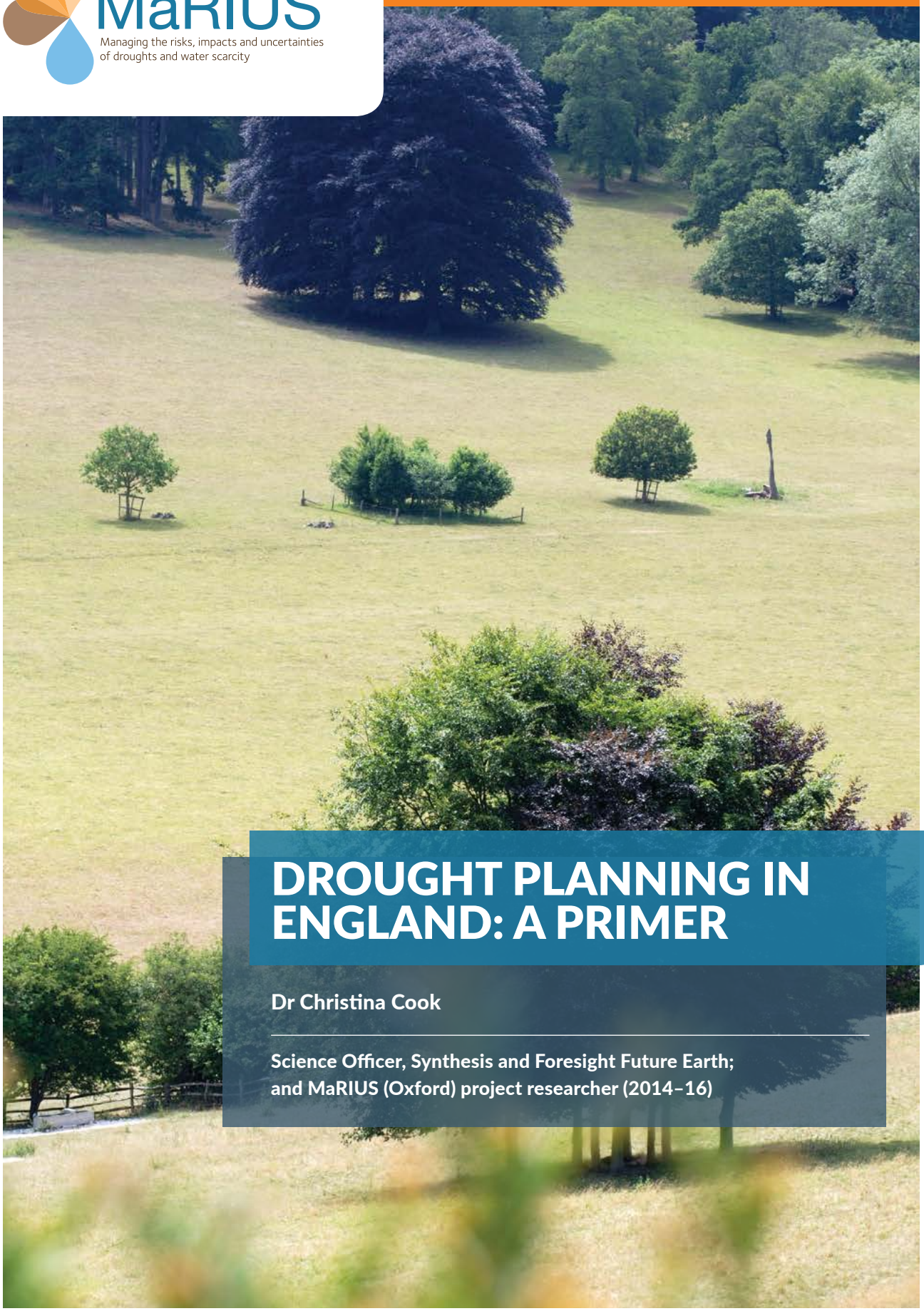
MaRIUS

Managing the risks, impacts and uncertainties of droughts and water scarcity



DROUGHT PLANNING IN ENGLAND: A PRIMER

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About MaRIUS

Following the 2011–2012 UK drought experience, the MaRIUS project received NERC funding to explore how best to manage future droughts. Managing the Risks, Impacts and Uncertainties of drought and water Scarcity (MaRIUS) introduces a risk-based approach to drought and water scarcity in order to inform management decisions and prepare households.

MaRIUS is funded by the Natural Environment Research Council, and undertaken by a project team spanning the University of Oxford [NE/L010364/1], University of Bristol [NE/L010399/1], Cranfield University [NE/L010186/1], the Met. Office, and the Centre for Ecology and Hydrology [NE/L010208/1].

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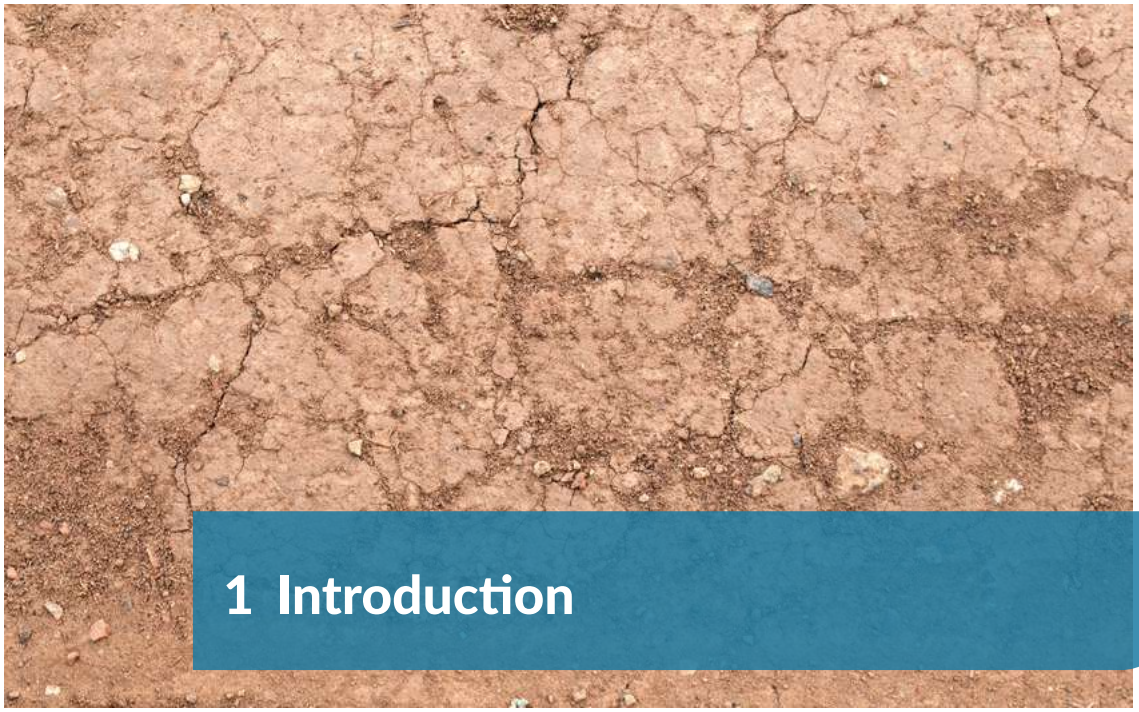


1 Introduction

This primer explains and examines statutory drought planning in England by water companies. A water company drought plan sets out the company's operational plans for drought; it explains the management actions a company will take in the course of a drought. A water company drought plan is related to, and based upon, the Water Resources Management Plan – the mandatory twenty-five-year plan water companies must prepare every five years. Here we aim to provide an accessible guide to the process of drought planning in respect of public water supply.

This primer also offers an overarching view of how drought planning works in practice, based on conversations with water managers in a range of organisations including water companies, regulatory agencies and consultancies. It pulls together disparate wide-ranging key materials, (e.g. legal provisions and public policies relevant to managing drought) and attempts to add transparency to a highly technical process.

This primer first defines drought and water scarcity then discusses why we care about drought in England and how we plan for it. It then reviews the context of drought planning in the UK, the role of water companies and other organisations, and the regulatory framework. Included in the primer are contributions from a range of researchers on the MaRIUS project[1] regarding the impact of drought in England and the UK more widely. In the United Kingdom, the constituent countries have competencies in relation to environmental management (Fisher *et al*, 2013).

1 MaRIUS: a UK Research Council funded project examining the impact of drought in the UK: Managing the Risks, Impacts and Uncertainties of drought and water Scarcity.

This means that England, Wales, Scotland, and Northern Ireland have, to some degree, distinct regulatory approaches to the management of drought. The drought planning framework in Wales is similar to that of England while Scotland and Northern Ireland have quite distinct frameworks. Focussing on England, this primer offers some preliminary commentary on the strengths and limitations of current practice of drought planning, including the challenge of trading-off responsiveness to local circumstances shaping water resources planning, and the need for national guidance in light of a comparative economic regulation regime which seeks to create a level playing field for water companies.

2 Understanding Droughts

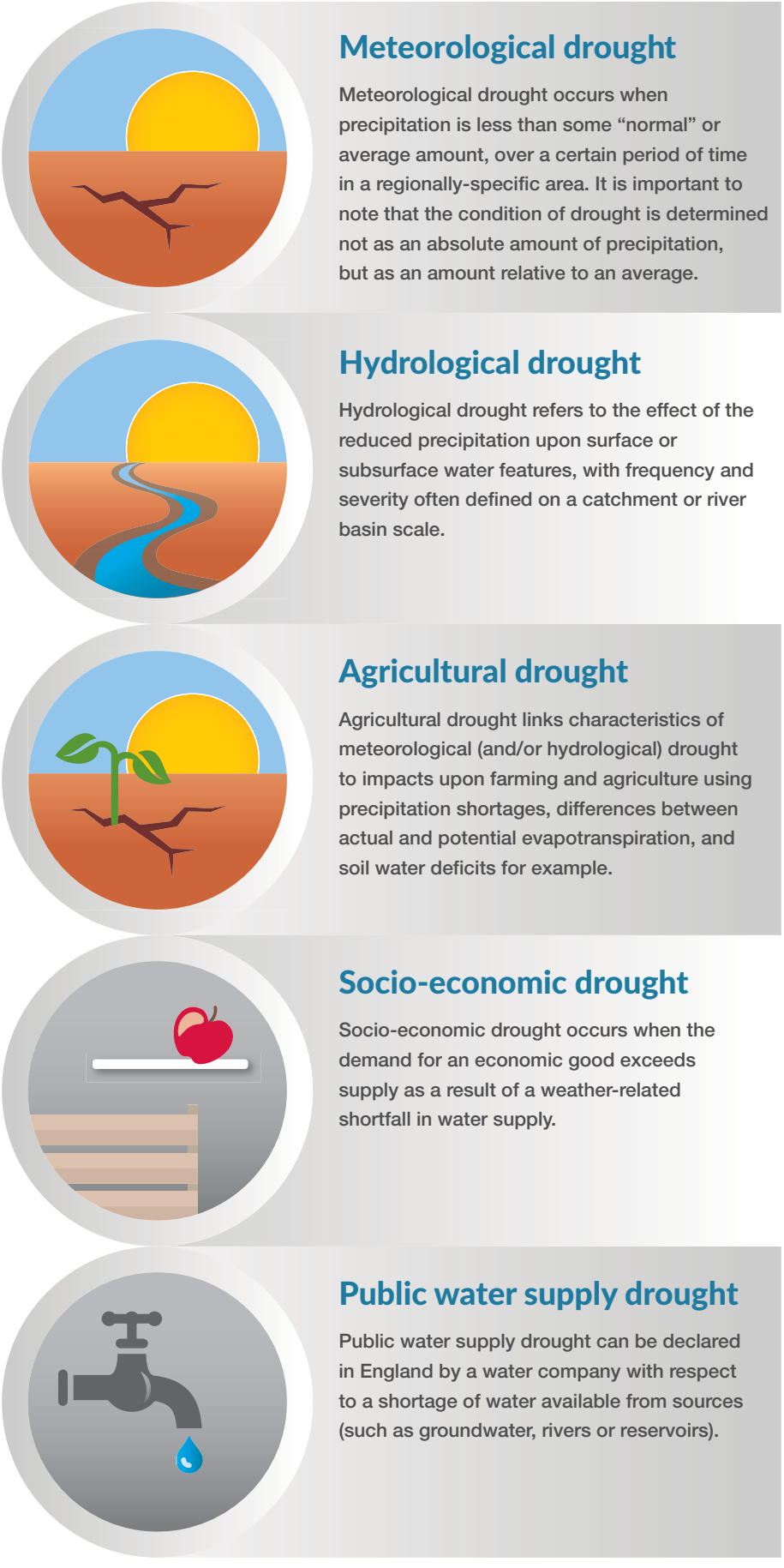
What is drought?

For many natural scientists, drought is a natural hazard that happens just like floods, earthquakes and hurricanes. More specifically, drought is often defined as a climate event in which precipitation is relatively less than some normal range, for some recent time period, in a particular region (Field *et al*, 2012). The onset of drought is sometimes referred to as a meteorological drought (Wilhite *et al*, 2014) because there is an observed deficiency of precipitation. As time goes on, drought affects the environment and society via impacts on farming and agriculture, reduced river flows and socio-economic impacts where demand for an economic good can exceed supply as a result of a weather-related shortfall in water (Wilhite *et al*, 2014).

For many social scientists, drought is socially-constructed. In other words, drought is a normal climate event but its impacts on natural and social systems is, in part, the result of our social structures, behaviours, and expectations. We have configured ourselves so as to considerably amplify the impact of drought. The more ways in which a society demands water, the more stressful the experience of drought is likely to be. If an ecosystem is already stressed from reduced water quantity when a drought occurs, arguably both natural and social systems will be less able to withstand and adapt to the drought. Although not the subject of this primer, the differing viewpoints about drought as a natural or a socially-constructed hazard has important implications for thinking about possible solutions.[2]

2 For further reading on this point please see Taylor *et al*, 2009.

Figure 1: Different types of drought. Visualised from National Drought Mitigation Center & Environment Agency.



Meteorological drought

Meteorological drought occurs when precipitation is less than some “normal” or average amount, over a certain period of time in a regionally-specific area. It is important to note that the condition of drought is determined not as an absolute amount of precipitation, but as an amount relative to an average.

Hydrological drought

Hydrological drought refers to the effect of the reduced precipitation upon surface or subsurface water features, with frequency and severity often defined on a catchment or river basin scale.

Agricultural drought

Agricultural drought links characteristics of meteorological (and/or hydrological) drought to impacts upon farming and agriculture using precipitation shortages, differences between actual and potential evapotranspiration, and soil water deficits for example.

Socio-economic drought

Socio-economic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply.

Public water supply drought

Public water supply drought can be declared in England by a water company with respect to a shortage of water available from sources (such as groundwater, rivers or reservoirs).

Notably, legislation in England does not explicitly define drought. Rather, it limits the use of particular regulatory tools to specific conditions. For example, Section 73(1) of the Water Resources Act 1991 provides that "If the Secretary of State is satisfied that, by reason of an exceptional shortage of rain, there exists or is threatened— (a) a serious deficiency of supplies of water in any area, or (b) such a deficiency in the flow or level of water in any inland waters as to pose a serious threat to any of the flora or fauna which are dependent on those waters" then the Secretary of State may issue either an ordinary or emergency drought order. The available regulatory tools for drought management will be further explained in section 6.

Is there a difference between drought and water scarcity?

Water scarcity and drought are both conditions in which water availability is less than the collective demand for water from humans (e.g. domestic and industrial use) and the environment. Drought is an acute phase of water scarcity linked to hydro-meteorological conditions. Water scarcity is not necessarily linked to hydro-meteorological conditions; for example it may be locally produced by infrastructure faults (e.g. frozen or burst pipes). More typically, water scarcity exists when, over a certain time period (perhaps more than 2 or 3 years), demand for water is greater than available supply (European Commission, 2012a). Unlike drought, water scarcity is well understood as a social phenomenon because it is the demands of humans, based on our social and cultural expectations for using water, which exceed the amount of water available in a natural system (Aguilera-Klink, 2000).

Different societies (in different times and places) have different demands for water. Flush toilets, daily showers and regular laundry are just a few examples of the ways in which people use water intensively in our (affluent Western world) domestic lives in the 21st Century. In non-domestic sectors, use of water has also increased manifold, not least in the form of irrigated agriculture, drinks manufacturing (from carbonated beverages to bottled water), pulp and paper production, use in electricity generation, chemical and metal manufacturing and petroleum refining. Industrial manufacturing uses water in multiple ways to fabricate, process, wash, dilute, cool, transport, or clean. How much water we use is deeply connected to our social expectations for products, for food, and cleanliness.

Why do we care about drought in the UK?

We care about drought in the UK because science suggests, with medium confidence, that we can expect droughts to intensify in some areas and some seasons in the 21st Century (IPCC, 2012)[3]. The European Commission has stated that, "Over the past thirty years, droughts have dramatically increased in number and intensity in the EU.

3 The IPCC explains that "Definitional issues, lack of observational data, and the inability of models to include all the factors that influence droughts preclude stronger confidence than medium in drought projections" (IPCC, 2012.

The number of areas and people affected by droughts went up by almost 20% between 1976 and 2006" (European Commission 2012). In England, the environmental regulator (the Environment Agency) has classified most of south-east England as seriously water stressed (Defra, 2008), using a methodology that "identifies areas of serious water stress where: (a) The current household demand for water is a high proportion of the current effective rainfall which is available to meet that demand; or (b) The future household demand for water is likely to be a high proportion of the effective rainfall available to meet that demand" (Environment Agency and National Resources Wales, 2013). As noted above, in areas with pre-existing water scarcity the impacts of drought are likely to manifest more quickly and with deeper effect.

All droughts are different in nearly every way – how long they last, how severe they are, how many people are affected, and how the environment is impacted; thus, planning for drought is complicated. Additionally, variability in droughts matters for drought planning, and shows that not just water companies but also other abstractor groups such as farmers may find it necessary to engage in 'drought planning'. Recent major droughts around the world have highlighted the importance of preparing for drought. We know drought differs from other natural hazards in important ways. It is a slow-onset natural hazard so that the extent of its impacts may not reveal themselves at first. That all droughts are different means that drought will always be defined by region and have specific impacts. Finally, unlike some other natural hazards, drought impacts and damages are diffuse and can spread over a large geographical area (Wilhite *et al*. 2014).

Climate change is expected to affect the occurrence and characteristics of droughts in the UK in various ways as the meteorological conditions change. First, precipitation is expected to change in a warmer climate. Model results from the MaRIUS project and from other climate projections projects such as the UKCP09[4] show that, on average, precipitation will likely increase in winter, but decrease in summer and, to a lower extent, in spring and autumn. In addition to changes in precipitation, the increase in temperature, together with other factors, is expected to lead to an increase in potential evapotranspiration (this is the evapotranspiration that takes place when soil moisture is not limiting). This increase is predicted to be most pronounced in summer and for the south of the UK, and can be expected to lead to a stronger drying in summer than what could be expected from a decrease in precipitation alone.

Thus, droughts in the UK should be expected to become particularly more frequent and/or more intense in summer. Conversely, winter meteorological droughts may decrease in the future. These results are, however, based on changes in the average precipitation and potential evaporation, and do not account for the temporal persistence of low rainfall, high potential evaporation period. Most climate studies agree that, overall, drought frequency and intensity will likely increase in the future, although with large uncertainties.

4 http://ukclimateprojections.metoffice.gov.uk

What are potential impacts of drought in the UK?

Impacts of drought in the UK will be felt in numerous ways and by all sectors. Here we look at the effects on agriculture, on water quality, and on ecosystems.

Agriculture

Due to its dependence on weather conditions, the agricultural sector will be significantly affected by drought and water scarcity. A lack of water makes it difficult to meet crop water requirements, leading to a decrease in crop yield and quality, which will have important consequences for farmers, the rest of the food supply chain, the wider economy and food security. For example, the financial benefits of supplemental irrigation in England and Wales in a dry year have been estimated at more than £660 million at the farm level (Rey, 2016). However, a future of increased drought frequency and increased water scarcity requires more collaborative management of catchment water resources, where agriculture plays an important role. For example, such measures could involve improved seasonal forecasting to allow farmers to plan for future water related risks and improved (re-)allocation of water resources within agriculture. There should be a more equitable sharing of water resources to relieve the burden of drought impacts across multiple sectors: this needs to be informed by an improved evidence base of the ecological impacts of abstraction and the resilience of natural systems to recover from drought and water scarcity.

Water quality

Drought affects water quality in many ways with the first and major impact being the reduced ability of rivers to dilute pollutants as flows reduce due to lower rainfall. With reduced dilution, point sources of pollution in rivers have a larger impact, increasing concentrations of nutrients such as nitrogen and phosphorus, and these, in turn, affect the aquatic environment, for example, by stimulating algal blooms. These algal blooms cause changes to the natural functioning of the ecosystem, and can be innocuous or harmful to humans depending on the species of algae. For example, cyanobacterial blooms are highly toxic and can threaten and prevent the water being used for multiple purposes, from recreation to public and industrial water supply. Algal blooms also significantly lower the amount of dissolved oxygen in the water, particularly at night (due to the respiration of the algae) which can damage fish and macroinvertebrate populations.

Droughts are also associated with increased water temperature, and this in turn alters natural chemical reactions in rivers, in particular by speeding up chemical processes. Higher temperatures also affect the levels of dissolved oxygen, as water of a high temperature cannot hold as much as colder water. The net effect is to lower the amount of dissolved oxygen and reduce the capacity of the river to naturally (reaerate) absorb oxygen again with consequential adverse effect on aquatic fauna. Increased temperatures can also affect fish populations as certain species (e.g. trout) prefer cooler waters.

A result of drought-induced lower flows is a regime in water courses where the water moves more slowly; this, in turn, creates a higher residence time. The residence time is the length of time for water, or a chemical or sediment suspended in the water, to move through an area. So, a higher residence time means that water and suspended pollutants take longer to pass through the system, resulting in more time for organic pollution to reduce the water quality of a particular location. During low flow periods, there is a build-up of sediments comprised of nitrogen and other pollutants such as organics, metals and plastics (particularly in urban areas). Upland streams for example, could experience increased dissolved organic carbon in the water, and higher colour levels during drought, as a result of the desiccation and erosion of peaty soils into the streams.

Storms that terminate drought periods will flush nutrients from urban and rural areas, generate acid pulses in acidified upland catchments, and remove the accumulated materials that have been built up (Whitehead, 2009). The flush of pollutants into rivers can further reduce water quality, which is another threat to water users. These post-drought pollutant flushes may require additional action at water treatment plants to prevent toxic by-products passing into potable supply.

Ecosystems

Droughts span terrestrial and aquatic environments and have the potential to affect a wide array of habitats and species according to their precise magnitude, timing, frequency and duration. The water requirement of plants and animals varies according to the species, and therefore so do their tolerance and response to drought. This is important because it is species assemblages that support the healthy functioning of ecosystems, for example through the structure of food webs.

In terrestrial ecosystems, droughts reduce plant productivity and species richness, which, in turn, affects the distribution and abundance of other organisms. In aquatic ecosystems such as rivers and lakes, droughts reduce the amount of wetted habitat as well as affecting water quality, as mentioned above. The resulting habitat leads to reduced abundance, species diversity and ecological functioning in aquatic plants and animals. In wetland environments, drought stress can have profound effects for the many species of birds and mammals that use these habitats.

Given time, organisms and habitats may recover fully, because they have evolved strategies to be resilient to drought. However, if droughts are severe, prolonged, occur seasonally, or are so frequent that recovery time is insufficient, species can be locally extirpated and habitats altered, compromising ecosystem functioning for the longer-term.

Given these significant impacts of various types of droughts on different sectors, it is crucial that we prepare for drought. But how do we do this?

How do we prepare for drought?

Importantly, the diffuse impacts of a drought make it difficult to prepare at the household level. Unlike an earthquake, drought is not the type of scenario for which one prepares a 72-hour response kit. The onset of drought is slow and its future impacts can only be estimated. Household preparation for drought may include the installation of low-volume appliances or greywater systems, i.e. the reuse of water in the household, as well as changed behaviours leading to water conservation.

Governments (local, regional and national) prepare, or fail to prepare, for drought when they make decisions explicitly about how to manage for drought (and water scarcity) and, importantly, when they make decisions about land use whether it be for human settlements (including infrastructure and transportation), agriculture, industry, or environmental preserves. Many government decisions have an impact on the availability of water resources, directly or indirectly, and together these decisions shape our collective ability to respond to drought.

3 The context of managing drought in England

This section provides background on public water supply management in England. It is against this background that government makes decisions in relation to water resource management. Subsequent sections therefore map key actors in drought planning and explain and examine the process of statutory drought planning and management. In England, drought management is a component part of Water Resources Management Planning.

The legacy of the 1989 privatisation of water services and sewerage provision is a mosaic of privatised utilities, managing water services separately from land use and wider environmental management. This mosaic is rather patchy on account of Ofwat's appointments and variations of new water suppliers, formerly known as inset appointments. As of 2017, England has 21 private water companies, twelve of which supply potable water and nine that both supply potable water and sewerage services[5] (see Table 1). In the other three countries of the United Kingdom, water services and sewerage provision are delivered by non-corporate entities: in Northern Ireland by a government-owned company (Northern Ireland Water); in Scotland by a publicly owned company, answerable to the Scottish Parliament and thus the people of Scotland (Scottish Water); and in Wales by a limited guarantee company which does not seek to obtain profits for shareholders (Welsh Water-Dwr Cymru), but note that part of Wales is serviced by Severn Trent Water and by Dee Valley Water. Many features of the regulatory framework in Wales are largely the same as in England, but increasing divergence may develop henceforth from the 2013 creation of the Welsh environmental regulatory agency, Natural Resources Wales.

5 WaterUK provides a map showing water company boundaries.

Table 1: Potable water & sewerage services by company		
	Potable water	Sewerage services
English water companies		
Affinity Water		
Anglian Water		
Bournemouth Water		
Bristol Water		
Cambridge Water (South Staffs)		
Cholderton and District Water		
Dee Valley Water		
Essex & Suffolk Water (Northumbrian)		
Water (Anglian)		
Northumbrian Water		
Portsmouth Water		
SES Water		
Severn Trent Water		
South East Water		
South Staffs Water		
South West Water		
Southern Water		
Thames Water		
United Utilities		
Wessex Water		
Yorkshire Water		
Devolved administration water companies		
Dŵr Cymru – Welsh Water		
Northern Ireland Water		
Scottish Water		

Before privatisation, public organisations known as 'Water Authorities' provided drinking water and sewage services and also managed rivers, land drainage and water pollution. Privatisation transferred the environmental regulatory functions (river management etc.) from the Water Authorities to the National Rivers Authority, which later became integrated into the Environment Agency for England and it assigned the duty to supply drinking water and sewage services to private water companies.

The realignment of the regulatory framework to respond to privatisation created three regulators for the water industry: an environmental regulator the National Rivers Authority, now the Environment Agency; an economic regulator: the Water Services Regulation Authority, known as Ofwat; and a drinking water quality regulator: the Drinking Water Inspectorate. To consolidate the regulatory framework for the new arrangements brought into existence by privatisation, the UK Parliament passed five pieces of legislation. For the purposes of understanding how drought and water scarcity are managed in England (and currently in large part, in Wales), two of those five statutes are key: the Water Resources Act 1991 and the Water Industry Act 1991 (both as amended). Together these two acts are the backbone of the regulatory framework.

Box 1: Water Resources Act 1991

The Water Resources Act 1991 sets out the functions and powers of the Environment Agency (hereinafter the EA) in relation to water resources management, environmental water quality, and pollution offences.[6] The Water Industry Act 1991 sets out the roles and responsibilities for Ofwat and for water and sewerage companies (in the legislation, water undertakers), including the standards of wholesomeness for drinking water (as overseen by the Drinking Water Inspectorate).

In England, the Department for Environment, Food and Rural Affairs (Defra) sets the regulatory framework for the provision of water services and sewerage. Defra develops water policy for England through the periodic release of White Papers, which are government documents that provide information about an environmental governance challenge and may provide proposals for legislation. Defra also issues consultation documents, for example on specific proposals for legislation or guidance. Along with the EA and Ofwat, and in consultation with water companies, Defra develops policy through legislation and soft law guidance. The latter are documents that interpret legislation and explain how water companies can meet the legislative requirements. Drivers of policy and legislation include domestic environmental issues, as well as Brexit EU legislation.

6 With some of these offences now contained in the Environmental Permitting Regulations.

In its 2011 key White Paper, Water for Life, Defra set out its objectives for change in the water sector which included the development of a vision for improving water quality, tackling unsustainable abstraction, improving affordability, ensuring a stable framework for, and removing barriers to, competition in the water sector, and assessing resilience to future challenges. The Water Act 2014 implemented several of the policy statements of the 2011 White Paper, by amending the Water Industry Act 1991. Among the new statutory provisions, particularly relevant to drought and water scarcity, were those that:

- changed the frequency of drought plans from every three years to every five years in order to synchronise this with the frequency of water companies' Water Resources Management Plans being prepared;
- required Defra to report on abstraction reform;
- removed compensation in some circumstances for licence modification (in support of abstraction reform);
- increased transparency of negotiations between water companies for bulk water supplies; and
- introduced a new duty imposed upon Ofwat 'to further the resilience objective'.

All of these provisions have implications for drought planning. For instance, the scope of abstraction reform which is expected to be implemented in 2020 (although post-Brexit this may become less of a focus for the government) —and its potential effects may be very significant, but are still to be precisely defined.

Drought and abstraction reform

In January 2016, Defra outlined the broad strokes of abstraction reform – changing the rules for volumes, methods and timings of abstractions of water -- in England. Abstraction reform (prior to the EU membership referendum 23 June 2016, "Brexit") was expected to include five main changes to the existing practice (Defra, 2016a; Defra 2016b; Defra *et al*, 2016).

1. Licences will be replaced with abstraction permits that will be issued with permitted volumes that reflect current business use and have similar reliability to current licences. This change is expected to enable the Environment Agency to recapture the headroom contained in existing licences.
2. Seasonal permits will cease to exist. This change means that abstractors will be able to take water at any time when flows are high and store it. An expected response to this change is the greater use and creation of reservoirs.
3. Conditions that enable flow-based controls to protect the environment will be inserted into all abstraction permits that have a direct effect on surface water. Flow-based controls are intended to share environmental protection across abstractors in a proportional way.

4. Water trading will be better facilitated in catchments where it offers potential benefits. Such catchments will go by the name ‘enhanced catchments’ and, in these, surface water abstractors will be given a share of the catchment’s different water resources with the intent to facilitate pre-approval of upstream trades. Water trading is meant to give abstractors more flexibility to cope during low flows and reveal the value of water to underpin decision-making.

5. No water abstraction permit will be time limited. Instead, the adoption of a risk-based catchment approach to review of permits, and the publication of catchment data and information, is expected to help abstractors to better understand the environmental risks in their catchment. Reasonable notice (likely to be three years) will be given for potential permit changes. There will be no compensation for permit changes, and permits will not expire; however, abstraction conditions can change based on risk-based reviews. This change attempts to level the playing field of abstractors.

4 Statutory drought planning in England

In developing drought plans, water companies must meet the legislative and regulatory requirements set by Defra (and currently, some provisions mandated by the EU) and follow the guidance prepared by the Environment Agency (Environment Agency, 2011). The EA guidance explains the statutory process for drought planning – including the need for consultation and responses to that consultation – and it outlines the form and content required of the drought plan. Based on our research, in practice, most water companies view drought plans as operational plans that they write alongside the statutorily required Water Resources Management Plans (WRMPs) and their Business Plans. So, how does the regulatory framework shape drought planning?

Domestic legal provisions

Sections 39B and 39C of the Water Industry Act 1991 (as amended by the Water Act 2003) mandate drought planning by water companies. In drought plans water companies must outline how, in drought conditions, they will: maintain water supply systems and water quality, have as little recourse as possible to measures such as drought orders and drought permits and detail how they will restrain demand, obtain extra water, and monitor the effect of measures taken to manage a drought.

In addition, other provisions such as Defra policy documents, ministerial guidance, e.g. to Ofwat (Defra, 2016c) and industry Codes of Practice are important to understand the planning for, and the management of, drought and water scarcity. As noted, the two main statutes relevant to water resources management and drought planning in England and Wales are the Water Resources Act 1991 and the Water Industry Act 1991 (both as amended by the Water Act 2003) the Water Act 2014 and the Flood and Water Management Act 2010. Additional statutory instruments, including regulations and directions, outline more specific requirements for drought planning.

European Union: Water scarcity and drought

In light of Brexit the role of European Union law on English drought planning may change. To date the European Union has not issued a specific directive for water scarcity or drought. In 2007, the EU Commission published a communication which stated that the management of water scarcity and drought could be achieved through the already existing European Union Water Framework Directive (WFD) (Defra, 2008). The EU communication outlined seven policy options for tackling water scarcity and drought:

- pricing water;
- greater efficiency in water allocation;
- improving management of drought risk;
- expanded water supply infrastructure;
- greater uptake of water efficient technology and practice;
- greater uptake of water conservation; and
- improved data collection.

In 2012 the EU Commission published a report on EU Member States' implementation of the 2007 Communication. Persistent key policy gaps in addressing water scarcity and drought include: a lack of understanding of the causal relationships between water scarcity and drought and their impacts; a lack of data, including about current and future water demand and availability; and the integration of policies to manage the complexity of water scarcity and drought (European Commission 2012). The EU Commission called for a greater focus on the implementation of the WFD, and especially of its quantity measures. Hence, a key aspect of the EU approach is to consider the management of water scarcity and drought as an integral part of water resources management.

Although there is no specific EU Directive on drought, EU environmental Directives[7] – which have been transposed into UK law – and Regulations[8] have impacted the management of drought and water scarcity in England and Wales. Three EU Directives, in particular, are relevant to drought planning:

- the Water Framework Directive (WFD) (European Commission, 2000);
- the Strategic Environmental Assessment Directive (SEA Directive) (European Commission, 2001); and
- the Habitats Directive(European Commission, 1992).

7 EU Directives are laws made by the European Union that EU members must transpose into domestic legal frameworks.

8 EU Regulations apply without the need for transposition to all member states of the EU.

Box 2: EU Directives and Drought Planning

The WFD introduced river basin planning across the EU to improve coordination between different organisations involved in water resource planning and to enhance water quality across the EU. Transposed into domestic law (UK Statutory Instruments, 2003), the WFD required the UK to develop river basin management plans and to review new developments that might cause deterioration of a water body and to achieve and maintain, for example, Good Ecological Status or Good Ecological Potential of waterbodies.[9] Measures proposed for the management of both surface- and groundwater bodies in these River Basin Plans can impact Drought Planning, and thus ideally should be taken into account when water companies write their Drought Plans.

The SEA Directive was transposed into English law as the Environmental Assessment of Plans and Programmes Regulations 2004. These regulations set out the process to identify, describe and evaluate the likely significant environmental effects of implementing a proposed plan or programme (in this case a statutory Drought Plan), and reasonable alternatives to it, whilst taking into account the objectives and the geographical scope of the plan or programme (European Commission, 2001, para 14). Our empirical research for the MaRIUS project suggests that only a minority of water companies in the UK carry out SEAs of their Drought Plans, though companies do undertake a SEAs of their Water Resources Management Plans which may shape what drought management options are proposed in water company Drought Plans. This raises the question how best to capture environmental impacts of drought management options at a strategic level.

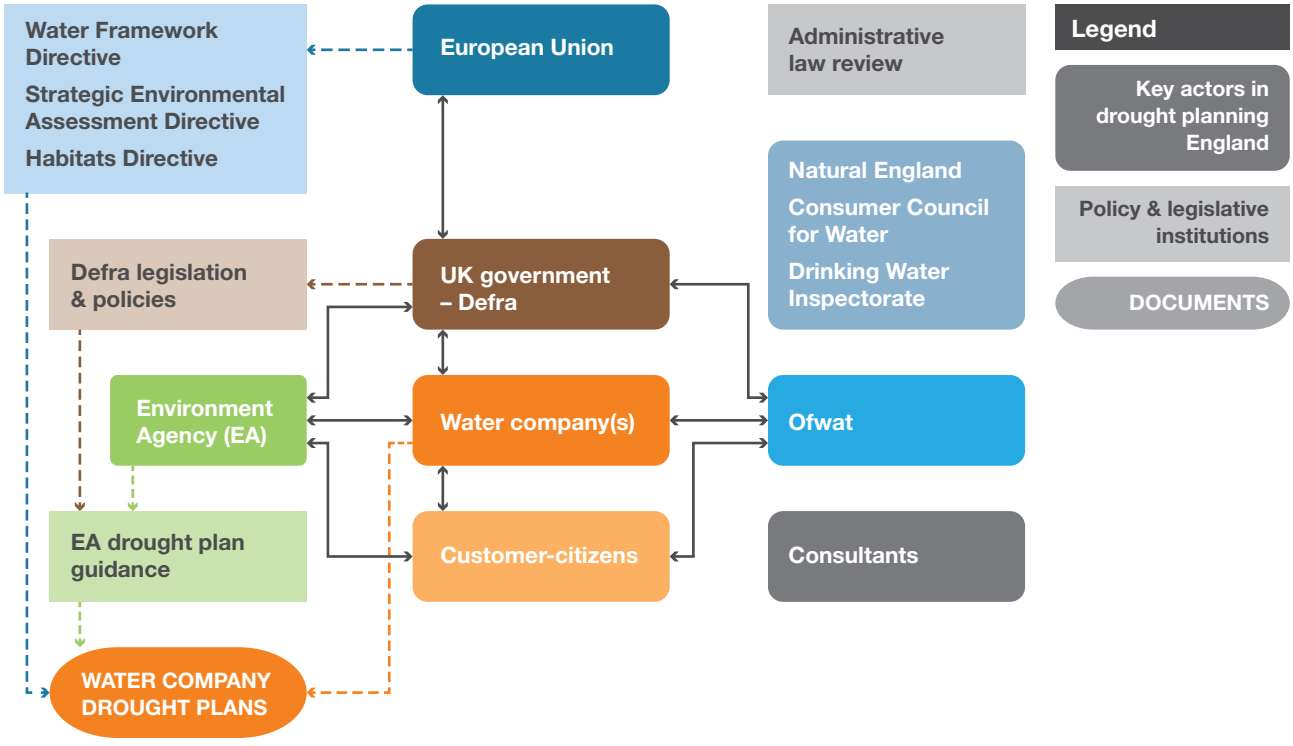
The Habitats Directive forms a key part of the EU's Natura 2000 initiative to protect nature, specifically, biodiversity and species habitat. In the UK, the EU Habitats Directive has been implemented through the Conservation of Habitats and Species Regulations, 2010, as amended (UK Statutory Instruments, 2012). The intent of the Habitats Directive is to ensure that European nature conservation sites are not harmed unnecessarily. But if there are 'imperative reasons of overriding public interest, including those of a social or economic nature' a European site may be harmed if compensatory measures are adopted (European Commission, 1992, Article 6(4); Fisher *et al*, 2013). Determining what might be considered to be 'imperative reasons of overriding public interest' has been contentious. Defra guidance sets out the test for determining 'imperative reasons of overriding public interest' and emphasises that it must be determined 'on a case by case basis in light of the objective of the particular plan or project and its particular impacts on the European site(s) affected as identified in the appropriate assessment' (Defra, 2012). Hence, there is significant scope, but also discretion for making sure that drought management options do not damage nature conservation sites.

9 This applies to both surface and groundwater bodies. Their ecological status or potential is classified with reference to a range of criteria, such as the composition and abundance of aquatic flora, as well as the composition, abundance and age structure of fish fauna, and further criteria listed in Annex V to the Water Framework Directive.

5 Key actors in drought planning

Figure 2: The drought planning framework in England.

Figure 2 maps the drought planning framework in England. The key actors in the governance space for drought planning in England are Defra, Ofwat, the EA, water companies, customer-citizens, and consultants. Other actors include Natural England (NE), the Consumer Council for Water (CCW), the Drinking Water Inspectorate (DWI), and the European Union (EU).



Box 3: Who's who in drought planning for England

Consumer Council for Water (CCW) works with English and Welsh consumers in order to represent their interests in Ofwat's review of water companies' prices for drinking water and sewerage services. It also resolves complaints between domestic customers and water & sewerage companies (Consumer Council for Water 2015).

Consultants based at consultancy firms are key actors in the governance space where they mediate knowledge exchange and expertise between regulators and water companies.

Customer-Citizens includes citizens, organised non-governmental organisations, such as the Rivers Trust and affiliated local action groups, such as 'Action for the River Kennet', as well as unaffiliated local action groups, such as GARD, the Group Against Reservoir Development at Abingdon. Citizens are important actors in the regulatory space because the legislation requires that their views are considered.

Drinking Water Inspectorate (DWI) regulates the quality of drinking water and helps Ofwat to fulfil its legislative mandate regarding water supplier licences and compliance with statutory requirements. The DWI participates in Ofwat's price review process and thus the review of Water Company's Business Plans.

Defra is the UK government Department for Environment, Food and Rural Affairs. It represents the executive in the regulatory space. It heads the civil service and develops policy and proposes legislation. In relation to drought management Defra has important legal decision-making functions.

The Environment Agency (EA) is the key environmental regulator of drought. Its role in relation to drought is both strategic by being involved in longer term planning processes that seek to prevent water scarcity and drought. It is also responsive in the short-term because it plays an important role in making specific drought management options happen during a drought including granting or denying water company applications for drought permits or making its own applications to Defra for drought orders.

Natural England (NE) is the government's advisor in relation to the natural environment. Its main role is as a consultee in relation to water company draft WRMPs and draft drought plans where these affect protected species and their habitats. In particular, NE reviews proposed drought orders or permits with a specific goal of advising on the potential impact of increased abstraction of water from the environment on protected species and habitats.

Ofwat is the economic regulator of the water industry in England and Wales. It regulates the water industry because even after privatisation water companies are still regional monopoly operators of the water industry and there is no direct competition governing the supply of water services. Market forces that would normally be expected to favourably influence prices charged for water and its quality are therefore largely absent. Ofwat conducts a price review process every 5 years through which it limits prices that water companies charge domestic and non-domestic customers.

Water companies in England are publicly-limited companies traded on the stock market; they may provide water services only or both water and sewerage services.

In Figure 2 the solid black two-way arrows between the actors represent relationships between actors and indicate a flow of information between them. The dotted arrows between actors and legal and policy institutions indicate which actors lead the development of particular policy or legal initiatives. The dotted arrows between the various institutions suggest a relationship between them. For example, the EA drought plan guidance is informed by Defra legislation and policies and, in turn, the EA drought plan guidance provides a structure to the mandatory water company drought plans. The administrative law review box references the review processes that can amend decisions made by government ministries and agencies. Sometimes these reviews can produce unexpected results that overturn earlier decisions. The relevance here is that the governance of drought planning may be less stable than it at first seems.

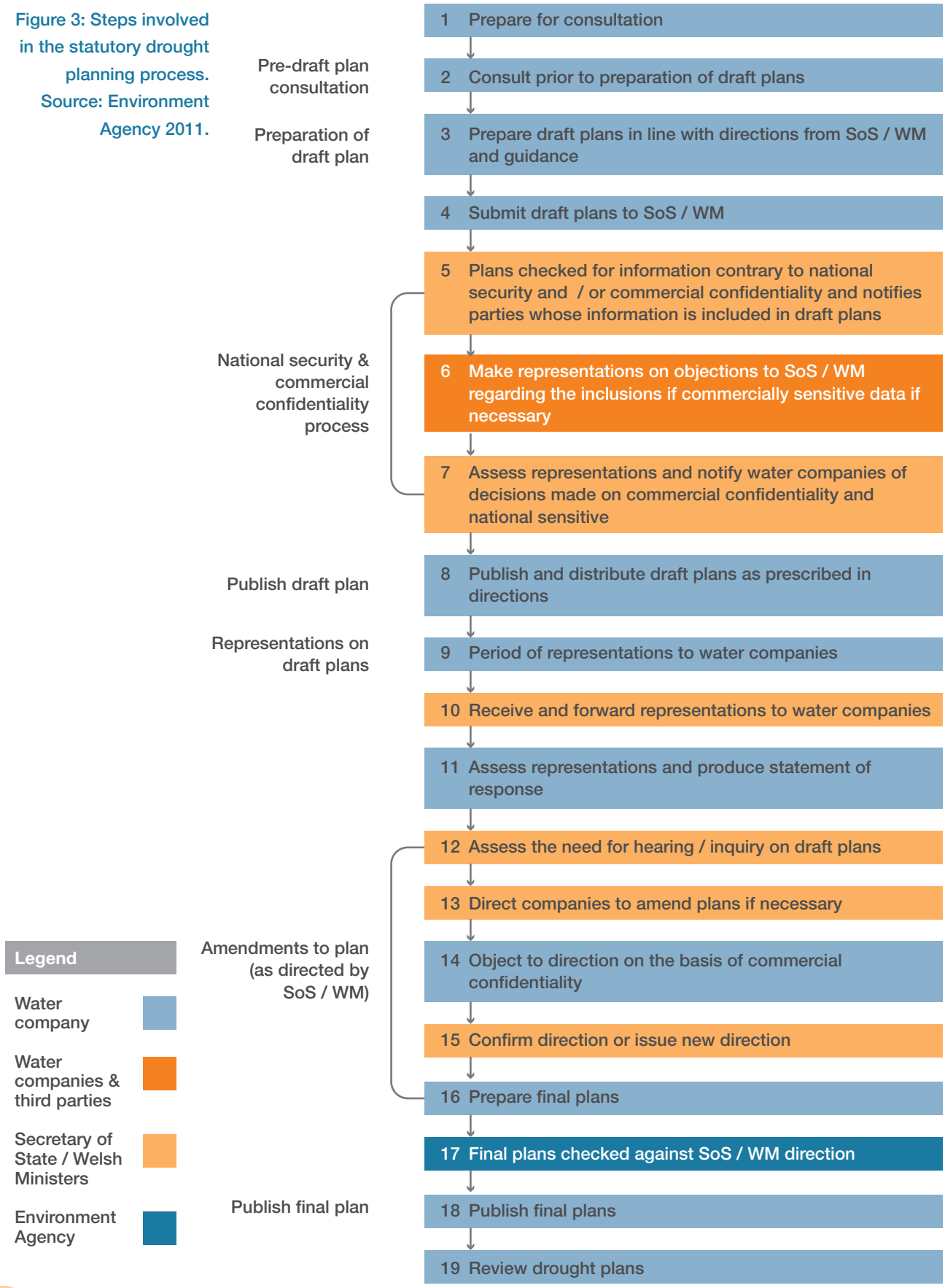
Water companies and drought planning

As noted above, water companies have a general duty to maintain a water supply (Water Industry Act 1991, Section 37) and, in the case of also being a sewerage undertaker, a general duty to maintain a sewerage system (Water Industry Act 1991, Section 94). As such, they have a duty to prepare and maintain a Water Resources Management Plan (WRMP) and a Drought Plan (Water Industry Act 1991, Sections 37A & 39B). In a WRMP, prepared every five years, the water company explains how it will, over the next 25 years or longer, manage and develop water resources so it can continue to meet its statutory obligations (Water Industry Act 1991, Section 37A [2]). The most recent WRMPs cover the years from 2015-2040; the next plans will be published in 2019 for the years 2020-2045.

The water supply and sewerage services industry involves limited competition and creates a risk that companies will deliver services either not desired by customers, or at higher prices due to limited competition. Ofwat regulates water companies by setting the price, investment and service package that customers receive by 'setting limits on the prices the companies can charge their customers' (Ofwat 2015). In effect, Ofwat has to 'balance the interests of consumers with the need to make sure the sectors can finance the delivery of water and sewerage services' while ensuring water companies can meet other legal obligations, both environmental and social (Ofwat 2015).

Ofwat's main regulatory process is known as Price Review and is conducted every 5 years. Each Price Review requires water companies to prepare a business plan, consistent with the WRMP (Environment Agency 2013, page 10), and submit it for review to Ofwat. Other organisations, including the EA, and the public may comment on the water company business plan and WRMP. Ofwat requires that each company, in its business plan, sets out the company's strategy and its implications for customer bills; its strategic objectives for service performance, quality, environmental and other outputs; necessary actions to meet the strategic objectives; and the scope for improvements in efficiency. Why does this matter for drought planning? Because the price review process conducted by Ofwat can shape and sometimes limit the options water companies can put in place for preventing and managing drought, on the basis of minimising increases in domestic water customers' bills.

Figure 3: Steps involved in the statutory drought planning process. Source: Environment Agency 2011.



This raises difficult and still unresolved questions about how to balance the economic interests of water company customers with environmental protection and long-term resilience of the sector.

The Environment Agency's involvement in drought planning

The Environment Agency (EA) is the leading agency in drought management planning and regulates how water companies plan to develop and maintain water resources. The process for statutory water company drought planning is described in the EA's 2015 guidance for drought planning and updated on the UK government's drought guidance website.

Figure 3 represents the steps involved in the drought planning process (Environment Agency 2011). Water companies are responsible for more than half of the multiple steps involved in preparing a drought plan, including the requirement to consult with statutory consultees and the public and to respond to any representations.

Although it is not obvious from Figure 3, the empirical research of the MaRIUS project suggests that in most areas, water companies work closely with their local EA office to develop their draft drought plan. As one interviewee put it: 'with water company Drought Plans, we provide technical advice to the companies around questions they might have putting together their drought plans. So we work quite closely with them in the development phase'.[10]

The EA gives advice and shares – if available – environmental information such as monitoring data as the water companies work through the various steps as detailed in Figure 2. At the end of the process, the EA's role changes from being an advisor to water companies, to being the regulator that advises the Secretary of State for Defra as to whether the water company's draft Drought Plan complies with the regulatory requirements. According to another interviewee, the influence of the EA is limited: It's 'an advisor to Defra as well. So any response back to Defra, it's advice. They don't have to take it. They're [= Defra] their own boss, they can make their own views. It is just in our opinion what we think'.[11]

Until 1 April 2014, the Agency operated on a three-tier structure of areas, regions and head office; after that date the regional level was removed. This restructuring is largely a response to reduced government resources. Our empirical research for the MaRIUS project suggests that this may limit the EA in its collection and assessment of environmental data in relation to water quantity, though there has always been some debate over who is responsible for the collection of various environmental science data about the state of water resources[12]: water companies or the EA.

10 MaRIUS Interview A2.DP1.REG5

11 MaRIUS Interview A2.DP1.REG3

12 MaRIUS Interview A2.DP1.REG5

Limited availability of environmental science data, in turn, has implications for how drought planning can be carried out. Less availability of environmental science information can limit the depth of understanding and knowledge of the potential and actual drought consequences on habitats and species. Moreover, applying guidance on how to write drought plans can run the risk of becoming a 'tick box' exercise.[13] It can be a challenge for the regulatory framework to match environmental data and science with policy guidelines (see Box 4).

Box 4: Matching environmental data and science with policy guidelines: the application of environmental flow indicators (EFIs) set under the WFD

The EFI is not a target or objective, but indicates where abstraction might be unsustainable. The EFI is a high-level assessment of river health on the basis of flow thresholds tied to a particular percentage deviation from the natural river flow. In this way, it is possible to identify water bodies where changes to the flow regime may be causing or contributing to adverse effects to river ecology, if the flow regime falls below an acceptable threshold of deviation. Application of the EFIs may lead to the conclusion that water bodies fail to comply with the 'Good Ecological Status' standard required by the WFD, when – at the same time and somewhat paradoxically – environmental science results indicate that the aquatic ecosystem is in good health. This shows how the strategic and high-level EFIs need to be matched by collection and analysis of local data, and both sets of information should be used to determine the potential impact of drought.

Moreover, there is a general perception among consultants and water companies that 'there's a geographical variation in how the Agency gets involved [in drought planning]'.[14] And, perhaps even in the way the Agency uses data: 'The Environment Agency is a big organisation and different sites have different representatives and they'll all have their own local understanding of the sites that they look after, and actually it's hard for us to disentangle whether the reason different aspects and different types of data will be looked at is because that's the particularity of the site, or actually that's just the preference of the individual'.[15]

13 MaRIUS Interview A2.DP1.CON3

14 MaRIUS Interview A2.DP1.CON3

15 MaRIUS Interview A2.DP1.WC6

Aside from the statutory drought planning of water companies, the EA does its own voluntary drought planning on an area basis and on a National Drought Framework. EA Drought Plans serve as operational manuals for area and Head Office drought teams. For example, the Head Office Drought Plan covers overarching and strategic issues, such as the EA organisational framework for dealing with drought; procedures for securing additional resources for managing droughts; procedures for identifying drought; key procedures for authorising specific drought management options, such as drought orders and permits; as well as strategies for communicating with citizens during drought.

Ofwat and drought planning

Ofwat's role in drought management is more indirect than direct. Its regulation of water services pricing does affect the feasibility of certain drought management options. Our empirical research, however, in the MaRIUS project suggests that Ofwat is engaged only to a very limited extent in the development of drought plans. Reorganisations of Ofwat have resulted in less emphasis on a technical remit when considering water resources and drought planning.[16]

This more hands-off approach by Ofwat to the writing of the water company statutory drought plans is interesting in light of the fact that there is a legal requirement for Ofwat to be consulted on draft drought plans. Ofwat emphasises, in particular, customer interests in affordability and reliability of public water supply in its brief responses, with some consultants considering this as a too 'hands-off' approach.[17] Hence, there are still unresolved questions about how best to integrate the EA's and Ofwat's environmental and economic perspectives in the process of statutory water company drought planning.

16 MaRIUS Interview A2.DP1.CON1

17 MaRIUS Interview A2.DP1.CON3

6 Managing and planning for drought

Managing droughts

One way to identify drought is to observe its particular impacts (see Figure 1). But, water companies each have their own definition of drought as expressed in its statutory Drought Plan.

For most water companies, the risk of drought is observed by a reduction in monthly or seasonal precipitation, which then manifests as less water available to use for potable supply. For many companies, the actual onset of drought is observed by reduced level of water in its water sources.

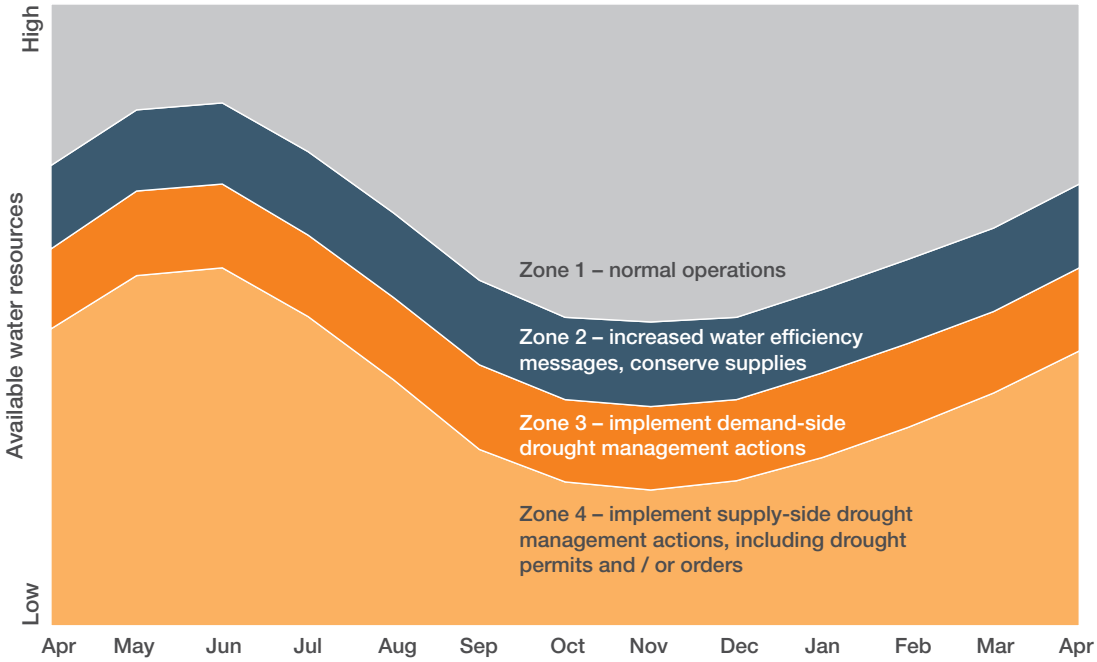


Figure 4: Example control curve. Source: Appendix D from the EA Drought Plan Guideline 2011.

Table 2: Drought triggers and drought management options
These actions are all described in companies' approved Drought Plans

Drought Level / Trigger	Actions to reduce the demand for water ('Demand-side options')	Actions to increase the availability of water ('Supply-side options')
Normal Zone 1	Perform business as usual actions May install meters	Perform business as usual actions May undertake engineering and operational improvements
Pre-Drought Zone 2	Work with industry and businesses to reduce demand Start household water efficiency initiatives, other than those initiatives already in operation during normal circumstances (metering, publicity, restraint)	Engineering/Operations: stop compensation flows, maintain deployable output, maximise output, optimise, lowering pumps or deepening boreholes where test pumping or reassessment of yield characteristics demonstrates it is worthwhile, engineering work, for example water treatment works enhancements and/or network distribution improvements (conjunctive use, operations, pressure reduction, leakage), reduce outage
Drought Zone 3	Reduce the pressure of water mains Increase leakage identification and repair Implement temporary water use restrictions('TUBs')	Engineering/Operations: more of the above Source Augmentation: re-commission unused sources, use sources that are restricted for use only in a drought, use alternative sources, for example satellite boreholes to provide additional security within an existing aggregate quantity Initiate drought water transfer agreements between and within company areas
Severe drought Zone 4	Seek permission to, then implement an 'ordinary' drought order, also known as non-essential use restrictions Seek permission to, then implement an 'emergency' drought order Implement other operational actions such as halt mains flushing; reduce water company use of water; reduce ship watering	Implement Drought permits/order Consider and implement other options such as desalination, tankering by lorries, recycling
Recovery from drought Zone 3 & 2	Continue requests to customers to be efficient with water Cease to use drought permits and orders	Continue actions or cease/reduce most expensive interventions

Source: Created by C. Cook based on a review of the EA guidance and water companies' drought plans

Figure 4 shows a control curve – a tool used by water companies to assess the level of water availability, e.g. in a reservoir, against historical trends, and to inform drought management actions. Each water company (as outlined in its drought plan) has a set of drought triggers for each of its water sources. Each trigger corresponds to a set of drought management actions or options that the company will implement, should the availability of water reduce to that level.

Table 2 sets out a general approach to implementing drought management options as drought trigger zones are passed. Table 2 shows the variety of drought management options used in England and Wales, grouped into those that reduce demand ('demand side' options) and those increase supply ('supply-side' options).

As can be seen in both Figure 4 and Table 2, typically a water company's first response to the onset of drought is the implementation of measures to reduce customer water demand such as initiating conservation and efficiency schemes for domestic customers; they will also undertake greater efforts to control leakage in their distribution network. Next, they will consider ways to increase the amount of water they can provide, such as re-commissioning unused sources, lowering pumps or deepening boreholes.

In summary, water companies implement particular drought management options when drought trigger zones are crossed; in other words, when supplies in water resources are measured and found within a particular drought trigger zone, the water company will then act in the way set out in its drought plan. These actions taken by water companies thus demonstrate how the formal drought regulatory framework is actually implemented in practice.

Drought planning by water companies

A water company drought plan explains how it will continue to meet its statutory obligations during a period of drought. Specifically, the company needs to explain how it will 'discharge its duties to supply adequate quantities of wholesome water, with as little recourse as reasonably possible to drought orders or drought permits' (Water Industry Act 1991, Sections 39B [2]). This regulatory requirement means that water companies must consider, and where necessary implement, a variety of drought management options leaving drought permits and orders as options of last resort.

Drought management options can have adverse impacts on the environment and, once put into place (e.g. desalination plants) also shape future water resources management and drought management. Drought management options are interventions to ensure sufficient water supply is maintained during a drought. They can be predominantly concerned with reducing demand or increasing water supply; some options can do both concurrently, such as Drought Orders, which are further explained below.

Supply-side options can reduce the amount of water available for the environment. Therefore, for each supply-side drought management option, the water company must carry out an environmental assessment of the likely impacts from implementing the option, include a summary of this in the drought plan, develop an environmental monitoring plan, and provide details of any further surveys needed to support the environmental assessment, in-drought and also post-drought.

In autumn 2014, MaRIUS researchers reviewed the most recent Drought Plans of nineteen water companies[18] and sorted drought management options referenced in the plans into the Environment Agency 2011 Drought Guidance categories. The results from this are shown in the following figures.

Figure 5 shows that temporary water use restrictions (see Boxes 6 and 7) were the most frequent option chosen by water companies to reduce the demand for water, followed by household efficiency measures.

Figure 5: Popularity of particular demand-side options in water company drought plans.

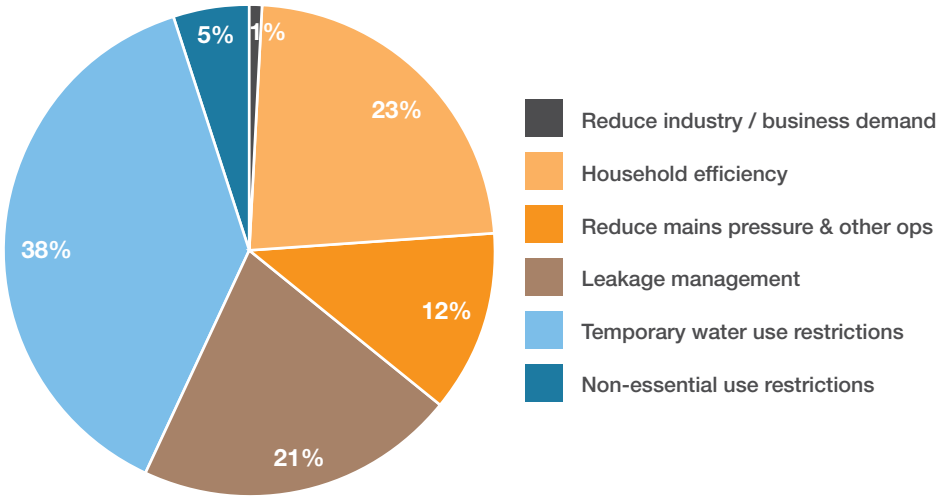
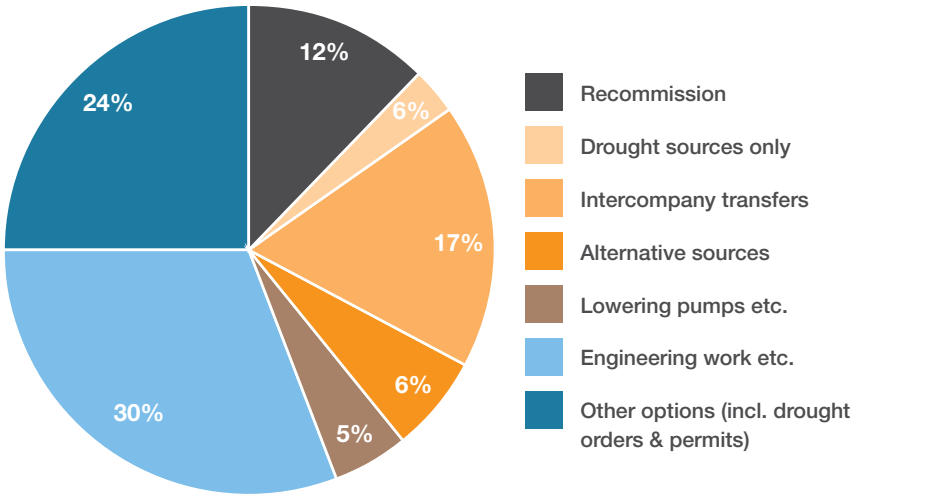


Figure 6: Popularity of particular supply-side options in water company drought plans.



18 Affinity, Anglian, Bristol, Cambridge, Cholderton & District, Essex and Suffolk, Northumbrian, Portsmouth, Sembcorp Bournemouth, SES Water, Severn Trent, South Staffordshire, South West, Southeast Water, Southern, Thames, United Utilities, Wessex, Yorkshire.

Figure 6 shows that the most frequent supply measures water companies chose were engineering work and efforts to 'maintain deployable output, maximise output, and optimise supply' and 'intra-company transfers', i.e. transfers of water between different water companies.

Figure 7 and figure 8 show the frequency of particular drought management options in the nineteen Drought Plans examined. They show how many companies intend to use a particular drought management option. On the demand-side each water company in the sample intends to manage household efficiency, and nearly all intend to enhance their leakage management activities and use Temporary Use Bans. Only four companies from the sample of nineteen envisage the possibility of using Emergency Drought Orders.

The following sections explain in further detail some of the key drought management options currently referred to in the regulatory framework for statutory water company drought planning.

Figure 7: The number of companies that include a particular demand-side option in their drought plans.

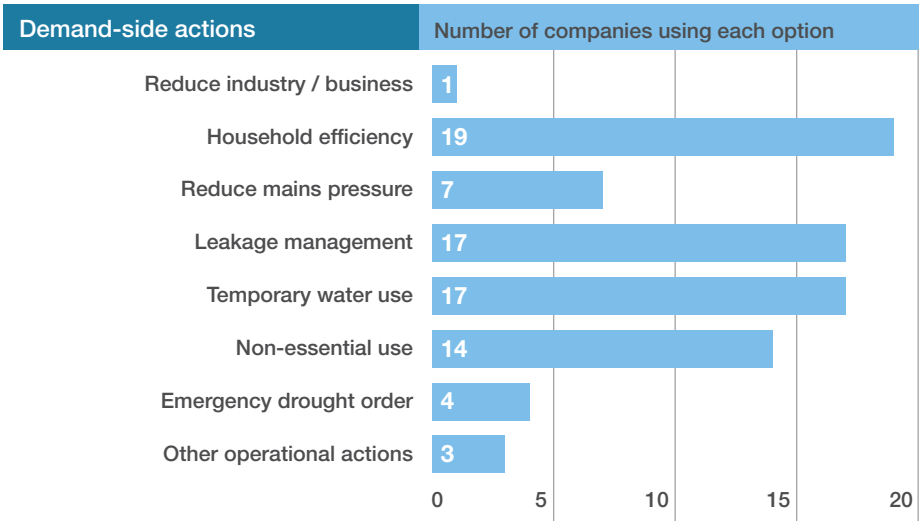
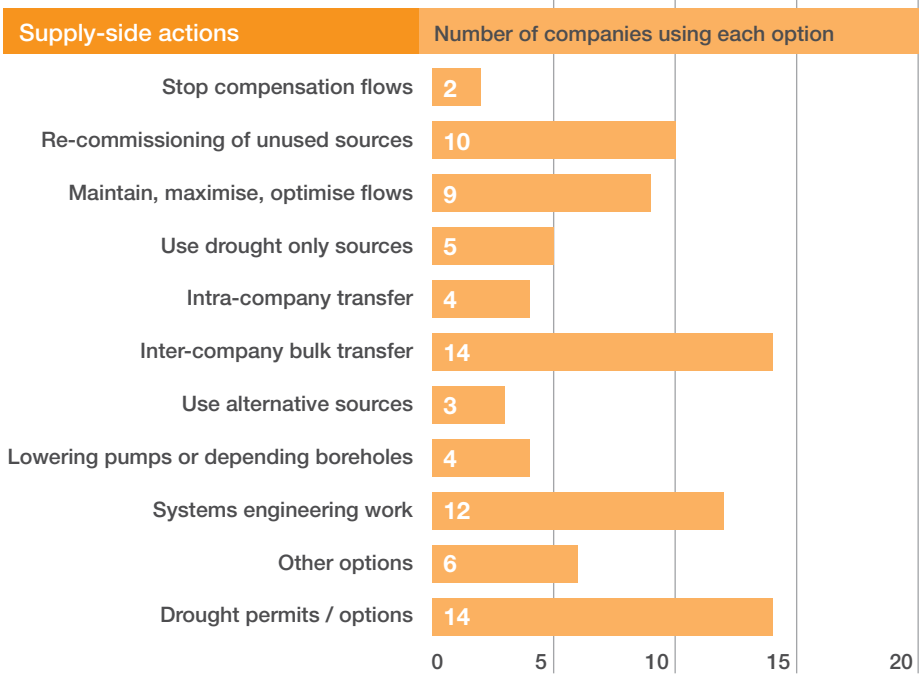


Figure 8: The number of companies that suggest they will include a supply-side option in their drought plans.



Key regulatory drought management options[19]

Temporary Use Bans

Temporary Use Bans (TUBs) are temporary water restrictions that water companies can apply at their discretion; they do not need EA approval in order to implement the restrictions. TUBs allow water companies to prohibit one or more uses of water (as specified in s. 76 of the WIA 1991 and the Water Use (Temporary Bans) Order 2010)) and are applied across a water resource zone (WRZ).

Box 5: Water Resource Zones

Water Resource Zones: A WRZ is the area within which the management of supply and demand is largely self-contained. Within the WRZ, supply infrastructure and demand centres are generally integrated to the extent that customers in the WRZ should experience the same risk of supply failure. Consequently, all customers share the same level of service provided for them by the water company.

TUBs are usually implemented once a water company's quantity of water resources drop into trigger zone 3 (see Table 1). TUBs may restrict the use of water in certain circumstances for:

- Watering a 'garden' using a hosepipe
- Cleaning a private motor vehicle using a hosepipe
- Watering plants on domestic or other non-commercial premises using a hosepipe
- Cleaning a private leisure boat using a hosepipe
- Filling or maintaining a domestic swimming or paddling pool
- Drawing water, using a hosepipe, for domestic recreational use
- Filling or maintaining a domestic pond using a hosepipe
- Filling or maintaining an ornamental fountain
- Cleaning walls, or windows, of domestic premises using a hosepipe
- Cleaning paths or patios using a hosepipe
- Cleaning other artificial outdoor surfaces using a hosepipe

19 A discussion of regulatory tools for drought management and the knowledge practices that inform these tools can be found in Lange & Cook, 2015.

Box 6: Temporary Use Bans

Temporary Use Bans (TUBS): Many people know TUBs as hosepipe bans. Section 76 of the WIA 1991 and the Water Use (Temporary Bans) Order 2010 set out the use of TUBs. If a water company issues a TUB it must make arrangements for a reasonable reduction of charges for customers which are made in respect of prohibited uses.

Drought Orders and Drought Permits

The regulatory framework requires the use of Drought Permits and Drought Orders to be limited in their use. The process and application of Drought Orders and Permits is set out in sections 73-79A of the Water Resources Act, 1991. In addition, water companies follow Defra guidance (Defra *et al*, 2015) and the industry bodies WaterUK and UKWIR Code of Practice on Water Use Restrictions (Water UK 2013).

Box 7: Drought Permits & Orders

A Drought Permit only addresses supply options. To implement a drought permit, water companies must apply to the environmental regulator, the Environment Agency. The EA may authorise a water company to take water from a particular source (specified in the Drought Permit) or it may allow the suspension or modification of particular restrictions or obligations on an existing water abstraction licence for a water company (e.g. the modification may allow the company to take more water than it normally can).

An Ordinary Drought Order may restrict non-essential water use (reduce the demand for water) or impact water abstractions and discharges under existing licences (i.e. affect the supply of water); Emergency Drought Orders will restrict essential uses (i.e. affect the demand of water). Both Ordinary and Emergency Drought Orders are issued by the Secretary of State heading Defra, and can be granted to both water companies and the Environment Agency.

Defra guidance regarding Drought Orders and Permits states that applicants prepare ‘an assessment of likely environmental impacts relating to possible drought permits and drought orders as part of the water company’s drought plan’. The objective of this is to identify potential issues and impacts in order to develop appropriate mitigation approaches before the drought order or permit is needed. Many water companies have developed the practice of keeping environmental assessment reports ‘on the shelf’ for the drought orders and permits outlined in their drought plans.

Such environmental reports should cover the expected changes in flow/level regime, the likely impacts on sensitive features, and mitigation options to prevent or reduce impacts of the proposed drought order or permit; and monitoring requirements during and after the drought. To demonstrate potential impacts of a particular water supply option, some water companies have begun to collect annual baseline data to build a dataset.[20]

If the proposed drought orders or drought permits are likely to have an impact on a designated nature conservation area, particularly those with a European level of significance such as a Special Area of Conservation (see section 2.4.3), then Natural England will become involved in the process and review the Drought Plans. As long as EU Directives have legal force in England, water companies that have such sites will need to consider whether they need to prepare a Strategic Environmental Assessment or what is called an 'Appropriate Assessment' under the Habitats Directive (see Box 2 on EU Directives and Drought Planning).

Drought Orders and Permits are expensive drought management options that carry the potential for significant environmental impacts; moreover, the regulatory approval process has often meant that by the time the permit or order is granted, the condition of drought has abated. Indeed, the empirical research undertaken for the MaRIUS project shows that in practice drought permits and orders are seldom denied and rarely implemented.

20 Interview A2.DP1.WC3

7 Conclusion

This drought planning primer has highlighted key elements of the regulatory framework for managing drought in England. The frequency of drought in the UK is expected to increase as a phenomenon associated with climate change. The primer outlined a range of interventionist tools available in to private water companies and, to some extent, the EA, to ensure that there is sufficient public water supply during drought. It highlighted how the regulatory framework seeks to ensure that both environmental and economic impacts of drought, e.g. on consumers of water, are considered. As the climate changes, some aspects of this regulatory framework may change too which, in turn, raises questions about the value we place upon water and what our collective priorities are. Finally, the impacts of Brexit on environmental legislation (much of which has been driven by the EU), including water resources regulation and drought planning, remain to be seen.

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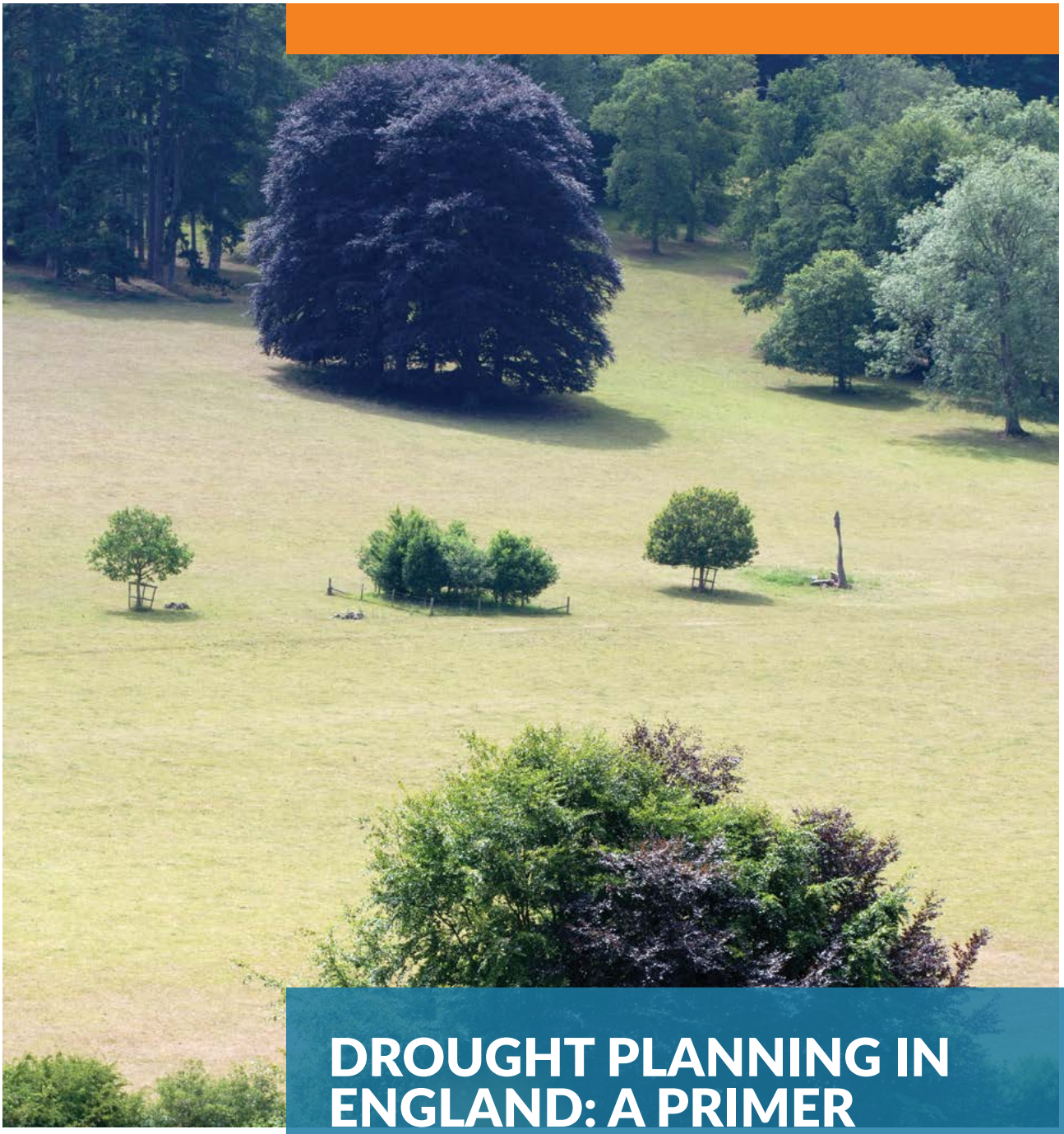

DROUGHT PLANNING IN ENGLAND: A PRIMER

MaRIUS
Managing the risks, impacts and uncertainties of droughts and water scarcity

Dr Christina Cook, Science Officer, Synthesis and Foresight Future Earth; and MaRIUS (Oxford) project researcher (2014–16)

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NERC SCIENCE OF THE ENVIRONMENT

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