse water pollution in England and Wales report - May 2007*, Environment Agency: Bristol. [Online]. Available at: http://www.fwr.org/WQreg/Appendices/EA_Diffuse_Pollution_Report_geho0207bzlvee_1773088.pdf [9 November 2015].

DEFRA (2015) *Consultation on new basic rules for farmers to tackle diffuse water pollution from agriculture in England*, DEFRA: London. [Online]. Available at: https://consult.defra.gov.uk/water/rules-for-diffuse-water-pollution-from-agriculture/supporting_documents/Consultation%20document_New%20basic%20rules%20for%20farmers.pdf [23 November 2015].

National Coastal Tourism Academy (2015) *Coastal Tourism in 2015*. [Online]. Available at: http://coastaltourismacademy.co.uk/news/article/coastal-tourism-in-2015--our-new-report [9 November 2015].

DEFRA (2004) *Developing Measures to Promote Catchment-Sensitive Farming*. A joint DEFRA-HM Treasury Consultation. June 2004. DEFRA: London.

3.3 Working with nature

Scarlett, L. and Boyd, J. (2011) *Ecosystem services: Quantification, policy applications, and current federal capabilities*, Resources for the Future Discussion, 11-13.

3.4 Predicting eutrophication

Environment Agency (2012) *Freshwater eutrophication*, Briefing note for 10.12.2012 workshop. [Online]. Available at: http://pubs.acs.org/doi/abs/10.1021/es020793k [9 November 2015].

Wainwright, M (2010) *UK's biggest outdoor swimming event postponed due to algae*, Guardian, 3 September 2010. [Online]. Available at: https://hurricane.ordnancesurvey.co.uk/sport/2010/sep/03/,DanaInfo=www.theguardian.com+swimming-event-postponed-algae [16 November 2015].

3.5 Inland swimming locations

Comley, V. and Mackintosh, C. *The Economic Impact of Outdoor Recreation in the UK: The Evidence*, Reconomics, Liverpool John Moores University. [Online]. Available at: http://www.sportandrecreation.org.uk/sites/sportandrecreation.org.uk/files/web/Reconomics%20-%20The%20Evidence.pdf [9 November 2015].

3.6 Aqua acid

UNEP (2010) *Environmental consequences of ocean acidifcation: A threat to food security*, UNEP: Kenya. [Online]. Available at: http://www.unep.org/dewa/Portals/67/pdf/Ocean_Acidification.pdf [9 November 2015].

3.7 Washing away soils

Global Food Security, *Agriculture's impacts on water quality*, Farming and Water 1, Sub report. [Online]. Available at: http://www.foodsecurity.ac.uk/assets/pdfs/agriculture-water-quality-report.pdf [9 November 2015].

DEFRA (2009) *Protecting our Water, Soil and Air: A code of good agricultural practice for farmers, growers and land managers*, TSO: Norwich. [Online]. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/268691/pb13558-cogap-131223.pdf [9 November 2015].

DEFRA Eden Demonstration Test Catchment (2013) *Moorland Catchment Water Quality*, EdenDTC. [Online]. Available at: http://www.edendtc.org.uk/2013/04/morland-infosheet-now-available/ [16 November 2015].

3.8 Plastic from pollution
Environmental Health Perspectives (2015), *New link in the food chain? Marine plastic pollution and seafood safety*, Environmental Health Perspectives, 123, 2, 34-41. [Online]. Available at: http://ehp.niehs.nih.gov/wp-content/uploads/123/2/ehp.123-A34.alt.pdf [9 November 2015].
DEFRA (2015) *Plastic bag numbers rise for the fifth year*. [Online]. Available at: https://www.gov.uk/government/news/plastic-bag-numbers-rise-for-the-fifth-year [10 November 2015].
World Wildlife Fund (2006) *Chain of Contamination: The Food Link*, WWF: Surrey. [Online]. Available at: http://www.wwf.org.uk/filelibrary/pdf/contamination.pdf [9 November 2015].

3.9 Stop sea sickness
Pond, K. (2002) *Recreational Water Quality Objectives and Standards: Phase 1 - data collection, presentation and recommendation*, Environment Agency: Bristol.
Economics for the Environment Consultancy Ltd (2002) *Valuation of Benefits to England and Wales of a Revised Bathing Water Quality Directive and Other Beach Characteristics Using the Choice Experiment Methodology*. [Online]. Available at: http://webarchive.nationalarchives.gov.uk/20130402151656/http://archive.defra.gov.uk/environment/quality/water/waterquality/bathing/documents/bw_study4a.pdf.
Mills, B. and Cummins, A. (2015) *An estimation of the economic benefits of surfing to the United Kingdom economy*, Tourism in Marine Environments, 11, 1, 1-17. [Online]. Available at: https://www.cognizantcommunication.com/component/content/article/832 [9 November 2015].
National Coastal Tourism Academy (2015) *Coastal Tourism in 2015*. [Online]. Available at: http://coastaltourismacademy.co.uk/news/article/coastal-tourism-in-2015--our-new-report [9 November 2015].
World Health Organisation (2003) *Guidelines for safe recreational water environments, 1, Coastal and fresh waters*. [Online]. Available at: http://apps.who.int/iris/bitstream/10665/42591/1/9241545801.pdf [17 November 2015].
Marine Conservation Society (2011) *Combined sewer overflows. Pollution Policy Position Statement*. [Online]. Available at: http://www.mcsuk.org/downloads/pollution/CSO%20policy.pdf [17 November 2015].

3.10 Polluted dry rivers
London Wildlife Trusts (2014) *A new way to manage water: A community led management strategy for Herne Hill, South London*. [Online]. Available at: http://www.wildlifetrusts.org/sites/default/files/a_new_way_to_manage_water_-_live_draft_feb_2014.pdf [28 October 2015].

3.11 Beyond regulation
Suff, P. (2011) *Regulation in an age of austerity*, The Environmentalist, 15 April 2011. [Online]. Available at: http://www.environmentalistonline.com/article/regulation-age-austerity [17 November 2015].
Bichta, C. (2003) *Corporate Social Responsibility: A Role in Government Policy and Regulation?*, Centre for the Study of Regulated Industries, The University of Bath: Bath. [Online]. Available at: http://www.bath.ac.uk/management/cri/pubpdf/Research_Reports/16_Bichta.pdf [17 November 2015].

4. AGEING INFRASTRUCTURE

4.1
Map my poo

PROBLEM

A major cause of water pollution incidents is misconnections – from properties to drainage and sewage network systems. We need a comprehensive understanding of where stuff goes once it enters a drain.

WHY IT MATTERS

Approximately 140,000 properties are misconnected (Chartered Institute of Plumbing and Heating Engineering). It costs water companies an estimated £450 million per year to investigate misconnections and an additional £42 million to fix the drainage (Welsh Water).

4.2
Sealed surface expansion

PROBLEM

The regulations around laying down impermeable surfaces are indirect and complex. Impermeable surfaces prevent water from infiltrating into the ground, resulting in rapid runoff which leads to flooding and increases water pollution.

WHY IT MATTERS

A 10% increase in green space cover can reduce surface runoff volumes during heavy rainfall by 14%, compared to runoff rates of 60-70% for hard landscaped urban areas (Chartered Society of Designers 2011). 12,000-16,000 new houses in England are built in flood risk zones each year, with over a third more ‘high risk’ homes built since 2012 (Royal Institute of British Architects 2014).

4.3
Where are my pipes?

PROBLEM

A lot of critical water infrastructure is locked underground. It leaks, blocks and collapses sporadically which causes flooding, pollution and is a waste of clean, treated drinking water. There’s little understanding about where most of the problems lie, making the infrastructure difficult to manage.

WHY IT MATTERS

UK sewers add up to a total length of 624,000 km (DEFRA 2012), with only a quarter of the network being monitored for overflows. There are around 25,000-31,000 combined sewer overflows in the UK per year (Marine Conservation Society 2010). 20% of treated water is lost to leakage (WWT 2015).

4.4
Fish migration barriers

PROBLEM

There are around 28,000 known barriers in rivers in England and Wales that prevent fish movement and impact the fisheries economy.

WHY IT MATTERS

There are one million anglers in England and Wales, supporting £1 billion of household income and 37,000 full-time national jobs (Environment Agency 2009).

4.5
Don’t dig again

PROBLEM

Water infrastructure is ageing and as more areas are becoming urbanised, impermeable surfaces are trapping more rainfall which leads to flooding. It costs a lot to replace or refurbish sewage infrastructure and it also causes massive disruption to dig up roads, houses, gardens, parks etc. to renew them.

WHY IT MATTERS

London’s main sewer network has been fundamentally unchanged for almost 150 years. Originally built for a population density of <7,000 per square kilometre, it now serves a population density of >18,000 per square kilometre. 2mm of rainfall in certain parts of London can cause sewers to overflow because the infrastructure is ageing. These overflows discharge sewer contents into the River Thames on average once or more per week (Thames Water 2014).

4.6
Eel screening alternatives

PROBLEM

Under UK eel regulations, all abstractions over 20m3/day are required to be screened using a 2mm mesh screen – to prevent trapping eels. This is costly and can decrease water flow for hydropower schemes. It can also lessen the argument for protecting eels.

WHY IT MATTERS

Eel populations have fallen by over 95% since the 1980s (Environment Agency).

THEME 4
References

4.1 Map my poo

Chartered Institute of Plumbing and Heat Engineering. *Plumbing Misconnections.* [Online]. Available at: http://www.ciphe.org.uk/consumer/safe-water-campaign/plumbing-misconnections/ [5 November 2015].

Welsh Water *Misconnections Matter - the facts*. [Online]. Available at: http://www.dwrcymru.com/en/My-Wastewater/Misconnections.aspx [5 November 2015].

4.2 Sealed surface expansion

Chartered Society of Designers (2011) *Understanding the Contribution Parks and Green Spaces can make to Improving People's Lives*. [Online]. Available at: http://en.calameo.com/read/00087401259cc61bceeaf [4 November 2015].

Royal Institute of British Architects (2014) *Building a Better Britain: A vision for the next Government*. [Online]. Available at: https://www.architecture.com/Files/BuildingaBetterBritainReport.pdf [5 November 2015].

4.3 Where are my pipes?

DEFRA (2012) *Bathing Waters*. [Online]. Available at: https://www.gov.uk/government/collections/bathing-waters [Accessed 4 November 2015].

Marine Conservation Society (2010) *Good Beach Guide: The UK Guide to Clean Sites*. [Online]. Available at: http://www.mcsuk.org/downloads/pollution/gbg/Good%20Beach%20Guide%202010.pdf [3 November 2015].

Water and Wastewater Treatment (2015) *Digging Deeper: Meeting the 20:20 Challenge*. [Online]. Available at: http://wwtonline.co.uk/features/digging-deeper-meeting-the-20-20-challenge#.VkoJDrfhBdg [16 November 2015].

4.4 Fish migration barriers

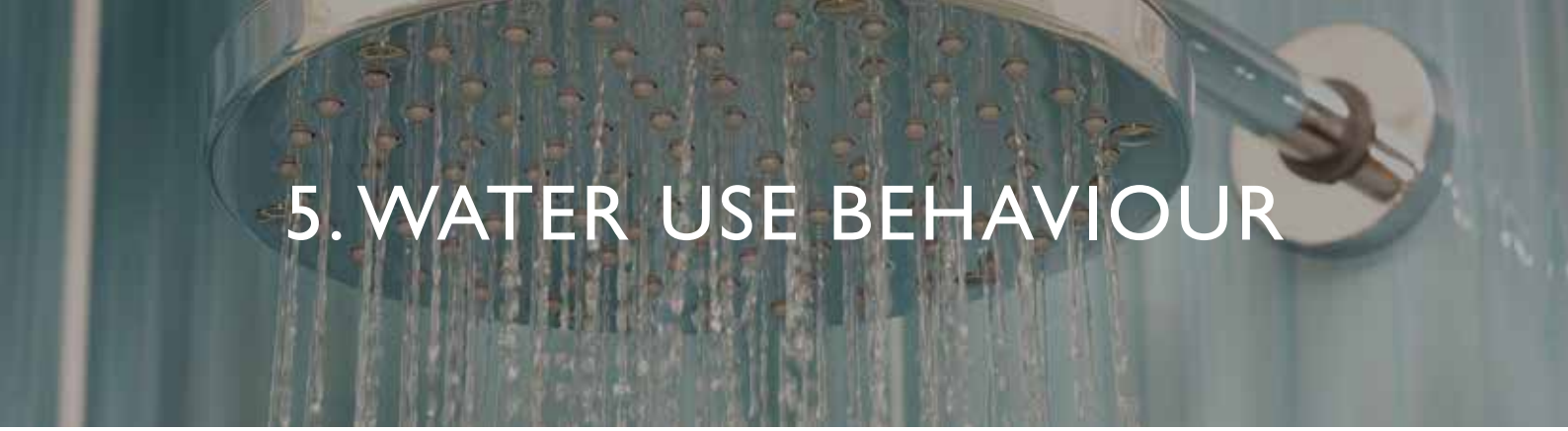
Environment Agency (2009) *Using science to create a better place: Economic evaluation of inland fisheries*, Environment Agency: Bristol.

4.5 Don't dig again

Thames Water (2012) *Why does London need the Thames Tideway*. [Online]. Available at: https://www.thameswater.co.uk/aboutus-projects-tidal-thames/london-tideway-improvements-the-case-for-the-thames-tunnel.pdf [28 October 2015].

4.6 Eel screening alternatives

Environment Agency The Eel Manual: an overview. [Online]. Available at: https://www.thameswater.co.uk/aboutus-projects-tidal-thames/london-tideway-improvements-the-case-for-the-thames-tunnel.pdf [5 November 2015].



5. WATER USE BEHAVIOUR

5.1 Efficient irrigation

PROBLEM

Using too much water for irrigation is not cost effective or good for plants. Irrigation usually happens at the hottest and driest time of the year but when water supplies are lowest.

WHY IT MATTERS

Almost 90% of a human being's water needs are accrued through food production (Royal Geographical Society 2012). In England, there are close to 150,000 hectares of irrigated agricultural land; it is estimated that only 1-2% of the water abstracted from rivers and groundwater in England is consumed as irrigation (Jolly et al 2009).

Potatoes and other vegetables take up the majority of water used by irrigation, using approximately 25% and 54% of abstracted irrigation water respectively. In England and Wales, agricultural water use could increase by between a third to more than double by 2015 (Environment Agency 2013).

5.2 Wear dirty jeans

PROBLEM

Households need a lot of water for clothes washing. This increases the potential for pollution, for example from phosphate in detergents.

WHY IT MATTERS

12% of household water is used for clothes washing (Affinity Water 2015).

5.3 Stuffing our sewers

PROBLEM

Wet wipes and other 'flushable' items cause large blockages in the sewer infrastructure. Blockages are also caused by people disposing of fats and oil down household drains and pipes. These blockages cause sewer flooding and pollution which is expensive to resolve.

WHY IT MATTERS

Around 200,000 sewer blockages occur per year across the UK. These are predominantly caused by fats, oil and grease down drains and items like wet wipes which are put down toilets. This costs utilities an excess of £15 million and causes over 3,000 homes to flood (Water UK 2015).

5.4 Chemical cleaning costs

PROBLEM

Chemical pollution, for example from human pharmaceuticals, commonly enters sewage and wastewater. This requires greater treatment.

WHY IT MATTERS

Conventional water treatment processes only remove 50% of pharmaceuticals. More advanced treatment methods can remove 99% (WHO 2011) but require 25% more energy and come at a higher cost (Royal Society of Chemistry 2008).

5.5
Stinking waste

PROBLEM

Waste is often thrown into public water courses in urban locations. This is partly because of human behaviour, overflowing and lack of bins.

WHY IT MATTERS

Approximately 70% of global industrial waste is dumped into water bodies. 14 billion pounds of waste – mostly plastic – is deposited into the ocean every year (Conserve Energy Future 2015).

5.6
Plastic for dinner?

PROBLEM

Plastic marine litter takes centuries to decompose. It threatens the environment and health of wildlife and humans, and there's the risk it will enter the food chain.

WHY IT MATTERS

Plastic makes up 60-80% of all marine debris (Derraik 2002). It has increased over the last 30-40 years because of a rise in synthetic materials. There are around 18,000 pieces of plastic per square kilometre floating on the ocean surface (Allsopp et al 2006).

5.7
Cross country water management

PROBLEM

Following the separation of Natural Resources Wales (NRW) from the Environment Agency (EA) and Scottish Environment Protection Agency (SEPA), it has become a greater challenge to manage water across borders. Although there is some scope to integrate information more effectively.

WHY IT MATTERS

Cross country water management is important because freshwater resources are unevenly distributed across the UK: 90% of the volume and 70% of the surface area of freshwater is in Scotland (UK National Ecosystem Assessment 2011).

5.8
Water waste woes

PROBLEM

Water is a limited resource but often people use more than what is necessary – even if it is unintentionally. General household water users are often unaware of the wider water management process and how much water they use, or of the effort and cost involved in providing clean water.

WHY IT MATTERS

A household of four people who use a shower daily, for eight minutes each, will spend approximately £343 per year on heating water for their showers. Using hot water in the UK causes 35 million tonnes of carbon dioxide to be emitted per year, around 8% of the UK's total carbon emissions: 90% is due to heating water in the home (Hinchliffe 2012; Bristol University).

5.9
Disconnected water data

PROBLEM

Data is often disconnected. For example currently, information about sewer infrastructure and catchment areas isn't shared enough. It's also difficult to digest and explain data when engaging with customers and stakeholders.

WHY IT MATTERS

The United Nations (UN) estimates that tighter water management by using smart data analytics is worth an advantageous $20 billion (University of Queensland 2012).

5.10
Open data inhibitions

PROBLEM

A major hurdle in releasing government data is 3rd party intellectual property rights; unfavourable 3rd party data options discourage the sharing of data.

WHY IT MATTERS

Open government data is projected to provide an estimated value of £1.8 billion in direct benefits and £6.8 billion to UK consumers, businesses and other public sector organisations (Deloitte 2013).

5.11
Water abstracting and trading

PROBLEM

Abstraction licences are limiting. There needs to be a better way of restricting water abstraction whilst still meeting individual needs. There needs to be a system for sharing water for those already with licences, and the ability to track water rights in order to promote better use of water. Reform is underway but there are still data needs.

WHY IT MATTERS

In 2008 almost 20% of the 119 water catchments in England were over-licensed, and 15% were over-abstracted (Stern 2013). A 2013-14 public consultation addressing reform of the water abstraction policy has since been conducted. This has recognised that managing abstraction needs to be more flexible and water trading needs to be more straight-forward and responsible (DEFRA 2013).

THEME 5
References

5.1 Efficient irrigation

Royal Geographical Society (2012) *Water policy in the UK: The challenges*, RGS-IBG: London. [Online]. Available at: http://www.rgs.org/NR/rdonlyres/4D9A57E4-A053-47DC-9A76-BDBEF0EA0F5C/0/RGSIBGPolicyDocumentWater_732pp.pdf [9 November 2015].

Jolly, T., Youngs, P., Hargreaves, L., Kay, M., Knox, J. and Weatherhead, K (2009) *Food security and irrigation in the UK*, UK Irrigation No. 36 Summer 2009. [Online]. Available at: http://79.170.40.182/iukdirectory.com/iuk/journals/36/Tim%20Jolly%20et%20al.pdf [23 November 2015].

Environment Agency (2013) *Case for Change - Current and Future Water Availability, Environment Agency: Bristol*. [Online]. Available at: http://webarchive.nationalarchives.gov.uk/20140328084622/http://cdn.environment-agency.gov.uk/geho1111bvep-e-e.pdf [23 November 2015].

5.2 Wear dirty jeans

Affinity Water (2015) *How much water do you use?* [Online]. Available at: https://www.affinitywater.co.uk/water-efficiency-water-usage.aspx [29 October 2015].

5.3 Stuffing our sewers

Water UK (2015) *Disposal of Fats, Oils, Grease and Food Waste: Best Management Practice for Catering Outlets*, Water UK: London.

5.4 Chemical cleaning costs

World Health Organisation (2011) *Guidelines for drinking-water quality: Fourth edition, WHO: Geneva*. [Online]. Available at: http://apps.who.int/iris/bitstream/10665/44584/1/9789241548151_eng.pdf [10 November 2015].

Royal Society of Chemistry (2008) *Something in the water, Chemistry World, 5, 9*. [Online]. Available at: http://www.rsc.org/chemistryworld/Issues/2008/September/SomethingInTheWater.asp [10 November 2015].

5.5 Stinking waste

Conserve Energy Future (2015) *Pollution Water Facts*. [Online]. Available at: http://www.conserve-energy-future.com/various-water-pollution-facts.php [10 November 2015].

5.6 Plastic for dinner?

Derraik, J. (2002) *The pollution of the marine environment by plastic debris: a review*, Marine Pollution Bulletin, 44: 842-852.

Allsopp, M., Walters, A., Santillo, D. and Johnston, P. (2006) *Plastic Debris in the World's Oceans, Greenpeace: Amsterdam*. [Online]. Available at: http://www.unep.org/regionalseas/marinelitter/publications/docs/plastic_ocean_report.pdf [10 November 2015].

5.7 Cross country water management

UK National Ecosystem Assessment (2011) *The UK National Ecosystem Assessment: Synthesis of the Key Findings*. UNEP-WCMC, Cambridge.

5.8 Water waste woes

Hinchliffe, D. (2012) *Energy down the drain? Improving domestic shower efficiency*, Schumacher Institute for Sustainable Systems, Bristol University: Bristol.

5.9 Disconnected water data

University of Queensland Business School (2012) *Big data in action: the water industry*. [Online]. Available at: https://www.business.uq.edu.au/momentum/big-data-action-water-industry [10 November 2015].

5.10 Open data inhibitions

Deloitte (2013) *Market assessment of public sector information, Department of Business, Innovation and Skills: London*. [Online]. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/198905/bis-13-743-market-assessment-of-public-sector-information.pdf [17 November 2015].

5.11 Water abstracting and trading

Stern, J. (2013) *Water Rights and Water Trading in England and Wales, The Foundation for Law, Justice and Society: Oxford*. [Online]. Available at: http://www.fljs.org/sites/www.fljs.org/files/publications/Stern.pdf [9 November 2015].

DEFRA (2013) *Water abstraction reforms published*. [Online]. Available at: https://www.gov.uk/government/news/water-abstraction-reforms-published [17 November 2015].

ACKNOWLEDGEMENTS

- **AR Carbon** – Richard Page, Founder and Managing Director

- **Cranfield University** – Tim Hess, Reader in Water Management, Water Science Institute

- **DEFRA** – Elaine Connolly, Policy Adviser, Bathing and Shellfish Water Quality

- **Environment Agency** – Angela Wallis, Technical Specialist, Water Demand Management
- **Environment Agency** – Angharad Stone, GIS and Data Officer
- **Environment Agency** – Marian Zelman, Solution Architect
- **Environment Agency** – Paul Ashton, National Data & Engagement Lead
- **Environment Agency** – Mark Whitling, Project Manager, Flooding
- **Environment Agency** – Russell Robertson, Senior Adviser, Fisheries
- **Environment Agency** – Will Pegg, National Misconnections Advisor

- **katausten.com** – Kat Austen, Scientist and Artist

- **Nesta** – Tris Dyson, Director, Centre for Challenge Prizes
- **Nesta** – Zofia Paczkowska, Centre for Challenge Prizes

- **Nonon** – Sean Miller, Director, 'Deep Dive' Facilitator

- **Ordnance Survey** – Ben Nduva, Account Manager, Swimmer
- **Ordnance Survey** – Chris Parker, Geovation Challenge Manager
- **Ordnance Survey** – Gauri Kangai, Geovation Challenge Research Analyst
- **Ordnance Survey** – Jason Bateman, Solutions Engineering
- **Ordnance Survey** – Julie Buck-Rogers, Visual Designer, Surfer
- **Ordnance Survey** – Viv Alexander, Geovation Challenge Community Manager

- **Rivers Trust** – Lucy Butler, GIS Services Delivery Manager

- **Southern Water** – Alison Hoyle, Head of Strategic Planning

- **Surfers Against Sewage** – Andy Cummins, Campaigns Director

- **TYF Group** – Andy Middleton, Founder Director