ice
Institution of Civil Engineers

THE STATE OF THE NATION

WATER 2012

THE STATE OF THE NATION: WATER

ABOUT ICE

Founded in 1818, the Institution of Civil Engineers (ICE) is an international membership organisation with over 80,000 members in 166 countries worldwide. Its members range from students to professional civil engineers. As an educational and qualifying body, ICE is recognised for its excellence as a centre of learning and as a public voice for the profession. It also has charitable status under UK law.

ABOUT THIS REPORT

State of the Nation reports have been compiled each year since 2000 by panels of experts drawn from across the ICE membership and beyond.

For the last four years, ICE's State of the Nation reports have focused on a specific issue, such as capacity and skills, transport, defending critical infrastructure, low carbon infrastructure and waste resource management. In June 2010 we also issued an overall assessment of UK infrastructure. Previous editions are available at www.ice.org.uk/stateofthenation.

The aim of the State of the Nation report is to stimulate debate in society, influence governments' policies and highlight the actions that we believe are needed to improve the state of the nation's infrastructure and associated services. This report has been compiled through a process similar to that of a select committee enquiry, with a wide range of stakeholders providing verbal and written evidence. The material was then reviewed in the light of the Department for Environment, Food and Rural Affair's (Defra) *Water for Life*[1] report, the Environment Agency's (EA) *The Case for Change*[2] report and the Scottish Government's *Hydro Nation*[3] consultation.

CONTENTS

1. Defra 2011 Water for Life http://www.official-documents.gov.uk/document/cm82/8230/8230.pdf
2. EA 2011 The case for change – current and future water availability http://publications.environment-agency.gov.uk/PDF/GEHO1111BVEP-E-E.pdf
3. The Scottish Government 2012 http://www.scotland.gov.uk/Resource/0038/00386783.pdf

WELCOME TO THE STATE OF THE NATION REPORT ON WATER

Water has been described as "the bloodstream of the biosphere".[4] It is a vital and precious resource which the developed world too often takes for granted.

The challenges facing the management of water resources, and particularly the looming imbalance between demand and supply have been brought to centre stage in 2012, as a sustained drought has affected more and more of the UK. Whilst it should not take such unusual events to raise water security up the social and political agenda, the current circumstances provide an opportunity for those involved in the water community to engage with all stakeholders, including the public, business and farmers, as well as all UK governments, on this important issue.

The UK and Scottish governments have set out the challenges and outlined aspirational plans in documents including *Water for Life* and the Hydro Nation consultation, respectively. Highlighting the water security challenges facing the UK is important; however, there is need for a long-term and coherent strategic roadmap implemented by legislation and regulation. This roadmap would include a sequence of clear steps that enable us to deal effectively with the critical issue of balancing supply and demand under the rising challenges of population growth, climate change and economic uncertainty.

As engineers and water professionals we seek to manage water effectively as part of our everyday working lives; as a Learned Society ICE must pass on our knowledge and persevere in our attempts to provide leadership. We must also engage with the extensive and growing group of stakeholders involved in water resource management. The interdependencies of water, energy, food and the environment have long been evident and it is time for us as professionals and government as policy-makers, to establish a strategy that recognises this.

Ultimately, it is UK policy-makers and decision-makers who must set the legislative agenda for innovative and effective approaches to water resource management, which this report aims to identify. However, it is crucial that the whole of society is also involved. To appreciate the value of water citizens must be encouraged and empowered to play their part in managing this most precious resource proactively and conscientiously.

I would like to thank all the contributors to the inquiry, particularly the steering group, who dedicated their time and provided their expertise so freely, and the Institution's internal project group, who managed the process and produced the final report.

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4. Malin Falkenmark & Johan Rockstrom July 2004 Balancing Water for Humans and Nature: The New Approach in Ecohydrology p.3

EXECUTIVE SUMMARY

Water scarcity is upon us. The 2012 drought across much of England has brought this reality into focus; but the future of chronic shortage has long been evident. Demand increases from population growth and supply uncertainty caused by climate change will lead to a growing gap between demand and supply. It is now urgent that a long-term and strategic roadmap to water security is drawn up and that resources are mobilised to implement it.

The variations in temporal and spatial precipitation mean that, increasingly, water will not always be available where and when we require it. As climate change exacerbates this situation, rainfall will intensify, summer temperatures will rise and summer precipitation will become less frequent. An appropriate mix of demand and supply side measures will be required in order to manage these future challenges.

The way the public in the UK perceives and values water must also be urgently addressed. Water is relatively inexpensive in relation to other household costs, yet it is vital to human health and well being. Unlike other services provided by utilities it is not subject to volatile price changes. This has led to water being taken for granted. Whilst it is important that water remains available to all at a reasonable price, the vast benefits society gains from it must not be undervalued.

ICE believes that it is time for the development of a coherent and coordinated strategic roadmap, which integrates demand and supply measures to ensure our water security. In order to do this, ICE recommends that the UK governments[5] establish a UK Water Security Task Force to provide leadership on the UK's long-term water needs by addressing three key issues:

- Establishing how much water we currently have and how existing resources can be better used and shared
- Incentivise behaviour change to reduce water demand and consumption
- Developing new resources in a sustainable and cost effective way

The current drought is due to a sequence of low rainfall across two winters and the intervening spring and summer. Although there is no panacea, there are measures that can be taken to help deal with the current stresses. Using water wisely and providing a framework for stronger collaboration among water companies and other water users can be achieved relatively quickly using regulatory and legislative levers.

If plans are not urgently put in place for the UK's long-term water security then the economic, social and environmental consequences will worsen. As we move into the next decade and beyond the pressures from climate change and population growth will make the equitable distribution of water to all users far more difficult to achieve.

FIGURE 1:
WATER SECURITY STRATEGY

OUTCOMES, ENABLERS AND PRESSURES – WHERE ARE WE NOW?

5. By UK governments, ICE means the Westminster government, the Scottish government, the Welsh government and the Northern Irish Assembly.

THE STATE OF THE NATION: ICE'S MAIN RECOMMENDATIONS

The UK has a looming and significant challenge to its water security. As a matter of urgency ICE recommends that leadership is established to deliver a strategic, coherent and integrated roadmap to water security. ICE recommends that:

1:

GOVERNMENT SHOULD ESTABLISH A UK WATER SECURITY TASK FORCE AND ROADMAP TO DELIVER WATER SECURITY BY 2025.

- A UK Water Security Task Force, providing directive leadership, should be established by the UK governments and in collaboration with regulators and all water users should publish four national water resource management road maps and an integrated UK water security strategy no later than spring 2014
- The roadmaps should centre on water resource availability and the supply/ demand balance over an extended time horizon and set out a clear plan for delivering the knowledge, governance, technologies and interventions required to provide water security for all

2:

THE IMPORTANCE OF WATER TO SOCIETY IS MORE EFFECTIVELY EMPHASISED AND WATER CONSERVATION MORE ACTIVELY PROMOTED TO DRIVE REDUCED WATER USE.

- UK governments should drive ambitious changes to reduce domestic per capita consumption by 30%.[6] Reductions across agriculture and industry should be promoted to reflect our need to conserve water
- UK governments, regulators and water companies must implement universal metering, complemented by social and discretionary tariffs, as well as demand management information, so that all water users pay for the water they use depending on the nature of that use and when they use it, whilst at the same time protecting the poor and the vulnerable
- Industry, UK governments, regulators, NGOs and Learned Societies must work together to raise the importance of water as a vital and valued natural resource to society through dedicated campaigning

3:

NEW SUSTAINABLE AND COST EFFECTIVE SUPPLY SCHEMES ARE DEVELOPED TO MAXIMISE THE USE OF WATER RESOURCES IN OUR RIVER BASINS AND WHERE APPROPRIATE AT WIDER SCALES.

- Regulators and users should work to maximise the use of available renewable water resources within catchments to ensure that water is utilised for the benefit of the public, agriculture, industry and the environment
- UK governments and regulators must remove the regulatory barriers and disincentives that prevent collaboration and limit transfers between adjacent water companies and river basins
- UK governments and regulators must remove the regulatory barriers and disincentives that hinder collaboration in investment and development for new regional water resources, particularly the water storage that will be important in addressing the temporal and spatial variations in availability of water resources
- Water companies, in collaboration with other water abstractors, should develop new major supply schemes that have multiple uses, such as hydropower, flood control, water for agriculture, and public water supply

6. From the current average of 150l/h/d.

1. BACKGROUND: WATER SECURITY NOW AND IN THE FUTURE

FOCUS OF ICE'S REPORT

Water resource management is an important tool in addressing the water security challenges that the whole of the UK faces. Water resource management extends beyond water supply for domestic use and includes water for industry, agriculture and the environment and this report includes all of these uses of water. A broad approach to water resource management, which considers the use of levers such as legislation, regulation, engineering, behaviour and pricing, will be outlined in the following chapters.

CHALLENGES

Climate change, population growth and a requirement to meet sustainability standards set out in legislation are arguably the greatest challenges facing water security in the UK. By the 2050s, summer river flows may reduce by 35% in the driest parts of England and by 15%for the wetter river basin regions in Scotland.[7] This will put severe pressure on current abstractions of water.

This concern is significant in London and the South East of England, where the population is predicted to increase by approximately 23% by 2035.[8] This is an area already suffering from water stress and increased abstraction will further intensify this problem. This is not the only part of the UK predicted to grow in population. Table 1 shows that populations throughout the UK will continue increasing through to 2035 with Wales increasing by 13%, Scotland by 11.5% and Northern Ireland by 11%.

TABLE 1:
ESTIMATED AND PROJECTED POPULATION OF THE UNITED KINGDOM AND CONSTITUENT COUNTRIES, 2010 TO 2035 [9]

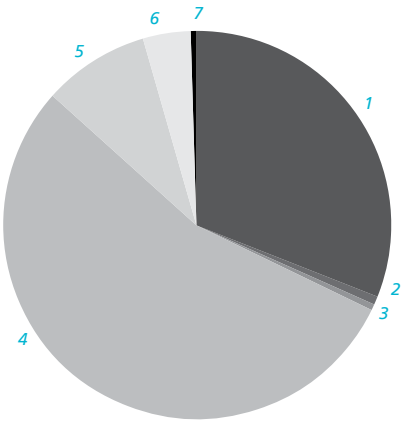
Millions	2010	2015	2020	2025	2030	2035
UK	62.3	64.8	67.2	69.4	71.4	73.2
England	52.2	54.5	56.6	58.6	60.4	62.1
Wales	3.0	3.1	3.2	3.2	3.3	3.4
Scotland	5.2	5.4	5.5	5.6	5.7	5.8
Northern Ireland	1.8	1.9	1.9	2.0	2.0	2.0

ONS October 2011

This growing population will not only require greater volumes of water for public water supply, but also for agriculture and industry as the consumption of food, energy and goods increases. Figure 2 shows the estimated abstraction by sector in 2010. Although average water use for agriculture is approximately 1%[10], it varies among regions and is as high as 24% in East Anglia during peak irrigation demand. As summers become hotter and drier more irrigation will be required. This will increase the pressure on supplies of blue water, which is the main source for public water supply. Climate change will also impact on the nature of water use for agriculture. Farmers' reliance on green water will reduce and they will have to increase their usage of irrigation from sources of blue water.[11]

7. Defra January 2012 Climate Change Risk Assessment for the Water Sector Executive Summary p.vii http://randd.defra.gov.uk/Document.aspx?Document=CCRAfortheWaterSector.pdf **8.** ONS Table 1, 2010-based subnational population projections by sex and five year age groups for England and the Regions http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-246448 **9.** ONS Table 1: Estimated and projected population of the United Kingdom and constituent countries, 2010 to 2035 http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2010-based-projections/sum-2010-based-national-population-projections.html **10.** Defra 2011 Water Usage in Agriculture and Horticulture Results from the Farm Business Survey 2009/10 and the Irrigation Survey 2010. add http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-farmmanage-fbs-waterusage20110609.pdf

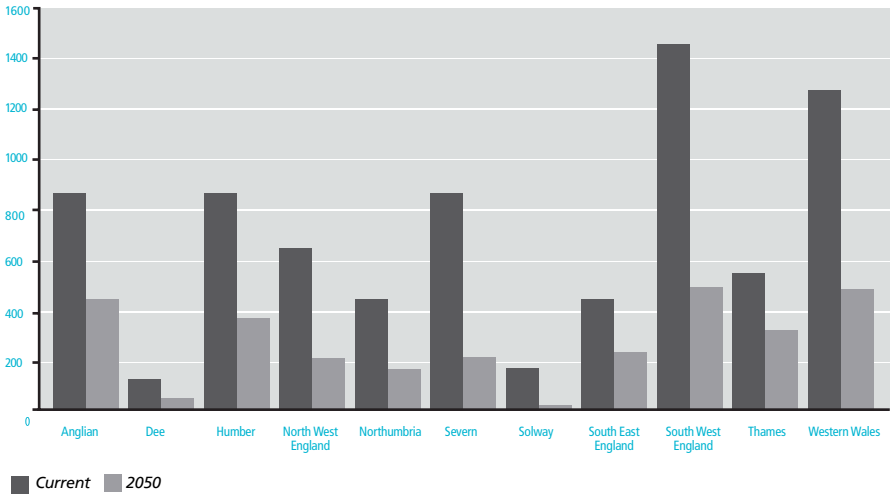
FIGURE 2:
ENGLAND AND WALES ABSTRACTION: ALL SURFACE AND GROUNDWATERS'



1 *Public water supply - 30%*
2 *Spray Irrigation - 0.5%*
3 *Agriculture other than spray irrigation - 0.1%*
4 *Electricity supply industry - 55%*
5 *Other industry - 9%*
6 *Fish farming, cress growing and amenity ponds - 5.3%*
7 *Other - 0.1%*

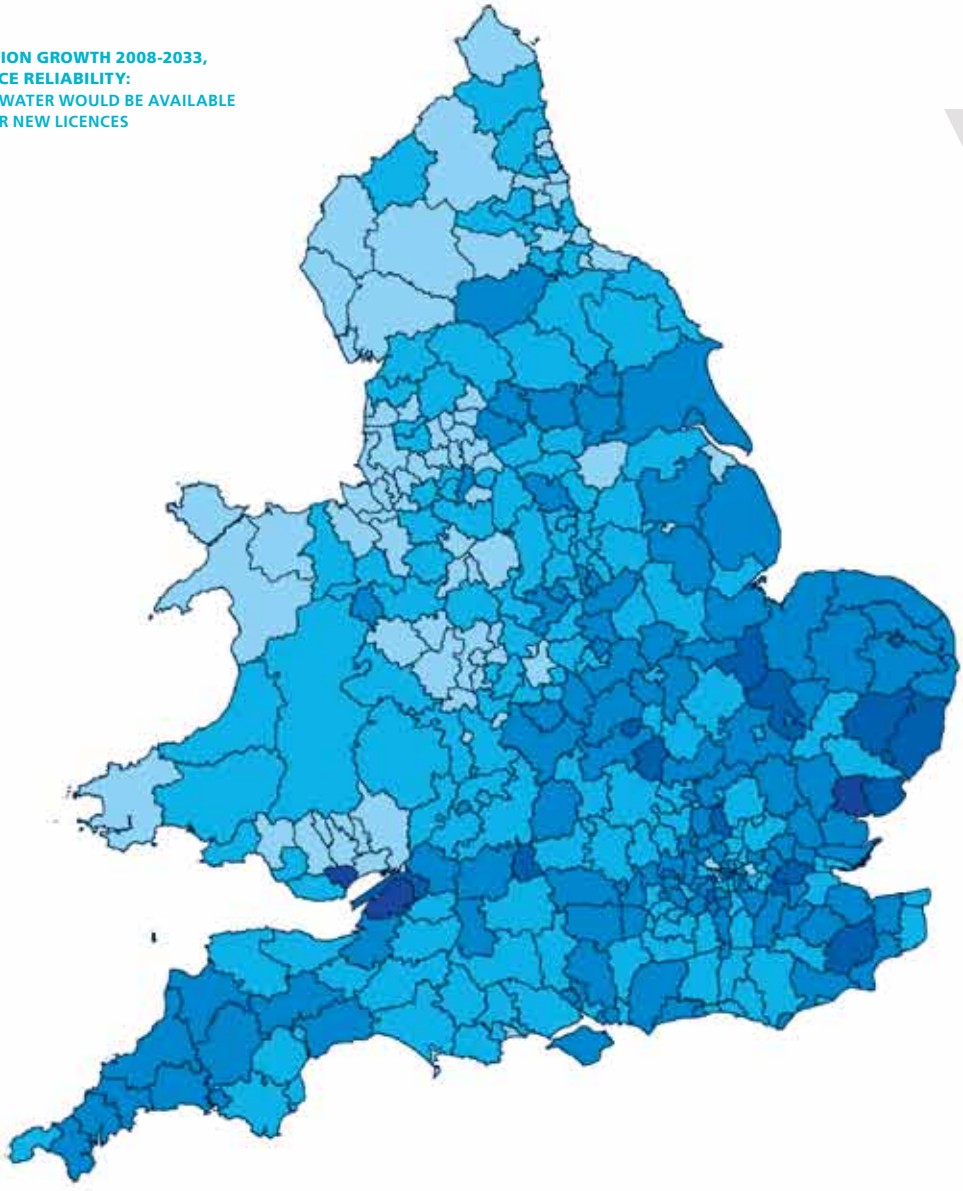
The availability of water for abstraction is likely to decline if current trends continue. Figure 3 shows the number of catchments within particular regions from which sustainable abstractions occur. Under the medium emissions scenario[12] in the Department for Environment Food and Rural Affair's (Defra) *Climate Change Risk Assessment* (CCRA), the numbers of catchments offering sustainable abstraction is predicted to reduce significantly by 2050. These reductions are predicted to be particularly acute in the South West and North of England, and in Western Wales.

FIGURE 3:
SUSTAINABLE CATCHMENT ABSTRACTIONS [13]



11. Green water is the precipitation on land that does not run off or recharge the groundwater but is stored in the soil or temporarily stays on top of the soil or vegetation. Blue water is the water in freshwater lakes, rivers and aquifers. http://www.waterfootprint.org/?page=files/Glossary **12.** For more details on these scenarios please refer to Defra January 2012 Climate Change Risk Assessment for the Water Sector. **13.** Based on figures from Defra January 2012 Climate Change Risk Assessment for the Water Sector p.188.

FIGURE 4:
PROJECTED POPULATION GROWTH 2008-2033, AND WATER RESOURCE RELIABILITY:
PERCENTAGE OF TIME WATER WOULD BE AVAILABLE FOR ABSTRACTION FOR NEW LICENCES



PROJECTED INCREASE IN POPULATION: 2008 – 2033

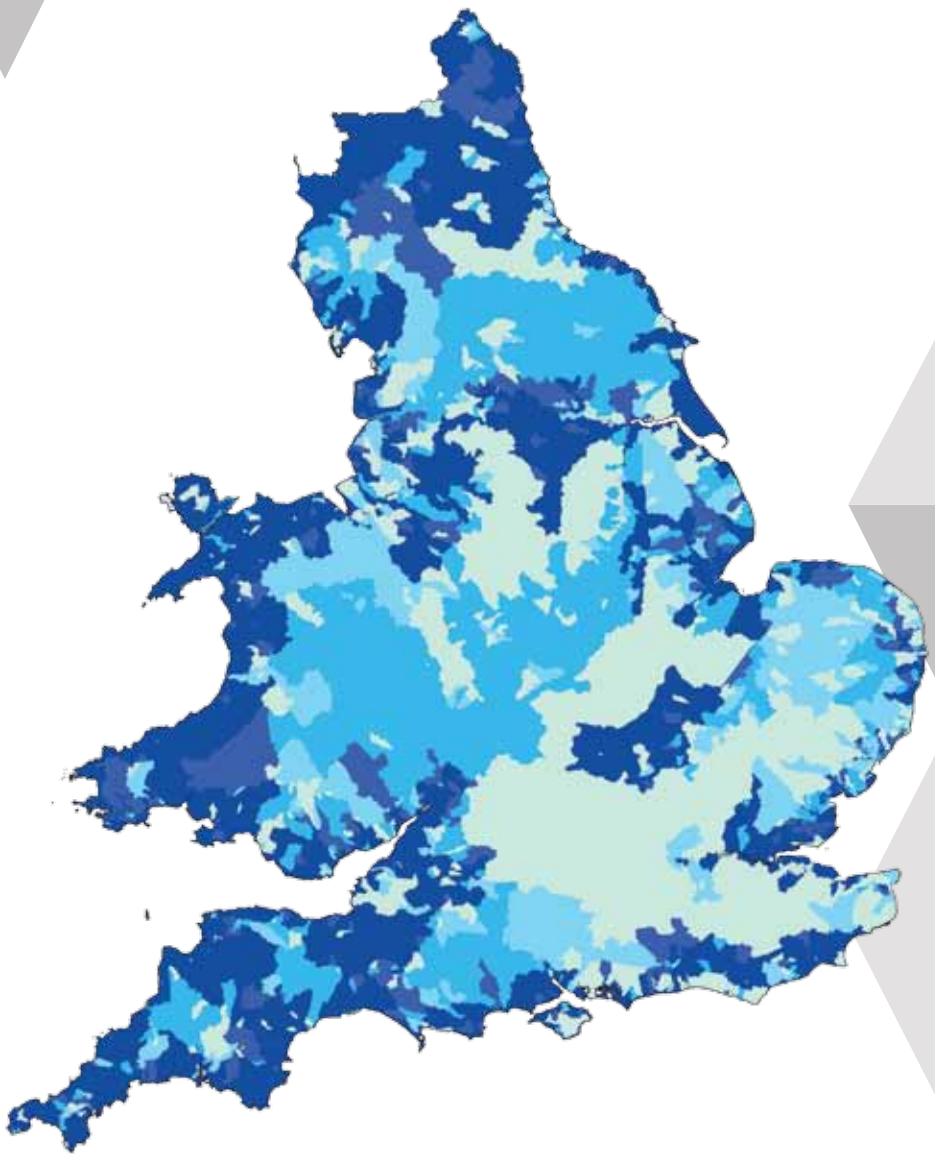
- *0-10%*
- *11-20%*
- *21-30%*
- *31-40%*
- *41-75%*

Figure 4 shows that population is likely to increase in areas already suffering from water stress. Perhaps most significantly this further demand on abstraction may cause serious damage to the UK's natural ecosystems. CCRA warns that both quality and quantity of river systems and groundwater sources of water could be damaged by a combination of increased public and agricultural abstraction particularly at times of low precipitation.[14]

As well as the direct abstracting impacts, there may be indirect damage through increased diffuse pollution which is caused by the release of potential pollutants from a range of activities.

These demand and supply challenges have to be resolved whilst delivering stringent environmental targets driven by European Union (EU) Directives. These targets include the improvement of water quality requiring increased use of energy intensive wastewater treatment technologies. There has already been significant capital investment in water infrastructure in order to meet targets set out by the EU Urban Wastewater Treatment Directive (UWTD); however, the Water Framework Directive (WFD) and Habitats Directive are placing further demands on water resource managers.

14. Defra January 2012 Climate Change Risk Assessment for the Biodiversity and Ecosystem Sector pp.106-118
http://randd.defra.gov.uk/Document.aspx?Document=CCRAfortheBiodiversityandEcosystemServicesSector.pdf
Map Source: ONS



WATER RESOURCE RELIABILITY:
PERCENTAGE OF TIME WATER WOULD BE AVAILABLE FOR ABSTRACTION FOR NEW LICENCES

- *Water available less than 30% of the time*
- *Water available at least 30% of the time*
- *Water available at least 50% of the time*
- *Water available at least 70% of the time*
- *Water available at least 95% of the time*

> Moving towards outcome focussed regulation is the way to go. Prescriptive regulation is of the past. Outcome focussed regulation that enables us to take the right steps to achieve benefits specific to local environments provides the opportunity to integrate climate change factors.
>
> **SCOTTISH WATER**

2. ROLE OF THE UK GOVERNMENTS AND REGULATORS

Legislation and regulation in the UK is underpinned by various EU Directives. The WFD and the Habitats Directive are arguably the most significant of these for water resource management. These Directives have to be transposed and implemented by each of the UK's governments.

There are notable differences in the way water management is structured across the UK, which affects the relationships between the primary actors in each of the water sectors. England's water and sewerage services are provided by private companies overseen by an economic regulator to provide an alternative to market competition and ensure protection for consumers. Wales is also subject to similar regulation, but has a unique water and sewerage company which provides the majority of water services and is owned by Glas Cymru a single purpose company with no shareholders run solely for the benefit of customers. Scotland and Northern Ireland have retained the publicly owned model and are regulated by a mix of government agencies and non-departmental public bodies with statutory responsibilities.

Although water management is structured differently across the UK, water remains a shared resource. ICE calls on each of the UK's administrations to develop a water resource management roadmap which establishes a series of steps that once completed will mean that by 2025 the UK is water secure.[15] The roadmaps should centre on water resource availability and the supply/demand balance over an extended time horizon and set out a clear plan for delivering the knowledge, governance, technologies and interventions required to provide water security for all. Whilst these roadmaps will have some differences, they should be integrated so that the UK has an overarching water security strategy.

FUTURE LEGISLATION AND DIRECTIVES

Complying with EU Directives requires significant investment in water infrastructure. This investment has enabled water companies to deliver water supply services to customers, whilst also improving water quality as required by EU Directives. Improvements to water quality have been welcomed; however, the energy-intensive wastewater treatment technologies required to deliver these water quality standards makes it more challenging for water companies to achieve reductions in the carbon footprint of their operations. ICE believes this tension requires attention by the EA and Ofwat, and Scottish Environmental Protection Agency (SEPA) and Northern Ireland Environment Agency (NIEA).

ICE is disappointed that the UK government will not present a full Water Bill for water industry reform in England and Wales in this Parliamentary session. The water security challenges faced by the UK require urgent attention. Without this important legislation the changes needed to manage water more sustainably will be delayed further and the risks to water security will only increase.

REGULATION OF WATER RESOURCE MANAGEMENT

Although there are nuances in the way economic regulators in England, Wales Scotland and Northern Ireland function they each have a remit to encourage and incentivise water suppliers to achieve the highest possible service for customers in terms of both quality and value. Regulation is not solely used to provide safe and reliable water for households. Environmental regulation within the UK seeks to ensure that water is abstracted and used in a sustainable manner, so as not to impact negatively on the environment.

Economic regulation in England and Wales has contributed to an improvement in drinking water quality and quantity; however, water resource management has become an increasingly complex issue. Regulation has not adapted to the needs of the 21st Century, particularly the requirement to enhance ecosystems, improve sustainability, manage carbon, adapt to the impacts of climate change and address the supply/demand imbalance.

15. For a comprehensive explanation of what makes a nation water sceure please refer to http://www.gwp.org/en/The-Challenge/The-Urgency-of-Water-Security/

Ofwat's outcomes approach discussed in their Future price limits[16] - statement of principles consultation empowers water companies, working in collaboration with customers, non-governmental organisations (NGOs) and other water users, to develop the most suitable solution to the specific challenges facing them. The Water Industry Commission for Scotland also supports this approach and the inclusion of customers in decision-making through customer panels is a positive approach. Whilst the outcomes approach has potential benefits to water companies and those to whom they provide services, it is vitally important that the impacts on private investment are fully understood.

Increasing the competition throughout the water supply and sewerage sector is viewed as a progressive step in the Cave Review[17]. Although this may provide short-term benefits to non-household customers through lower bills that may arise from increased competition, the long-term investment impacts of this must also be considered carefully. There is also a risk that the collaborative approach to water resource management will be negatively impacted if this part of the water sector becomes disparate and disjointed.

ICE believes that Ofwat must adapt their regulatory incentives to allow water companies to make a return on operational investment in innovative and sustainable solutions rather than only on capital investment and 'built' infrastructure.

Environmental regulation must also adopt a level of flexibility allowing for the uncertainties ahead. Defra's *Water for Life* report outlined plans to alter the abstraction regime; however, implementation will take some time.

CATCHMENT BASED MANAGEMENT

Catchment based management is often considered as a method for managing flood water and/or diffuse pollution. ICE considers catchment based management as more than this. ICE agrees with EA, EA Wales[18], SEPA and NIEA that many of the problems facing our water environment are best understood, and tackled, at a catchment level. ICE would like to see the advancement of catchment-based approaches for managing water resources, including best practice in land management.

Effective catchment management planning is a substantial institutional, social and political challenge. It requires implementation and resources, particularly for core planning, science, monitoring and stakeholder engagement. UK administrators and regulators must support and provide resources to those willing to facilitate the catchment-based approach.

16. Ofwat 2012 Future price limits – statement of principles' http://www.ofwat.gov.uk/future/monopolies/fpl/pap_pos201205fplprincip.pdf
17. Cave 2009 Independent Review of Competition and Innovation in Water Markets http://archive.defra.gov.uk/environment/quality/water/industry/cavereview/documents/cavereview-finalreport.pdf **18.** Due to become part of the Single Environment Body in Wales in 2013.

3. INFRASTRUCTURE AND INVESTMENT

Today water companies face a considerable challenge to meet increasingly stringent requirements whilst making operations more energy and carbon efficient.

THE NATIONAL WATER GRID - DISPELLING THE MYTH

A national water grid is regularly heralded as a solution to the spatial variation in water resources in the UK. The concept of designing a grid similar to the electricity grid to move water around the UK is held up as a "silver bullet"; however, the reality is not that simple. We must change our perception of the form of transfer systems that are likely to provide solutions to water scarcity problems in the UK.

This will not resemble a 'national grid' as such a solution would be too costly, too environmentally damaging and too grand a design for the need. The transfer capabilities we need are much more likely to take the form of short interconnections between adjacent water supply areas that enable water to be transferred to places of (transient) shortage from places of (transient) plenty. These may be transfers between adjacent regions or as transfers between more distant regions in a series of supply-demand rebalances that allow the water needed to be provided through a displacement chain rather than through a long pipe.

In England and Wales £90 billion[19] has been invested in water infrastructure over the last 20 years to deliver the necessary improvements to customer service and the environment and to ensure long-term sustainability. Scottish Water invested £2.45 billion[20] between 2006 and 2010 and in Northern Ireland £778 million[21] was invested between 2007 and 2010. Unfortunately the five year regulatory cycle in England and Wales continues to cause uncertainty due to the stop/start nature of investment. In Northern Ireland investment in water infrastructure is particularly volatile and uncertain due to the competition for public money from government departments.[22] This makes it very difficult for Northern Ireland Water to plan for long-term infrastructure investment and must be addressed by the Northern Ireland Assembly.

Ongoing investment in aging infrastructure to reduce leakage and improve resilience is required. The current leakage target setting methodology based on an 'economic level of leakage' should incorporate a more accurate value for water that reflects its true value to society and the environment. This will drive lower leakage levels by incentivising companies to make better use of existing resources in preference to developing new resources.

MODERNISING INFRASTRUCTURE

The conventional approach has been to incrementally maintain and improve upon the great engineering legacy of the UK's water infrastructure; however, as the magnitude and the temporal and spatial distribution of rainfall changes under climate change, we must adopt a new approach to the type of infrastructure assets that are proposed and constructed. Advances in sophisticated sensor networks, smart meters, deep computing and analytics, enable more detailed monitoring of entire water ecosystems, from rivers and reservoirs to pumps and pipes and water using devices in the home. These developments promise cost, energy and water savings, but require significant investment from industry and support from governments and regulators if they are to deliver on their potential.

While there may be those who view large-scale bulk transfers as a panacea to improve water security, this solution is costly and comes with its own range of problems. For example, the high energy required to pump water long distances significantly increases the carbon footprint of water companies involved.

Future water resource availability pressures will not be limited to the South East and East of England. Under many of the scenarios in the EA's *Case for Change* report Wales, South West and the North of England are likely to see significant unmet demand in the future.[23] Moving water from these areas will only provide a short-term solution to water scarcity elsewhere and may exacerbate future water scarcity in the regions transferring water.

19. Ofwat, Financial performance and expenditure of the water companies in England and Wales 2009-10 p.30. **20.** Scottish Water http://www.scotland.gov.uk/News/Releases/2011/01/24114415
21. Northern Ireland Water http://www.niwater.com/investmentoverview.asp **22.** Evidence from ICE Northern Ireland hearings. **23.** EA Case for Change p.8. http://publications.environment-agency.gov.uk/PDF/GEHO1111BVEP-E-E.pdf

DEVELOPING NEW RESOURCES

ICE believes that new water resources, additional storage and inter-company transfers will have to be developed to close the supply/demand imbalance; not as the only solution, but as part of an integrated strategy which includes demand management. New resources are expensive and water companies should be encouraged and incentivised to collaborate in order to share both investment costs and risk so as to optimise the benefits of any new resource. Where appropriate new resources should be developed for a range of uses including hydropower, flood control, agriculture and public water supply.

Multiple, smaller-scale, local solutions provide a significant opportunity to help alleviate current and future water supply deficits. This 'distributed infrastructure' is currently underdeveloped in the UK. Constructing medium and small scale storage, such as household and community-scale rain water harvesting and Sustainable Drainage Systems (SuDS), provides an effective way of collecting and managing precipitation at a local level and can help recharge groundwater levels. Aquifer storage and recovery (ASR) also offers a means of storing a proportion of high river flows and of treated wastewater. Recycling of grey water in the home and of treated wastewater for indirect uses offer, in effect, new sources of water to help alleviate the supply deficit.

Defra's *Water for Life* sets out plans for increased water storage on farms. ICE supports this idea in principle, but would like to see further guidance on how this would work in practice. Ownership and responsibility for maintenance must be clear and any trading arrangements agreeable to both parties.

Collecting raw rainwater in butts for use on lawns and gardens and for car-washing is a clear contributor to water efficiency. The contribution of small scale measures to solving future supply-demand shortfalls may be small, individually, but their benefits accumulate, as uptake rises, and they need to be pursued.

SKILLS AND CAPACITY

The stop/start water utility regulatory cycles in England, Wales, Scotland and Northern Ireland lead to significant numbers of water engineers and technicians leaving the supply chain due to deep troughs of workload during transitions from one cycle to the next, and uncertainties regarding investment in projects. These jobs are often filled once the cycle is over; but over time, the skills and expertise are lost to other sectors or to business in other countries. More has to be done by regulators and the water companies to ensure that this stop/start investment does not impact on the sector in this manner.

There are also significant concerns regarding the education of engineers in the UK. University degrees in topics such as hydrology[24] and irrigation[25] have declined dramatically in quantity. Graduates are often leaving university without the skills and knowledge required to work throughout the water sector.

In the Scottish government's Hydro Nation consultation water engineering expertise and knowledge are considered as a valuable export. Water engineers are a valuable resource to the UK and more should be done to promote their skills throughout the world.

24. BHS written evidence to ICE. **25.** Bruce Lankford written evidence to ICE.

> Per capita water consumption could be reduced by around a third[26], if there was a highly aggressive, integrated demand management programme. This would create green jobs; it would reduce carbon emissions; it would upgrade people's homes; it would help tackle bills – both water and energy; and it would reduce water consumption and the pressure on water resources.
>
> **JACOB TOMPKINS, BLUEPRINT FOR WATER COALITION**

4. DEMAND MANAGEMENT

Despite being termed "the bloodstream of the biosphere",[27] water is an undervalued natural resource. Most people in the UK take access to water for granted.

VALUING WATER AS A RESOURCE

In 2012 the EA[28] has already issued drought warnings across the South of England and up into the Midlands and parts of Yorkshire. In some of these areas hosepipe bans are in force to control demand during the summer months and whilst these have an impact on the way in which people use water they are a reactive and short-term mechanism. ICE believes that society should be proactive in its approach to reducing water use. Even in areas where water is perceived as abundant, it is still important for the public, industry and other water users to understand the need for and the (rather painless) means of contributing to good water management and conservation.

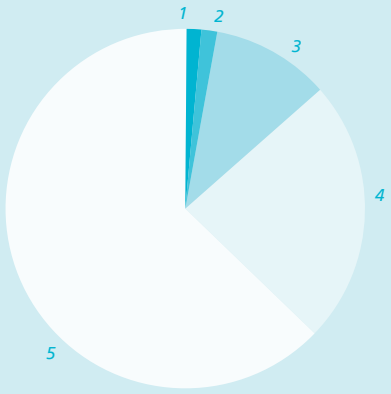
Defra's *The natural choice: securing the value of nature*[29] goes some way to begin the discussion ; however, other tools, such as water footprinting, are available to help articulate this message and begin the process of better demand management. *Water for Life* stops disappointingly short of endorsing the need for universal metering with appropriate tariffs as an effective means of incentivising domestic customers to use water carefully, in ways that encourage everyone to save water whilst protecting those in need of financial assistance.

WATER FOOTPRINT AND VIRTUAL WATER[30]

UK society is poorly informed about its wider demands on water. Whilst UK governments and water regulators focus on direct domestic consumption, the majority of society is unaware of the water which has been used to grow and process our food and beverages, or used in the raw materials and manufacture of clothing and products we consume. Figure 5 shows that three quarters[31] of our total water needs are met by water resources from other nations. ICE is concerned that UK governments do not yet recognise the significant importance of our global water footprint.

NB: in water footprint analysis, the term "consumption" means the net volume of water used, rather than "abstraction" which is that delivered to a consumer. Hence the domestic "consumption" is only 0.6% of the total

FIGURE 5:
UK WATER CONSUMPTION PER CAPITA (%)[32]



1	*Domestic - 0.6%*
2	*Industry - internal - 0.6%*
3	*Industry external - 11.3%*
4	*Food internal - 23.7%*
5	*Food external - 63.8%*

26. From the current average of 150l/h/d Defra **27.** Malin Falkenmark & Johan Rockstrom July 2004 Balancing Water for Humans and Nature: The New Approach in Ecohydrology p.3 **28.** EA http://www.environment-agency.gov.uk/static/documents/Leisure/39_Drought_management_briefing_30_Mar_12.pdf March 2012 **29.** Defra 2010 http://www.defra.gov.uk/environment/natural/whitepaper/ The Natural Choice: securing the value of nature. **30.** The term "virtual water" was coined by Professor Tony Allan of Kings College when he was working on water security studies in the Middle East in the 1980s. The term referred to the water "embedded" in food that the arid nations of the region must import. The subject was advanced by Chapagain and Hoeksta in the early 2000s, and resulted in their seminal book on Water Footprint in 2009.

METERING

We cannot continue to be so profligate with our water. Metering is an effective way to enable water consumers to manage their use. Understanding how and when water is being used will help customers to make informed decisions regarding water use. ICE considers that metering should be universally applied throughout the UK, though introduced on a regional basis according to the extent of water stress. Whilst some areas are not currently considered to be stressed, we believe that metering, allied with other measures, is an important tool in the long-term management of water.

ICE believes that discretionary tariffs which charge more per cubic metre for varying types of water use should be introduced to reflect the cost of providing water for essential and non-essential uses. Social tariffs are also needed to ensure that water is affordable for those requiring assistance with their everyday needs. As the tariff structure evolves, it should include peak tariffs that provide the opportunity to signal water availability/ scarcity, and to provide incentives to save money for reducing water use when and where it is in short supply. Smart water bills, which provide customers with clearer information on the nature of their water use should also be introduced and issued to customers more regularly.

UNDERSTANDING OUR WATER USE

Governments, industry, agriculture and the public must better understand their water use and should be empowered to change the patterns of their water consumption. Managing water at the catchment level is an effective way of improving collaboration and understanding of water use among abstractors. The importance of real time data and actual abstraction figures should be recognised as they provide regulators with a better understanding of the nature of water use from all sectors.

Providing information regarding the efficiency of water using appliances enables consumers to actively manage and reduce their water usage. Low flow showers and dual flush toilets are also important in the overall management of water. Current standards established by the Code for Sustainable homes should be better supported and developed further to ensure that at least minimum water efficiency targets are being achieved in new developments.

Governments, regulators and water companies and others involved in the water industry, including NGOs and Learned Societies, must collaborate to provide consumers, both domestic and non-domestic, with a better understanding of their water usage facilitated by metering and smarter bills. It is also important that the challenges faced by the water sector and those who abstract water are explained more thoroughly. The pressures from climate change and population growth and the importance of water for food, energy and the environment requires a widespread public awareness campaign. Raising awareness should be the first step in the reduction of water consumption within homes, public buildings and commercial activity.

Governments, regulators, water companies, Learned Societies and others involved in the water industry should also engage more actively in schools, providing young people with knowledge regarding water saving techniques. These lessons are best learned at an early age, so that they can be practiced throughout a lifetime and the wastage of water viewed as an unacceptable practice.

31. Mekonnen, M.M. and Hoekstra, A.Y. (2011) National water footprint accounts: the green, blue and grey water footprint of production and consumption, Value of Water Research Report Series No.50, UNESCO-IHE, Delft, the Netherlands. Download main report. Download appendices. **32.** The internal water footprint is defined as the use of domestic water resources to produce goods and services consumed by the nation's population. The external water footprint is defined as the volume of water resources used in other nations to produce goods and services consumed by the population in the nation under consideration.

5. WATER AND ITS INTERDEPENDENCIES

Understanding water and its interdependencies with food, energy and the environment is vital if water is to be managed effectively and efficiently.

The most successful and sustainable outcomes will be achieved by strategic management of the interfaces and interactions between these sectors.

This level of systems thinking[33] is not currently developed in the UK's approaches to water, energy, food or environmental management. If we wish to achieve a truly sustainable approach to managing these four areas then government departments must work in collaboration when developing policy and legislation. *The Water Environment (Controlled Activities) (Scotland) Regulations 2011*[34] is a proactive approach to improve engagement at the early stage of policy making which highlights the major interdependency issues and provides a platform from which to build an overall strategy.

WATER AND ENERGY

The UK water utility industry currently accounts for 5 million tonnes of carbon dioxide emissions per year.[35] Many water companies have already set in place programmes to reduce their operational carbon emissions through measures such as increased energy efficiency, recovery of energy from sewage sludge and other renewable energy generation. Scottish Water has announced a hydro power generating scheme that will use the flow in large water supply pipes to generate electricity and protect water treatment plants from power failures. These types of approaches are required if the water sector is to reduce its energy consumption and in turn its carbon dioxide emissions. Meeting this challenge is not helped by the tightening of public health and environmental regulation, which tends to increase the need for energy-intensive treatment with the consequence of further increasing carbon emissions.

Water is used throughout the energy sector, particularly for cooling purposes. The CCRA published by Defra in January 2012 warns that lower flows in summer caused by climate change may impact on the amount of freshwater inland energy stations can abstract for use in cooling. The risk of flooding due to more intense rainfall also poses a threat to resilience of power stations.[36] These inter-related issues illustrate why water and energy must be considered together.

WATER AND FOOD

Although only approximately 1% of abstracted blue water is used in agriculture in England,[37] this figure differs dramatically depending upon regional and seasonal variations. HM Government[38] acknowledges the importance of water in food production in its food strategy report, but does not propose a strategy for sustainable use of water in food production. The Welsh government recognises the importance of water to its food security[39] and plans to utilise it as a valuable resource in the future. This type of foresight is important in developing sustainable interactions between food and water.

Climate change is likely to cause more extreme flooding and drought leaving crops, particularly high value horticultural crops, more vulnerable to damage and destruction.[40] Changes in precipitation will impact on crops such as potatoes and field-scale vegetables and greater amounts of irrigation will be required which will increase demand for water for basic staple foods. In 2010 The Royal Agricultural Society of England stated that the better use of excess winter rainfall and flood water through capture and storage presents an opportunity that needs investigation.[41]

33. Engineering the Future April 2010 Global Water Security – an engineering perspective http://www.ice.org.uk/Information-resources/Document-Library/Global-Water-Security---an-engineering-perspective **34.** http://www.legislation.gov.uk/ssi/2011/209/contents/made **35.** EA http://www.environment-agency.gov.uk/research/library/publications/114393.aspx **36.** Defra January 2012 Climate Change Risk Assessment for the Energy Sector p.20 http://randd.defra.gov.uk/Document.aspx?Document=CCRAfortheEnergySector.pdf **37.** Defra 2011 Water Usage in Agriculture and Horticulture Results from the Farm Business Survey 2009/10 and the Irrigation Survey 2010. add http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-farmmanage-fbs-waterusage20110609.pdf **38.** HM Government January 2012 Food 2030. http://archive.defra.gov.uk/foodfarm/food/pdf/food2030strategy.pdf **39.** Welsh Assembly Government December 2012 Food for Wales, Food from Wales 2010 2020 Food Strategy for Wales. http://wales.gov.uk/docs/drah/publications/101207foodforwalesfoodfromwalesen.pdf

WATER AND THE ENVIRONMENT

Good stewardship of water quantity and quality is fundamental to maintaining a healthy water environment. The WFD and Habitats Directive have been developed to improve water ecology status and all UK governments have produced River Basin Management Plans to achieve this. There are concerns that guidance is still lacking with regard to what 'good' ecological status actually means.[42] Environmental regulators must collaborate with abstractors to ensure that the impact on habitats and biodiversity is understood and if abstraction licence restriction or removal is necessary, this is fully justified and explained.

Water is vital for human health; therefore, it is important that water for the environment and water for human needs are not conflicting. The uncertainties surrounding population and climate change mean that the natural environment will need to become more resilient to short-term shocks from variability.[43] This can be assisted through better management of diffuse pollution from both urban and agricultural sources. It is important to acknowledge that the water environment in the future will be different from that of today.[44]

40. Defra January 2012 Climate Change Risk Assessment for the Agriculture Sector p.6. http://randd.defra.gov.uk/Document.aspx?Document=CCRAfortheAgricultureSector.pdf **41.**Royal Agricultural Society of England October 2010 Water for Agriculture – Implications for Future Policy & Practice. **42.** Thames Water oral evidence to ICE **43** EA oral evidence to ICE **44.** EA Case for Change http://publications.environment-agency.gov.uk/PDF/GEHO1111BVEP-E-E.pdf p.35.

THE STATE OF THE NATION:
CONCLUSIONS

The challenges facing the UK's water security are with us, are serious, and require immediate attention. In the future, there will be a looming gap between supply and demand due to a growing population and the impacts of climate change.

There are many challenges that cannot be resolved in the short-term, which means that UK governments must now develop water resource management roadmaps and implement a water security strategy to address the long-term water problems facing the UK. Further, and because we depend heavily on water resources of other nations for much of our food and consumer products, our own water security is nested within a picture of increasing global water scarcity.

UK governments must begin the process of establishing a UK Water Security Task Force and build strategic partnerships across all of those involved in water resources management and water use, including regulators, farmers, industry, NGOs, the public and water companies. Building these relationships will improve the understanding of the different approaches taken to water resource management and provide the framework for effective management going forward.

The water utility sector should begin to break down the barriers that have made it conservative and risk averse. This means moving to a regulatory regime that encourages innovation; providing an integrated strategy which aligns academic and applied research and analysis with best practice in water resource management; and allows water companies and other water resource managers to test outputs that may provide more effective and sustainable outcomes.

Water scarcity has occurred due to water being undervalued as a resource. It is imperative that this attitude towards water changes and legislative, regulatory, engineering and pricing levers are utilised to drive behaviour change. Recognition of the true value of water and its symbiotic relationship with food, energy and the environment will raise the fundamental importance of water in the national psyche.

National water resource management roadmaps which combine to provide an integrated UK water security strategy should be developed by all UK governments. These integrated roadmaps should establish how the UK can make best use of existing water resources, develop new and sustainable water resources and alter the patterns of water use.

All of these actions are required to provide the short, medium and long-term solutions that will enable the UK to achieve water security.

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