About Drought

Maximising the impact of UK research on drought & water scarcity

Upper half of Howden Reservoir, looking down to dam wall in July 2018 © Katie Muchan

BRIEF

Drought monitoring and early warning: new developments to meet user needs

Context:

The UK, while typically regarded as a wet country, is vulnerable to drought, particularly in some areas of the south and east. There is, therefore, a need for systems that contribute to robust decision-making relating to drought risk. Such systems need to cater for a diversity of sectoral needs.

Based on recent drought research, a new suite of tools and approaches have been developed, leading to some advances in early warning capability in the UK. These tools were developed as part of the UK Government-funded Drought & Water Scarcity Research Programme.

This brief outlines the monitoring, forecasting and early warning needs for different sectors, the key new tools and strategies for monitoring and forecasting droughts, and highlights some ways that sectors have used these tools so far, and concludes by presenting applications for potential future uses.

Main findings:

1. Droughts cannot be prevented, but actions can be taken to mitigate their impacts. Monitoring and early warning systems (MEW) are key to preparedness.
2. Each drought tests organisations, institutions and society in distinctive ways.
3. There have been significant developments in MEW systems, including interactive portals providing real-time access to a range of datasets and indicators, as well as new catchment-scale river flow forecasts.
4. Water managers have been using the new systems to support decision-making and have been engaged in their development and refinement, for example in customising forecasts for their particular needs.


Derwent Reservoir levels starting to decline in May 2018. © Katie Muchan

What is drought?

Drought is a major hazard that occurs in all climate zones. It can have severe impacts on lives and livelihoods, economic impacts across many sectors and can also have serious impacts on terrestrial and freshwater environments.

The UK, while typically regarded as a wet country, is vulnerable to drought, particularly in some areas of the south and east (which are relatively dry in normal conditions and where water is used intensively). Drought is a major hazard on the UK National Risk Register of Civil Emergencies – over the past 40 years or so England has experienced five long-duration droughts and two shorter periods of drought (Cabinet Office, 2017). Droughts are also projected to become more severe in future due to climate change and increased water exploitation. The UK has suffered a number of major drought impacts in recent years; for example, the 2010-2012 drought cost the UK agricultural sector alone £400 million (Rey, Holman and Knox, 2017). Across all sectors, the drought was estimated to cost £1.5 billion (Defra, 2013).

Droughts are diverse hazards, and can be very different in terms of their severity, duration, spatial extent and impacts. Water scarcity affects a wide range of sectors, and the sectoral impacts of drought (and their viewpoints of what defines a drought) vary greatly, according to uses and sources of water. For example, water companies may be most concerned with water levels in reservoirs or underground, whereas dairy farmers may be more interested in shortages of rainfall affecting grazing fields for their cattle.

Monitoring, forecasting and early warning of droughts

Drought monitoring is a key part of preparing for droughts, and enabling mitigation of their impacts. There are currently a number of monitoring tools available in the UK, such as Water Situation Reports for England, Scotland and Wales[1] and the Hydrological Summary for the UK.[2] These reports indicate the current water resources situation and place them in historical context, but they do not allow users to explore the information on a local scale. Drought indicators are a key part of any MEW system, and are needed to identify the onset of drought and track status as events develop. However, as there is no harmonised definition of drought, and different sectors have divergent perspectives on the hazard, there are many potential indicators that could be used to characterise drought. Indicators for monitoring also need to play a role in early warning – to help make decisions as events evolve – rather than only with hindsight.

A key aspect of early warning is forecasting – that is, projecting the likely evolution of variables like rainfall, river flow and groundwater over coming weeks and months. Forecasts are mostly accurate for the upcoming 24 hours, but weather is a chaotic system, and accuracy declines with the length of foresight. Recently, some seasonal hydrological forecasting (projecting forwards 2-4 months) has become possible, but this skill is still very limited. There are few forecasting tools available: the Hydrological Outlook[3] for the UK is published monthly, and has been produced since 2013 but, like the Hydrological Summary, focuses on high-level regional-to-national-scale messages. While this is useful for a general picture of the UK, it has limited use for responsive decision-making in operational settings.

Ideally, a drought early-warning system should involve both a monitoring and a forecasting component, and needs to provide timely information in advance of the onset of drought to prompt action and reduce potential impacts. However, under the evolving conditions of a changing climate, the past does not provide a reliable guide to future conditions. Therefore there is also an acute need for systems that contribute to robust decision-making under uncertainty.

To meet the various sectoral needs, and based on recent drought research, a new suite of tools and approaches have been developed, leading to some advances in early warning capability in the UK. Several of these are profiled in this brief, along with initial responses and main needs of water users.

Sectoral needs

Each drought tests organisations, institutions and society in different ways. For example, a relevant impact for environmental agencies might include organising a fish rescue; for energy companies, it might mean millions of pounds in costs; for farmers it might mean they cannot meet the requirements of supermarket contracts; and, for public health professionals, it might mean increased hospital admissions. Whilst, for the UK public, it might mean trips to the beach and sun hats.

Across all sectors that supply, regulate or use the UK's water, there is the need for better information about – and understanding and handling of – uncertainty. It is also possible to identify some overlapping needs and indicators between sectors, pointing the way towards possible synergies and collaborative efforts.

An outline of early warning needs by sector is presented in a table at the end of this brief in Fig. 9 (p.14 and 15). It is clear from this table that the needs are many and various – however, some overlaps can also be identified. These overlaps could be used to build support around particular monitoring and forecasting priorities, or to identify ways to be more efficient when tailoring scientific findings for particular sectors. They also might help to create conversations between sectors about ways to mitigate impacts, although it is important to note that the link between indicators, needs and impacts is not always clear.

New tools and approaches responding to sector needs

Some of the new tools and approaches developed in the Drought and Water Scarcity Programme are described below, along with consideration of how they can meet user needs for monitoring and forecasting of droughts.

Standardised Precipitation Index

The Standardised Precipitation Index (SPI) is widely used to characterise meteorological drought on a range of timescales. On short timescales, the SPI is closely linked to soil moisture, while at longer timescales, the SPI can be related to groundwater and reservoir storage.

As the SPI is 'standardised' with respect to the climate of a particular area, it can be used to compare across regions with markedly different climates, and across different times of year.

The SPI values can be interpreted as the number of standard deviations by which the observed anomaly deviates from the long-term mean, allowing users to judge how far a drought is outside the norm.

The SPI has been recognised as a standard index that should be available worldwide for quantifying and reporting meteorological drought. One of the benefits of the SPI is that similar indicators can be applied across the water cycle. An index that also includes evapotranspiration (the SPEI) is widely used, while similar indices for streamflow (SSI) and groundwater (SGI) have been applied in the UK.

I found the tool both easy to use and understand. I thought it was an ideal tool (that was very timely too for the 2018 dry weather) that presented the data clearly in a pictorial way. This was very useful in showing the stark differences between the 2018 event and the benchmark 1976 drought once this information had been gathered.

Tony Brown, Hydrologist,
Natural Resources Wales

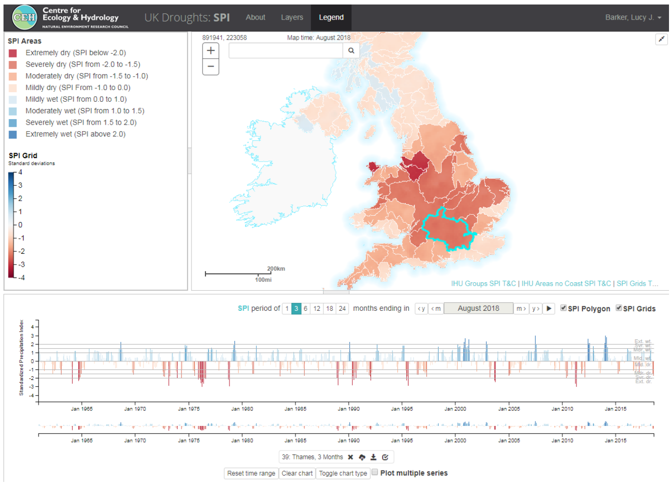

Figure 1. Example screenshot of the UK Drought Portal.

Dynamic Monitoring

To respond to the needs of the user community for more interactive, localised monitoring, in June 2017 UKCEH launched the UK Drought Portal (Fig. 1). The Portal provides a way for users to explore drought indicators on a localised scale (a 5km^2 grid) for the whole of the UK, in an interactive web tool. This allows users to map drought severity, and also to plot time series showing current drought conditions compared with historical events (dating back to 1961) for selected grid cells or catchment. The Portal has been updated monthly since June 2017. The Portal is updated in the first few days of each month, allowing users to explore recent rainfall deficits, over a range of timescales, in a historical context.

Since its launch, the UK Drought Portal has been widely used. It has been used by water companies (e.g. Yorkshire Water), regulators (Environment Agency (EA), Scottish Environmental Protection Agency (SEPA) and National Resources Wales (NRW)) and other users to help track drought severity. The Portal was used extensively during the 2018 summer drought (see box left).

Natural Resources Wales visit September 2014
© National River Flow Archive

*While the **UK Drought Portal** provides more dynamic, interactive drought monitoring, it is only based on one drought indicator (rainfall). However, users have a range of requirements and need to track many aspects of the water cycle including river flows, soil moisture, groundwater and so on.*

*Following the release of the Drought Portal UKCEH have developed a **UK Water Resource Portal**. Initially a regional demonstrator for south-west England (launched autumn 2018), it has now been extended to the national scale (formally launched in March 2020). The Water Resource Portal demonstrator for south-west England was co-developed with the Environment Agency (EA – Devon and Cornwall) and South West Water and extensively tested with other water stakeholders.*

*The UK Water Resource Portal is similar to the Drought Portal in offering dynamic, interactive mapping and time series plotting of recent hydrometeorological data, put in the context of long-term conditions. However, **the key difference is the inclusion of additional datasets of river flow, soil moisture and groundwater, rather than just rainfall.***

For river flows, a major innovation is the use of real-time daily data, making use of the EA's new Hydrology Data Service.

Real-time field-scale soil moisture data (50 sites) comes directly from the UKCEH COSMOS-UK sensor network (https://cosmos.ceh.ac.uk/).

For groundwater, UKCEH have collaborated with British Geological Survey (BGS) to show monthly updated groundwater levels in the Portal.

The WRP offers a wider range of visualisation options, including the ability to plot both the raw data and standardised indices (SPI, SSI, SGI) in a variety of ways.

Responding to water users' needs

The UK Water Resources Portal (WRP) serves the needs of its users better, with the inclusion of flow bandings which are used by the EA to communicate with water companies, and also in their Water Situation Reports (see Fig. 2). A further development added through consultation with South West Water was the option to plot current years against historical drought years, and against any given year chosen by the user (Fig. 3).

During development of the UK WRP, further testing and feedback was provided by a wide range of organisations. The UK WRP represents a step forward in delivering dynamic, interactive monitoring (Hannaford *et al.* 2019), adding value to the existing static products (Hydrological Summaries and EA Water Situation Reports).

The Portal is still aimed at a broad audience, rather than seeking to be 'for' a particular sector – although it is well placed in particular for regulators and water companies through the use of graphics aligned with their own mechanisms for communication. In the future this Portal could provide a core service for a range of users, and spin-off apps could be developed for particular user groups (e.g. for farmers/growers).

UKCEH envisage the Portal will be further refined and developed in collaboration with agricultural stakeholders, environmental organisations and the water sector. They are also currently scoping the development of a range of new potential data sources, e.g. earth observation datasets and modelled outputs.

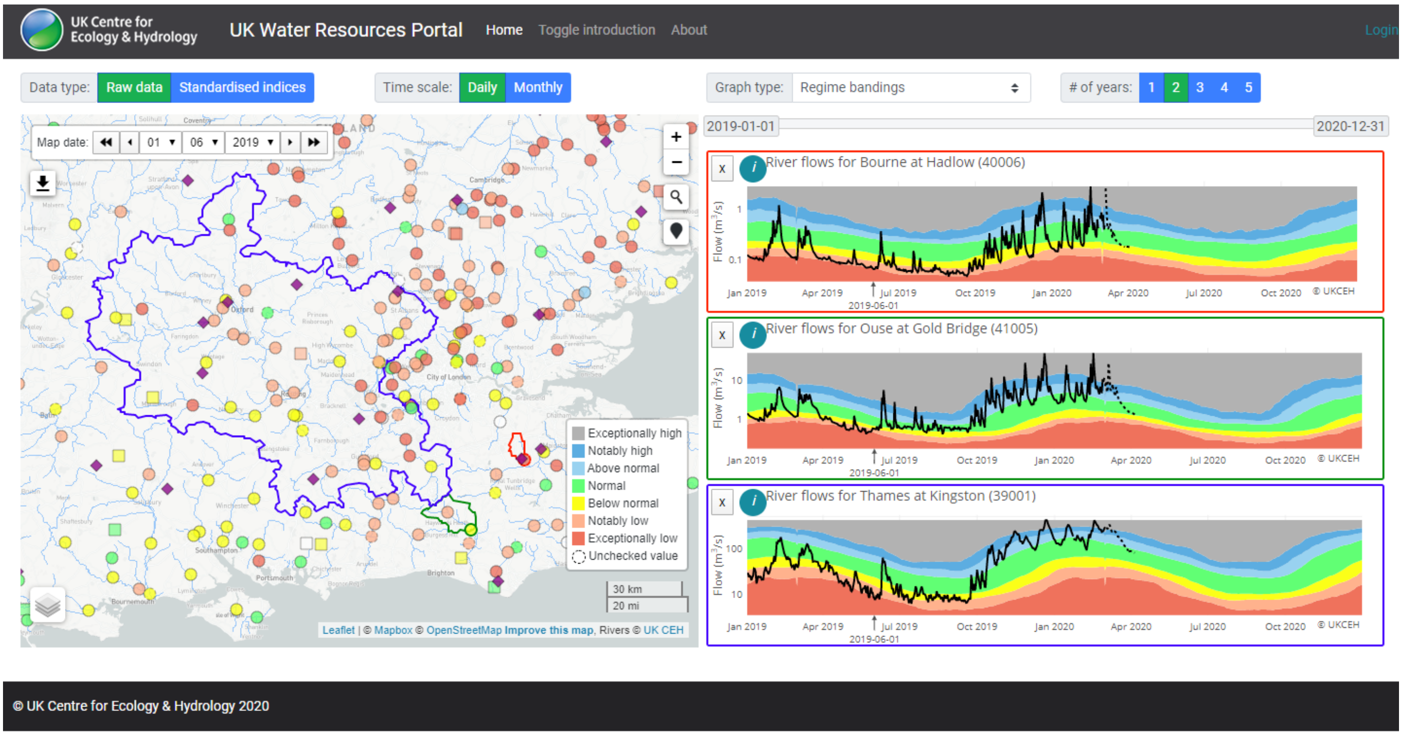

Figure 2. Example screenshot of the UK Water Resources Portal showing the flow bandings used by the Environment Agency.

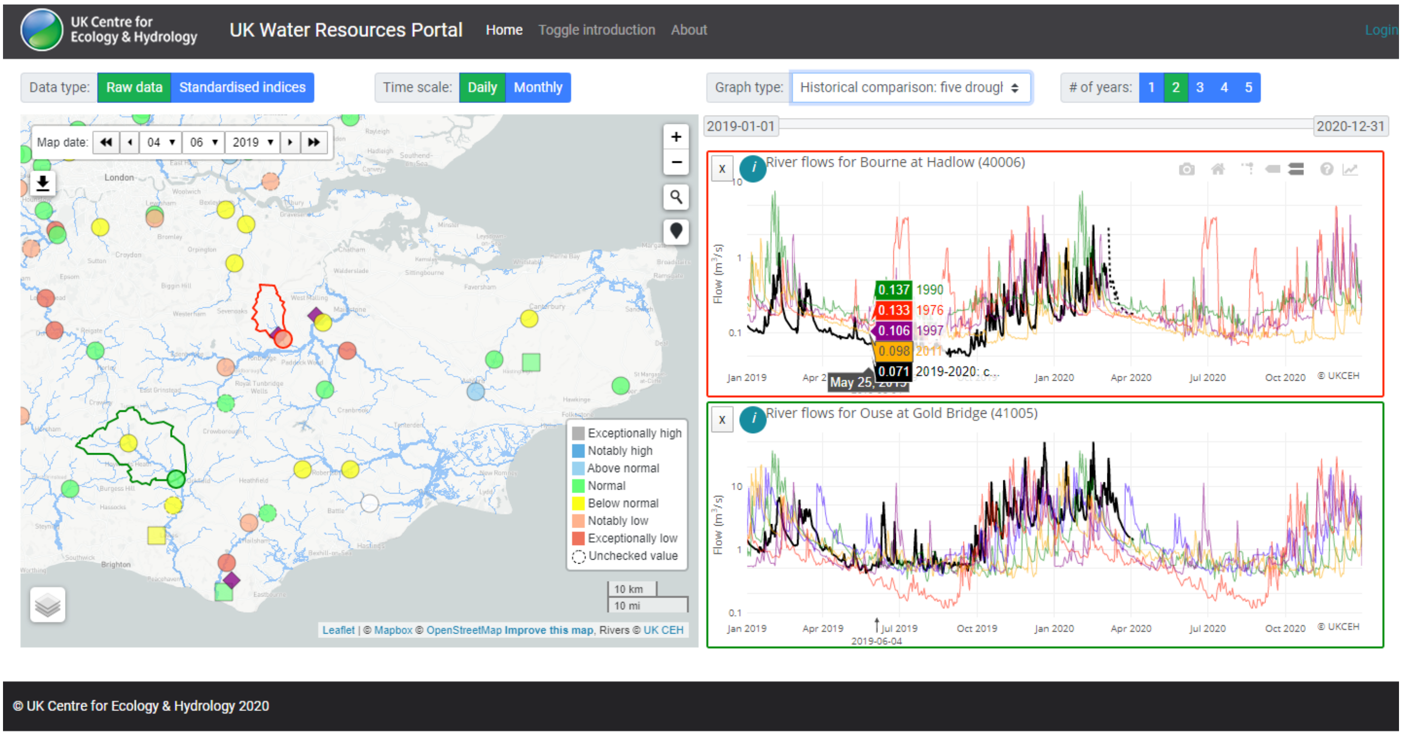

Figure 3. Example screenshot of the UK Water Resources Portal showing river flow hydrographs comparing current flows to those from past drought events.

Use of the Drought Portal

We use the Portal, mostly (perhaps obviously) when water resources are tight. We manage a network of 2,000 miles of waterway, so in a drought event we need to balance resource use very carefully across multiple sources on each canal system. In a more severe event we manage increasing restrictions and then the closure of canals, and justifying that to internal and external stakeholders is often backed up by summary stats from the Portal. Just knowing the severity of an event is really useful for placing our own datasets in the correct context, for example when comparing against other drought years. Knowing the data are robust and reliable is really important and helpful.

David Mould, Principal Hydrologist,
Canal & River Trust

Seasonal hydrological forecasting

Many users would benefit from longer-range forecasts at a seasonal timeframe – farmers, water companies and environmental agencies, for example. The Hydrological Outlook UK is an operational seasonal hydrological forecasting service (Prudhomme *et al.* 2017). Since June 2013, this service has delivered monthly and seasonal forecasts of streamflow and groundwater levels accompanied by outlooks over longer time horizons. The system consists of three complementary approaches combined to produce the operational outlook: (i) national-scale modelling of streamflow and groundwater levels based on an ensemble of rainfall forecasts, (ii) catchment-scale modelling where streamflow and groundwater level models are driven by historical meteorological data (i.e. the Ensemble Streamflow Prediction, ESP, approach), and (iii) a catchment-scale statistical method based on persistence and historical analogues. Through the IMPETUS (Improving Predictions of Drought for User Decision-Making) project, an improvement to the ESP system was developed using the GR4J hydrological model (Harrigan *et al.* 2018). The improved ESP system adds great value for water users as it now covers up to 300 catchments across the whole of the UK.

> *The Ensemble Streamflow Prediction outputs are used to look at the future projections of river flows across England – to supplement the assessment of a range of possible future outcomes. In the future, a portal where the ESP datasets are assessible would be great.*
>
> *Richard Davis, Senor Advisor, National Water Hydrology Team, Environment Agency*

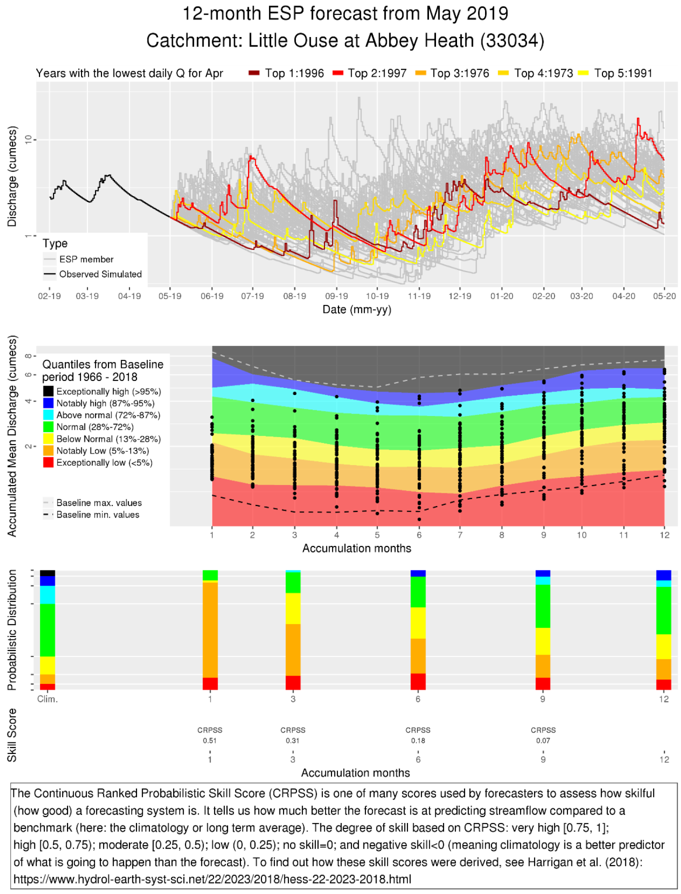

Figure 4. Standard streamflow forecasting outputs for the new ESP forecasting approach, co-designed with stakeholders.

As part of the About Drought project the ESP method has been used to engage stakeholders with hydrological forecasts. To enable this a standardised output was created to show the forecasting results for each of the 300 catchments (see Fig. 4). Since July 2018, this standard output has been shared every month with a range of stakeholders to seek feedback on the visualisations, but also to provide information on the potential trajectories of river flows going forward at various stages of the 2018 drought. The modelling work led to the simulation of 'What if?' scenarios (see p. 11) during the drought to support the EA.

Other MEW products and developments

UKCEH have implemented two new MEW products within the Hydrological Outlook UK. The monthly products are based on output from the Grid-to-Grid hydrological model run up to the end of each month (http://www.hydoutuk.net/current-conditions). The relative dryness (and wetness) product shows the model simulated subsurface water storage, expressed as an anomaly from the historical monthly mean. To highlight areas that are particularly dry (or wet), the storage anomaly is presented using a colour scale highlighting water storage relative to historical extremes (e.g. Fig. 5). A key benefit of this product is that it provides estimates of a quantity not routinely measured (i.e. subsurface dryness) on a 1km x 1km grid across Great Britain as opposed to in-situ soil moisture measurements which are at discrete locations (e.g. COSMOS-UK, see: https://cosmos.ceh.ac.uk/).

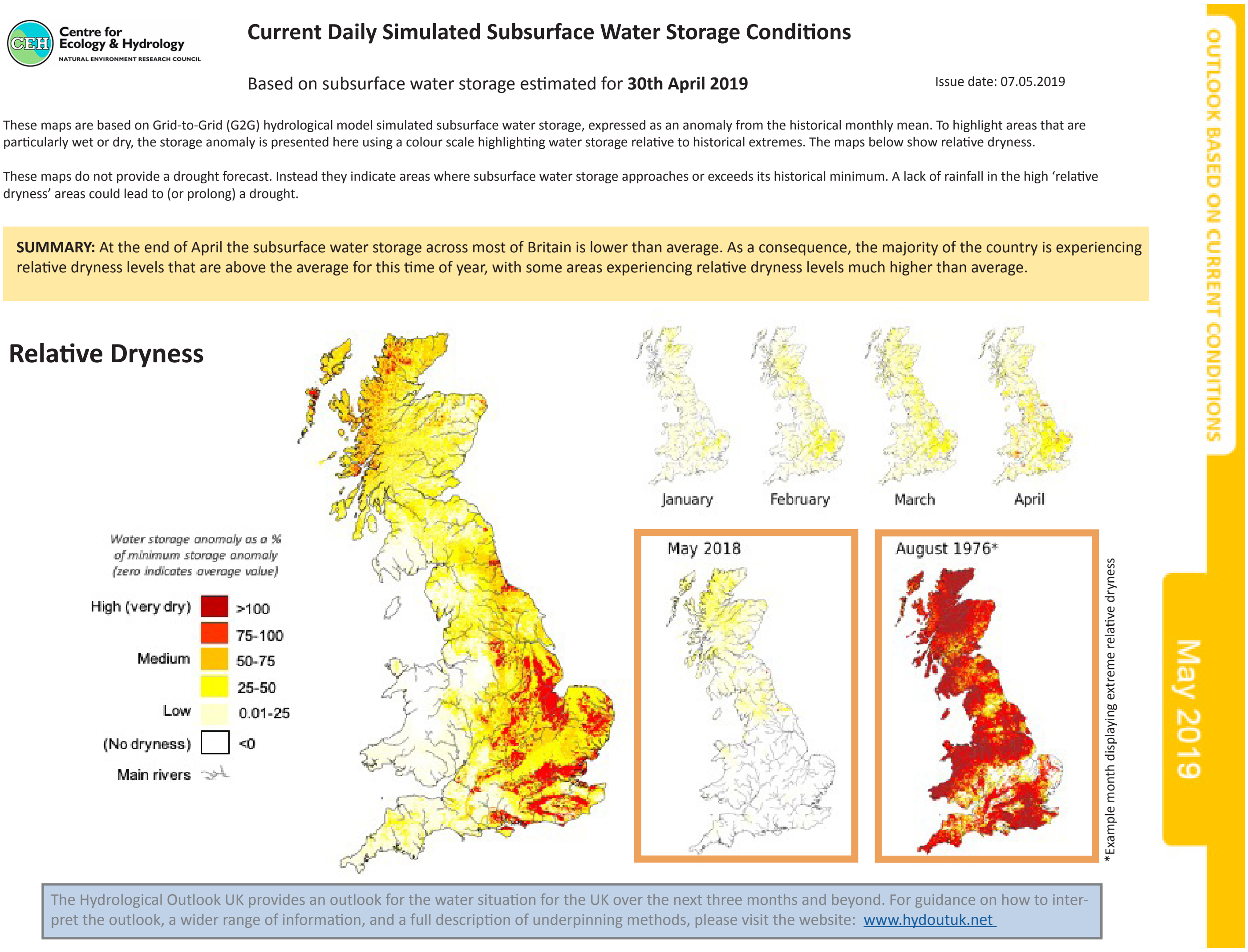

Figure 5. Example Hydrological Outlook UK Relative Dryness Map for May 2019. The rainfall required to end the dry conditions product shows the return period of the rainfall required to overcome dry conditions simulated using the Grid-to-Grid hydrological model.

In Fig. 6, maps are coloured according to the return period of accumulated rainfall required to overcome the estimated current subsurface water storage deficit over the next few months. A key benefit of these products is that they respond to a particular need for water managers to answer the question: how much rain is needed to end the drought?

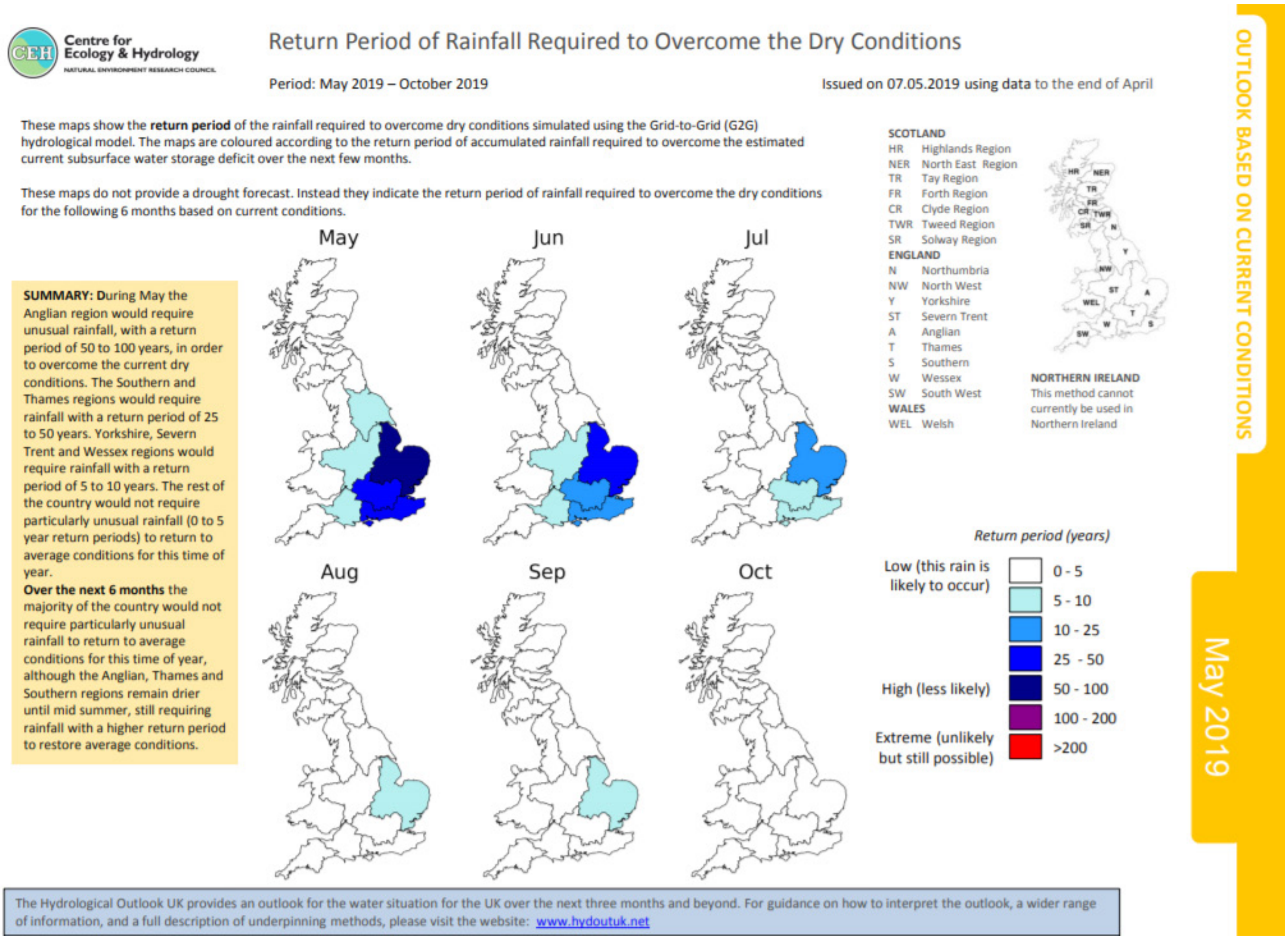

Figure 6. Example Hydrological Outlook UK rainfall required to overcome the dry conditions product.

The new relative dryness/wetness maps – with estimates of return periods and amount of additional rainfall required to overcome the dry conditions – have been used by the EA for monitoring current conditions. The new products add to the information available to water regulators and other stakeholders during a dry (or wet) period.

The new estimates of the amount of additional rainfall required to overcome the dry conditions (and associated return periods) added to the evidence base used to assess if the drought situation in Scotland was recovering as part of SEPA's water situation reporting.

The relative dryness maps within the Hydrological Outlook are useful in showing the current situation regarding soil dryness and how much rainfall would be needed to get these soil stores back to normal. I've used these maps in presentations to illustrate the situation to colleagues.

Richard Davis, Senor Advisor, National Water Hydrology Team, Environment Agency

Use of scenarios and forecasts by water stakeholders

UKCEH have provided streamflow forecasts for particular catchments to a wide range of stakeholders since summer 2018. This has enabled feedback to be gained on how the forecasts were being used or could be used in real-world applications and how they could be altered to improve their usefulness to water use stakeholders. The major sectors that UKCEH contacted to engage in this activity were water companies, regulators, agriculture, environment and energy.

Use of scenarios and forecasts by Regulatory Bodies

In July 2018, the EA asked UKCEH whether they could assist them in their scenario planning to help prepare and plan during the ongoing drought conditions. The specific challenge was to help forecast what the river flow situation might be a number of months (e.g. six) into the future, given a particular rainfall scenario. Initially, this was a 'Reasonable Worst Case Scenario' the EA developed alongside Met Office, projecting potential rainfall over the coming autumn and winter (see Fig. 7).

UKCEH ran these scenarios through the GR4J hydrological modelling framework set up for the ESP forecasts (see p. 8) and provided them to the EA for their internal briefings, and for discussion at the National Drought Group (NDG). The data for the full set of catchments has been supplied every month to the EA National team from late 2018 onwards. The plan for the EA nationally is to disseminate these data to area hydrologists who can use the information – this is an incremental process as EA staff have a need for guidance or training on use of the forecasts and data.

The EA has continued to refer to these projections in their briefings, NDG meetings and in their internal Drought Prospects Report as well as to key NDG stakeholders.

The projections have enabled the EA to plan for potential drought conditions as the situation has developed, and to communicate better with partners in the NDG (who include government departments, water companies, the National Farmers Union and environmental organisations, amongst others).

Natural Resources Wales area teams took part in a webinar in autumn 2018, in which UKCEH presented

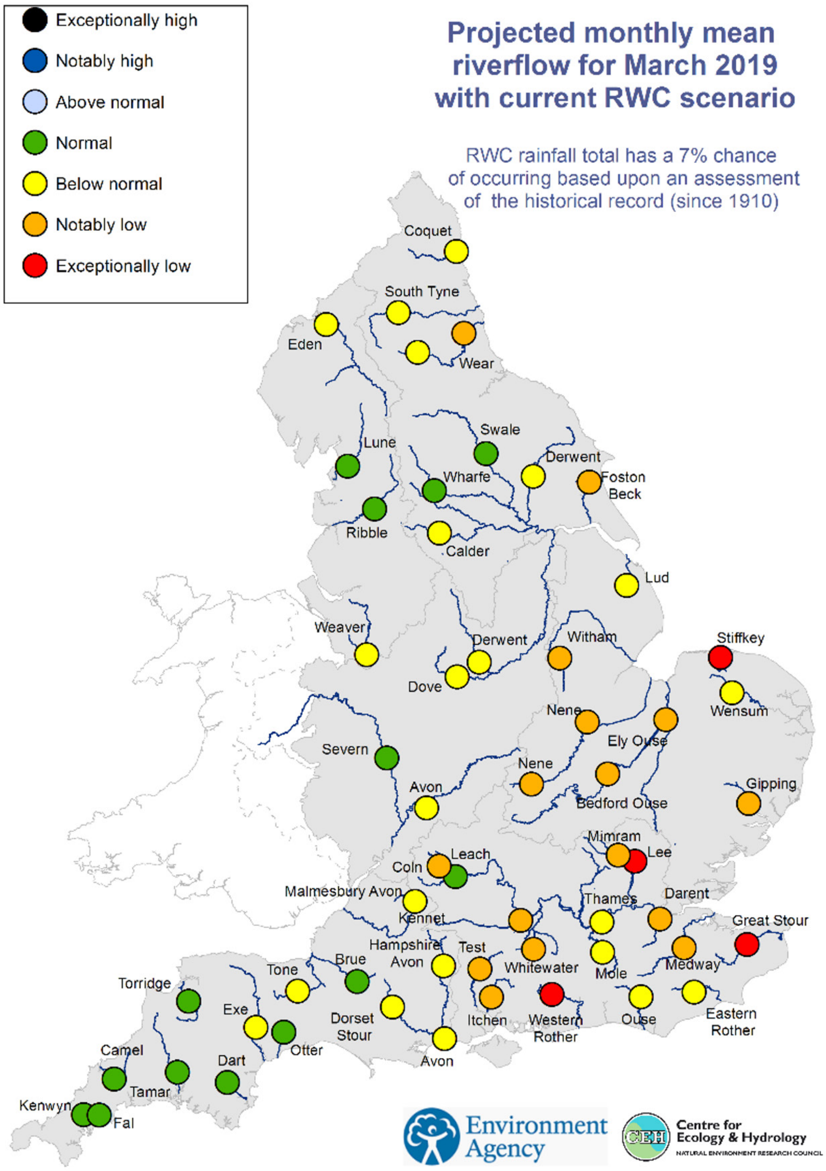

Figure 7. Projected monthly mean river flow for March 2019, based on the reasonable worst-case scenario developed in October 2018. Produced by the EA from UKCEH and EA hydrological models.

the forecasts to them with regard to the 2018 drought. They were interested in the forecasts, and keen to continue the conversation if and when there is an opportunity to take this forward in a live drought setting as Wales had largely recovered from drought in late 2018.

In 2019, the About Drought team also engaged with the Scottish Environment Protection Agency (SEPA) on the potential use of the forecasts. A bespoke forecast visualisation was created to look at the risk of reaching critical low flow thresholds in Scottish rivers (analogous to the Yorkshire Water case study described below).

Water Companies

Yorkshire Water, Southern Water (and the WRSE regional group), Anglian Water, and Severn-Trent, all engaged with using the ESP streamflow forecasts.

Yorkshire Water (YW) in particular engaged a great deal with the forecasting resource and were provided with forecasts over several months as the dry weather situation continued into late 2018/early 2019, as well as with the raw model forecast outputs for them to run through their own systems. Through conversation about YW's needs, UKCEH developed a specific visualisation that shows the likelihood of reaching certain Hands-off-Flows (HOFs) over particular time horizons (Fig. 8). This demonstrates how the Portal can be tailored to the needs of a specific user and illustrates how forecasts can be amended to look at the probability of crossing HOFs or other given thresholds.

> *I used the Drought Portal during the 2018 drought to illustrate aspects of the unfolding hydrological situation. The Drought Portal was useful in showing how serious the situation was compared to other time periods and highlighting the spatial extent of the drought. Data from the Drought Portal was used alongside other evidence on drought permit applications to the Environmental Agency in the winter of 2018/2019.*
>
> *Miranda Foster, Senior Hydrologist*
> *Yorkshire Water*

Other Sectors

The About Drought team have been engaging extensively with the agricultual sector, notably through the National Farmers Union (NFU) and Agricultural and

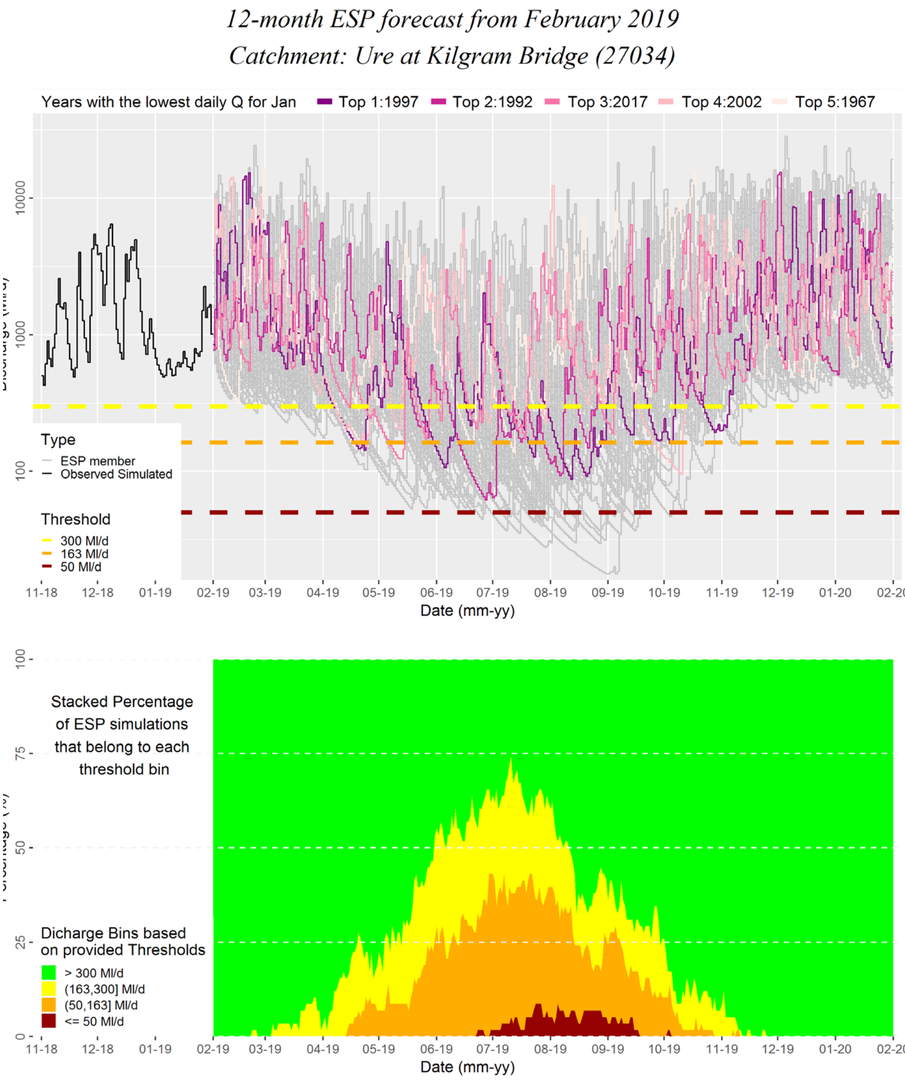

Figure 8. Example bespoke forecast for Yorkshire Water examining the likelihood of crossing HOFs.

Horticultural Development Board (AHDB). In addition, the team have engaged with individual farmers at several 'Irrigation Surgeries' hosted by the NFU, to examine how the various MEW products could be used to help on-farm decision making during the 2018-2019 drought situation. Within the sector, there is significant interest in the real-time flow monitoring through the UK Water Resources Portal, which could help irrigators plan ahead for potential abstraction restrictions. Several farmers and growers were also keen to follow up on the use of river flow forecasts for the same purpose, but with greater lead-times.

Other organisations that the About Drought team have liaised with include:

- Energy UK (trade association for the UK Energy industry)
- Canal and River Trust
- Rivers Trusts
- Natural England.

With all these organisations, there is interest in the potential of the new river flow forecasts to inform decision making, and especially the potential for forecasting critical flow thresholds (as with the Yorkshire Water example above). Accessibility to forecasts is seen as key to their usefulness, and this is now driving the development of a web application (similiar to and connected to the Water Resources Portal) that allows users to explore the forecasts interactively.

There is a need to use a combination of indices to feed into monitoring evolving droughts and provide appropriate responses. Thresholds and tailored composite trigger points are needed to meet defined purposes and to prompt appropriate strategic policies or actions that could be useful for stakeholders.

Further advances in and development of monitoring, forecasting and early warning systems are needed to identify the onset of drought, to characterise how drought severity evolves and also to identify signs of recovery from drought. There is also potential to tap into a much wider range of information for reporting impacts in real-time: for example, using citizen science, social media posts or existing informal monitoring networks (e.g. on-farm sensors).

Monitoring and early warning needs summary

Through the Droughts and Water Scarcity Programme, the UK has made great progress in refining a cohesive dynamic and interactive monitoring and early warning (MEW) system to aid decision-making and reduce the impacts of forthcoming drought or water scarcity events. Through workshops with multiple stakeholders involved in water management, the voices of those affected by drought and water scarcity have been recorded to capture the different impacts, timescales and spatial scales that are priorities for them in the design of an effective UK MEW system. Coupled with learning from US and Australian systems, the voices of UK water users have helped to create improved tools for MEW which are outlined in this brief.

The following table (Fig. 9 - set over page 14 and 15) summarises the needs of the main users of water, using information from Hannaford *et al.* (2018), including a selection of paraphrased comments from stakeholders, collected in Collins *et al.* (2016).

There are several areas of crossover in user needs For example, all users may find water scarcity thresholds useful, as well as clearer definitions of 'drought recovery' points.[5] Most users could use 'what-if' scenarios in their planning. There are also several MEW actions that would be useful to a particular group of users: for example, active, real-time monitoring of impacts could be useful to regulators/agencies, water companies, conservation managers, farmers and the public health sector. Equally seasonal forecasts at a regional and local level would be useful to each of: water companies, conservation managers, farmers, the public health sector and other water-intensive industries. This information may be helpful in creating systems that can be accessed and used by all of those sectors together.

Monitoring and early warning needs of key sectors affected by drought

 

Needs	Policymakers/ Government	Environmental agencies/Regulators
Water scarcity thresholds triggering action, relating to realistic scenarios – including drought recovery trigger points	●	●
‘What-if’ scenarios	●	●
Warning of when drought conditions should be classed as ‘exceptional’: i.e. a one-off, a step-change or a new norm	●	
Active, real-time monitoring of impacts (rather than impacts being used to define drought retrospectively)		●
Seasonal forecasts - and longer - at a local and regional scale		
Forecast of predicted loss and damage	●	
Real-time, open access information about water resources situation, e.g. reservoir levels		●
Seasonal forecasts at a local, regional and national scale	●	●
Restrictions such as Temporary Use Bans being issued		
Advance warning of when licensing restrictions are likely		
Tool for forecasting licensing restrictions		
Layered, vulnerability risk maps to understand the hazard with its impacts		●
Forecasts of predicted damage to ecosystems		●
Models of drought impacts on species abundance and biodiversity		●
Monitoring and catchment parameters to inform thresholds of when drought conditions should be classed as 'exceptional': i.e. a one-off, a step change or a new norm		●
Monitoring the extent to which scarcity is due to drought vs extraction		●
Water metering data		
Advance warning of water abstraction from the natural environment (and protection from excessive abstraction)		
Monthly to seasonal forecasts at a local scale		
Weekly to monthly forecasts at a local scale		
Co-ordination and consistency in media coverage – including for advance and preventative measures		
Indicators integrated into tailored, composite trigger points - triggering rights actions at right time	●	
Monitoring of acceptable tradeoffs between environmental and social consequences of drought	●	
Early warning of extraordinary pressures on licensing system	●	

Monitoring and early warning needs of key sectors affected by drought

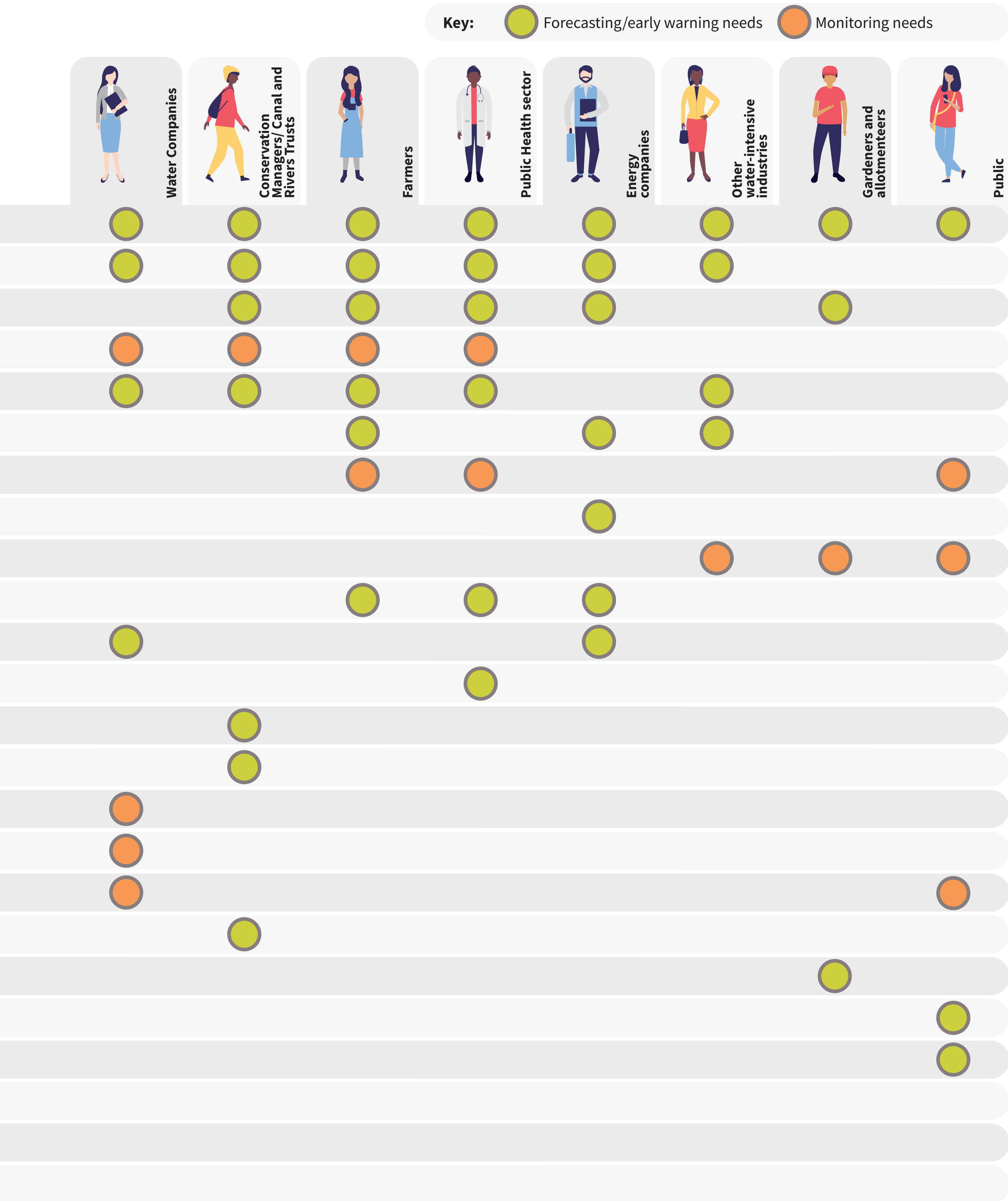

Fig. 9: Summary of early warning needs by sector, adapted from Hannaford *et al.* (2018), including a selection of paraphrased comments from stakeholders, collected in Collins *et al.* (2016). © About Drought, 2019.

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Endnotes

1. Water Situation Reports from Environment Agency: https://www.gov.uk/government/collections/water-situation-reports-for-england; Scottish Environmental Protection Agency: https://www.sepa.org.uk/environment/water/water-scarcity/; Natural Resources Wales: https://naturalresources.wales/about-us/what-we-do/water/resources/water-situation-report-2019/?lang=en
2. National Hydrological Monitoring Programme Hydrological Summary: https://nrfa.ceh.ac.uk/monthly-hydrological-summary-uk
3. UKCEH Hydrological Outlook: https://www.hydoutuk.net/
4. The electricity sector uses large quantities of water for cooling processes in thermoelectric power stations, accounting for around half of all water abstractions in England and Wales (Byers, Hall and Amezaga, 2014). However, water withdrawal or consumption per unit of electricity generation, is also spatially heterogeneous because thermal power plants in different areas use various cooling technologies (Macknick *et al.*, 2012).
5. However, there is a question about whether universal thresholds are useful, or even whether useful thresholds could be formulated, given the variability of natural systems, and a changing baseline under climate change.

Interested? Want to know more? Are you a water user who would like to get in touch about monitoring and early warning tools?

Visit the About Drought website: http://aboutdrought.info
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Maximising the impact of UK research in drought and water scarcity

About this Brief

This Brief is part of a series aiming to support improved decision-making in relation to droughts and water scarcity by providing research that identifies, predicts and responds to the interrelationships between their multiple drivers and impacts.

About Drought communicates about the UK Droughts & Water Scarcity Research Programme, a five-year, interdisciplinary, £12 million+ UKRI/NERC programme in collaboration with ESRC, EPSRC, BBSRC and AHRC. It is supporting improved decision-making in relation to droughts and water scarcity by providing research that identifies, predicts and responds to the interrelationships between their multiple drivers and impacts.

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