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POSTNOTE

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Water Resource Resilience

Overview

- Although regulated and supported by Government, response to water scarcity primarily falls to water companies and private users of water resources.
- The ecology of freshwater bodies may be altered by increasing water demand and climate change. This would create challenges to minimising costs to consumers for environmental protection.
- A range of both supply-side and demand side options with differing environmental, social and cost implications could be implemented if water availability is reduced.
- Efficient management of water resources requires consideration of hydrological processes in decisions on land use, planning and economic development.

The availability of water resources is fundamental for society and economic activities.[1] This POSTnote describes the reasons for uncertainties in water resource availability for future supply and demand and possible responses to managing these risks in the medium term.

Background

The high population density in England and Wales means that available water resources per person per year are on average less than that of some Mediterranean countries. In parts of England, aggregate water demand exceeds available water resources, such that they can be classified as water scarce or stressed areas.[2] In England, the current average per capita consumption of around 145 litres of water per person per day (l/p/d) is projected on current trends, to be reduced to 130 l/p/d by 2035.[3] Whilst direct comparisons are not always straightforward, some other European countries, such as Belgium (110 l/p/d), already consume less than this.[4]

Groundwater and Drought

Drought, a decrease in water availability due to low rainfall, occurs on average every 7 years in England and Wales. Rainfall in winter rather than summer is most important for recharging groundwater, the water that accumulates in the spaces in soil, sediment, and rocks, which maintains river flows during drier summer months. The consecutive dry winters of 2010/2011 and 2011/12 resulted in low levels of both surface water and groundwater. Annual rainfall across England and Wales ranges from more than 2500 mm in parts of Wales and the English Lake District to less than 600mm in parts of Eastern England. Areas of highest population density and demand in England receive some of the lowest rainfall and are the most dependent directly on groundwater for water supplies. Exceptionally high rainfall of April to July 2012 recharged river flows, although groundwater remains depleted in a few areas.[5] However, the drought has raised questions about future levels of risk to water security.

Availability for Abstraction

In 2010, 34 billion litres of water was withdrawn (abstracted) per day from non-tidal surface water and groundwater for a variety of purposes. The largest users were public water supply and the electricity supply industry.[6] Much of the water taken by these sectors is returned after use, with treated domestic sewage effluent returned upstream of further abstraction in catchments with multiple urban centres. Power plants abstract significant surface water flows for cooling, the majority of which is returned to watercourses, although in some cases up to 50% can be evaporated. However, abstraction demands have to be balanced against what freshwater is needed for ecosystems to function (Box 1), with no additional resources available for abstraction over much of England and Wales.[7]

The Water White Paper set out the case for reforming the management of water resources in England, supported by Environment Agency (EA) analysis of the impacts of population growth and climate change on water demand and availability. Changes in rainfall are uncertain in the UK Climate Projection.[8] The Government's UK Climate Change Risk Assessment identified a high level of uncertainty in relation to future water availability, but with a risk of a deficit in most

> **Box 1. Environmental Flow Indicators**
> The EA currently takes account of environmental constraints for freshwater through modelling of Environmental Flow Indicators (EFIs), which estimate the likely amount of water needed to sustain the ecology of a river. EFIs are adapted from flow standards proposed by the Water Framework Directive UK Technical Advisory Group to support achievement of 'good ecological status' in water bodies (POSTnote 320). However, these do not constitute a quantitative assessment of the functioning or 'health' of freshwater ecosystems. This would require repeated measurements that quantify key biophysical processes,[9] to determine the actual magnitude, duration and timing of a flow regime required to maintain them. Neither do EFIs encompass what level of flow is required in a specific part of a river at a particular time of year to sustain a certain habitat or species. Developing such comprehensive standards would require far more extensive research studies than has previously been undertaken. Despite these shortcomings, EFIs are more evidence-based than previous expert judgement approaches.

regions for the period 2010 - 2039, the largest in the Thames river basin.[10] Avoiding future environmental damage and maintaining resilient water supplies will require:

- changes to the management of abstraction of water
- measures to reduce water demand and adapt supply infrastructure.

Abstraction Management

The EA currently assesses water resource availability in catchments through the Catchment Abstraction Management Strategies process, which incorporates technical data and stakeholder interests. The licensing in the catchment, the area drained by a river, is set by the strategies, which are periodically reviewed (Box 2). Under the Restoring Sustainable Abstraction programme, the EA has also investigated 263 licences in England and Wales where there was a risk of damage to important conservation sites. This includes those designated under the EU Habitats Directive (POSTnote 259). This can lead to changes to the licence, including reducing the volume abstracted generally and/or at low flows, or to revoking it. Climate change is likely to have a significant impact on the hydrology of catchments, with the possibility that the majority of the 21,000 licences held need to be revised or revoked by 2050.

Abstraction and the Water Framework Directive

Under the EU Water Framework Directive (WFD), surface water bodies should meet the target of 'good ecological status' or 'good ecological potential' and groundwater 'good quantitative status' (subject to certain specific exemptions) through measures set out in River Basin Management Plans (RBMPs, POSTnote 320). The EA estimates that river flows in 11% of water bodies in England (1,075) are insufficient to achieve good ecological status, and 35% of groundwater bodies will not achieve good quantitative status (Box 1).[11]

At present, river catchment management partnerships among key stakeholders, such as water abstractors, are being developed as a model for delivering WFD objectives in time for the second round of RBMPs in 2015. However, the different organisations and individuals that manage or control activities that affect the hydrology and ecology of catchments operate at different scales and the institutional structures to co-ordinate these have yet to be developed.[12] An example of working together in a catchment could be broadening the roles of water companies to supply extra resources to farmers and for the environment. This may reduce overall abstraction, minimising impacts on the hydrology and ecology of the catchment.

> **Box 2. Abstraction Licences**
> An abstraction licence is a formal agreement allowing the holder to abstract the specified volume of water from the catchment, with licensing introduced in the 1960s in England to avoid conflicts between abstractors. It is now regulated by the EA under the Water Resources Act 1991, through powers inferred by the Environment Act 1995. Licences specify what quantity can be abstracted, the point from which the abstraction must take place and the use to which that water can be put. The Water Act 2003 supplemented the provisions of the Water Resources Act by introducing a number of regulatory changes to licensing. These include:
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> - Only abstractions of over 20 cubic metres per day require a licence.
> - All new licences are time limited, valid for 12 years with a review of the long term environmental impacts of those abstractions' that are undertaken in 6 yearly cycles.
> - Where the reason for revoking or modifying a licence is in order to avoid the risk of serious environmental damage, the right to compensation may be withdrawn.
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> However, most licences (79% in England) were issued in perpetuity under previous licensing regulations and did not include conditions to reduce or stop abstraction when water availability decreases. More than a third of licences are unused, equating to 20% of the volume of water that could be abstracted, mainly held by agricultural and industrial users.[11] If an abstraction licence has to be revoked, compensation raised through an annual Environmental Improvement Unit Charge on the abstractors in the catchment may have to be paid, delaying removal of the licence. The White Paper proposes that compensation costs for water companies should be incorporated into the Price Review, and the EFRA Select Committee has recommended this should be in place for the 2014 Price Review (Box 3).[13]

Reform of the Abstraction Regime

The Department for Environment, Food and Rural Affairs (Defra) will consult on reform of abstraction regulation in 2013. This will be followed by legislation and phased implementation in the 2020s tailored to over 100 catchments to avoid undesirable impacts on key economic sectors including power generation, industry and farmers. A review commissioned by Defra is looking at different options for abstraction licensing (Box 2), considering international best practice and then assessing the impacts of the options in catchment case studies under different climate change and other scenarios to determine preferred approaches. Defra has stated that intended outcomes of the revised regime will provide improved regulatory certainty on the availability of water to facilitate climate change adaptation, to help abstractors in all sectors meet water demands and environmental objectives at least costs to customers.[1] However, both the House of Lords European Union Committee[12] and the House of Commons EFRA Select Committee[13] have recommended that the timescale for reform should be shortened. The Adaptation Sub-Committee of the Committee on Climate Change (ASC) highlighted the risk that policy decisions may not take full account of future water availability, 'locking in' unsustainable levels of abstraction.[3]

Public Water Resources

The Water Services Regulation Authority (Ofwat), Drinking Water Inspectorate and the EA regulate public water supplies in England and Wales, which are provided by around 20 private-sector companies. The public water supply planning framework (Box 3) is implemented at the level of Water

Resource Zones (WRZs). These are the largest area within which water resources can be shared effectively such that all customers share the same risk of supply failure. Integrating resources across a WRZ provides more resilience than a more localised supply system. By 2035, despite expected increases in water efficiency per person and reduced leakage rates, around half of WRZs are projected to have a deficit.[3] The Institute of Civil Engineers (ICE) has stated that in addition to the current regulatory framework, a coherent and co-ordinated strategic national roadmap is required that integrates demand and supply measures to ensure future water security.[14]

Increasing Supply and Reducing Demand

A range of measures to decrease water demand (Box 4), increase supply (Box 5) and reduce leakage have been suggested by water companies to cancel out projected deficits by 2035 under low to medium climate change scenarios. However, as these are not without cost and social implications, and as water infrastructure is long-lived, the uncertainty about future water availability is problematic. Across the different scenarios, measures to reduce demand are the most robust, but it is likely other measures to increase connectivity and supplies will also be needed.

Value of Water

One way to ensure the long-term viability of the water resource management system, including addressing risks from climate change, is by giving a higher notional value to water in decision making to ensure sustainable outcomes. For example, the calculation of the leakage reduction target set by Ofwat, the Sustainable Economic Level of Leakage, includes consideration of social and environmental costs and benefits.[15] ICE and the Chartered Institute of Water and Environmental Management suggest higher environmental and social values of water should be incorporated to drive lower leakage levels. Defra, Ofwat and the EA are considering how to value water, but there are significant challenges to resolving the different values held by diverse stakeholders.

Price of Water

To support trading of abstraction licences and drive efficiencies in water use, water could be priced on the basis of the volume abstracted, availability, environmental cost of abstracting in the location, the quality and the needs of other users. However, there is a risk that trading could increase unsustainable abstraction if the abstraction licensing system is not reformed appropriately. Smaller abstractors, such as agricultural ones, are concerned that they could be squeezed out by a competitive market if not protected by regulation.

A Systems Approach to Water Resources

Adapting landscapes and infrastructure to changed patterns of future rainfall will require the restoration and recreation of habitats that increase infiltration into groundwater and reduce surface water flows (Natural Flood Management, POSTnote 396). Over the last 500 years, the natural hydrology of catchments has been altered in England through extensive drainage of land, water bodies and wetlands.[16] This has reduced the retention of freshwater, increasing vulnerability to drought. For example, South West Water "Upstream Thinking" initiative has included funding of upland mire restoration projects and wetland habitats to deliver both water quantity and quality benefits. Encouraging infiltration and conserving water is also a key agricultural adaptation, through adoption of

Box 3. Public Water Resource Planning Framework

Price Review

As part of the regulatory process with the EA and Ofwat, water companies must periodically review the investment required to maintain secure supplies and meet environmental objectives (through production of Water Resource Management Plans). Ofwat are moving to a 'total expenditure' (TOTEX) assessment approach combining operational (OPEX) and capital expenditure (CAPEX). Previously measures that increased OPEX, such as water efficiency measures, were considered inefficient. By contrast, large scale supply infrastructure under CAPEX increased the water companies' assets, against which debt could be leveraged. Ofwat published its 'Future price limits – statement of principle' in May 2012 will publish a draft methodology for the 2014 price review in Autumn 2012, and a final version in Spring 2013. Ofwat will now approve intended outcomes rather than signing off individual water company investment schemes and incentivise a more integrated approach to water resource use.

Water Resource Management Plans

Water company projections of resource availability and demand over the 25 year period, produced in line with the jointly published guideline (Defra, EA, Ofwat, Welsh Assembly Government),[17] include:

- a demand forecast
- a supply forecast, describing how much water is available for use now, and how this may change with climate change and revision of abstraction licensing
- an assessment of options to manage demand
- an assessment of the options for exploiting new water resources
- a Strategic Environmental Assessment to assess the state of the environment
- the impacts of the plan on the environment
- a Habitats Regulation Assessment to consider effects on conservation sites with a European designation.

Drought Plans

Under the Water Act 2003, companies are required to publish drought plans on a three year cycle. The draft Water Bill proposes changing this period to five years. Water company plans cover a range of scenarios from high demand during short summer dry spells (1 in 10 year events) to more prolonged drought events (1 in 20 and 1 in 50). They set out the actions water companies will take during a drought to maintain public water supply, including temporary bans for non-essential water uses, leakage control and publicity campaigns encouraging water conservation. Water companies can also apply for drought orders to abstract more water, restrict non essential uses of public water supply, or to reduce other's abstraction. In the case of prolonged drought, emergency drought orders may restrict or ration essential use. The EA has national and regional drought plans and can grant drought permits to water companies to abstract more water. The EA formed a National Drought Management Group with key stakeholders, including water companies, to co-ordinate responses to the 2012 drought. This group will produce a report on lessons learned.

measures such as creating ponds and building on-farm reservoirs, the latter already seen as critical by bodies such as the NFU. Farmers could also be paid to either retain water on land and increase infiltration during flooding or release water from on-farm reservoirs to maintain flows during droughts.

Adapting urban infrastructure would require minimising its impact on water resources, through 'water sensitive urban design'. This integrates development with the management, protection and conservation of the water to minimise impacts on natural hydrological and ecological processes. This approach, widely adopted in Australia, incorporates a range of technologies that promote water efficiency, manage the effects of surface water flows on watercourses and maintain groundwater levels and flows in watercourses.[18] Local Authorities are already required to take account of water supply infrastructure and water quality in local plans under the

Box 4. Reducing Demand

- **Universal water metering of domestic properties** is supported by ICE, Waterwise and the ASC. At present, companies are only able to compulsorily meter customers in some circumstances. In areas designated by the Secretary of State as seriously water stressed, companies can adopt universal metering programmes (as Southern Water has). Companies may also meter if they have successfully applied for a designation of water scarcity. Under the Flood and Water Management Act 2010, companies can include social tariffs for customers who would otherwise be unable to pay in full in their charging schemes.[19] Following meter installation, efficient use could be further incentivised through putting average area use on water bills, seasonal tariffs in times of restricted supply or 'smart meters' with innovative tariffs and offering water efficiency kits and advice to help control bills.
- **Retrofitting water efficiency products** can be carried out at the town or city scale, usually covering taps (fixing leaky taps and attaching aerators), lavatories (converting single flush to dual flush or reducing flush volumes) and showers (fitting aerators and new efficient showerheads). Products for efficient water use in gardens include water butts for rainwater harvesting and drip irrigation systems. The 'Green Deal' energy efficiency finance mechanism (POSTnote 409) applies only to hot water efficiency measures that also save energy. Planning authorities could require developers to fund retrofitting to ensure there is no net increase in demand.
- **Building regulations** already stipulate some water efficiency requirements for new build domestic properties and the Code for Sustainable Homes has a mandatory water efficiency element. The Greater London Authority has required incorporation of rainwater harvesting in new developments and Waterwise believe similar requirements could be made for grey water technologies (for reuse of wastewater that does not contain human waste), if health and safety and convenience issues are addressed. No requirements are placed on commercial or industrial new build, but other countries, such as Singapore, require commercial developments to incorporate the latest water efficient technologies
- **Behaviour change** studies, to determine people's water use habits in domestic settings and messages individuals are receptive to, are ongoing. Given the relatively low price of water, financial considerations may not be the key motivator for adopting water saving behaviours, although savings may be more significant if measures also save energy (POSTnote 417). Defra is seeking to increase community awareness of the impacts of water use on local watercourses through the 'Love your River' campaign.

National Planning Policy Framework, and under the 2011 Localism Act duty to cooperate, consult water companies on these plans. However, there is no duty on water companies to cooperate with local authorities, whose areas often cover a number of local authorities. Local authority boundaries may also fall across different water companies or WRZs, raising questions over whether there are the right institutional and planning structures to implement adaptation.

Understanding of the interdependencies of the food, energy and manufacturing sectors with water is also necessary to ensure economically resilient consumption and production (POSTnote 385). For example, there needs to be consideration of water use across the entire life cycle of an energy technology and its dependence on water availability. Future water demand may be driven by stages of energy production other than power generation. For example, fracking for shale gas (POSTnote 374) requires a large volume of water, 75% of which remains in the well (a 'consumptive' use). Such approaches could increase overall water use in energy production, reducing water availability for other sectors.

Box 5. Increasing Supply

- **Water transfer** between river catchments already exists, for example, the Ely Ouse to Essex transfer has been working since the 1970s. New water transfer schemes between neighbouring companies will be considered in the next round of WRMPs (Box 3); for example, between the lower reaches of the river Severn and the Thames over the Cotswolds. However, there are water quality issues arising from discharging into another river as well as the energy costs and carbon emissions from pumping that need to be considered in scheme designs.
- **New supply infrastructure** such as new reservoirs could be built or the size of dams of existing reservoirs raised, as is being done at Abberton reservoir in Essex. However, sufficient excess water is needed to fill additional reservoir capacity. Desalination plants, such as the Thames Water plant at Beckton, would be another possibility, but these have significant energy needs, supplying a litre of water through desalination costs more than saving it through demand management and the discharge of brine has environmental impacts.
- **Interconnection infrastructure** between water companies already exists, but since privatisation CAPEX (Box 1), has incentivised water companies to develop their own resources rather than sharing existing ones through inter-company trading of water resources. However, reliance on neighbouring water companies is part of a number of company's WRMPs.
- **Aquifer recharge** uses water treated to drinking water standards to recharge a groundwater aquifer for re-abstraction when required, for example, the Haringey aquifer recharged by Thames water. However, this supply option is limited by the availability of suitable aquifers and the pumping has energy costs and carbon emissions.
- **Direct effluent reuse** technology exists for treating effluent to potable standards for public water supply. Where there is risk from pollutants this could include additional treatment (reverse osmosis through membranes). At present, treated effluent is blended with river or reservoir water before indirect re-use. For example, Oxford's effluent is treated, then discharged to the Thames, re-abstracted to the reservoirs near Heathrow and treated to form part of the public water supply for London. The Langford recycling plant in Essex disinfects and removes phosphate, nitrate and ammonia from waste water previously piped into the Blackwater Estuary. The treated water is now released into the Chelmer, providing more water for the Hanningfield reservoir. Wastewater flows are resilient to climate change as they are constant and the most wastewater is produced in the same area that demand is highest.

Endnotes

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