UKGroundwaterForum

Drought — how resilient are we?

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Abstracts

What drought means for a water company

Richard Bienfait, Managing Director, Veolia Water Central

Droughts are unique, difficult to predict and associated with significant uncertainty. Even the word drought means different things to different people which complicates messaging and how to explain the impact of droughts on water supply.

Water companies have different approaches to droughts depending on their water resource split between surface water, reservoir storage and groundwater. We rely on groundwater for 60% of our resource, mainly from the Chalk aquifer. We have no significant raw water storage capacity.

Water resource management plans define how we manage the normal supply-demand balance and takes into account drought periods, and we have separate drought management plans which detail how such events are to be managed. These generally follow a similar pattern of decreasing customer demand and increasing source availability to ensure there remains sufficient resource to meet essential supply.

Imposition of restrictions follows a strict process and is associated with communication plans, enhanced water efficiency messaging and exemptions for certain categories of customer. Drought triggers are used to initiate the different levels of restrictions and these are explained for the case of VWC using the current drought as an example.

Drought and the environment - impacts and analyses

Anna Wetherell, Natural England

Drought is well known to impact on the environment, whether directly via simple lack of rainfall, or indirectly via impacts on groundwater resources. But while generic impacts can be identified, the situation on the ground is often more complicated. This talk will give an overview of the environmental impacts of drought, but also a flavour of the wider complexities, such as balancing the needs of the environment with the needs of other sectors, and building in the complexities of an already pressured environment impacted by abstraction and pollution.

Spatio-temporal relationships between the surface and groundwater manifestations of drought

Terry Marsh, Leader of National Hydrological Monitoring Programme, Centre for ecology and hydrology

Droughts are complex phenomena which vary in their causation, intensity and range of impacts both temporally and spatially. The 2010-12 drought has been particularly severe in relation to groundwater resources; only a handful of comparably sustained episodes of exceptional groundwater depletion can be indentified in the last 150 years. Whilst severe surface water stress can accompany notable within-year rainfall deficiencies, severe groundwater stress (manifested in both depressed groundwater levels and a major contraction in the groundwater-fed stream network) is normally associated with clusters of dry winters. Correspondingly, substantial surface water stress with very depressed river flows can co-exist with groundwater resources only moderately affected – as happened during the 2003 drought. On the other hand, historical data confirm that groundwater resources may remain exceptionally low through a number of the 'wettest droughts on record.'

Changing rainfall and evaporation patterns, together with changing water resource provision and management, all impact on the UK's vulnerability to drought. As yet, climate variability appears to be a more influential factor than climate change in relation to the frequency and magnitude of groundwater droughts. Whilst no compelling long term trend in average aquifer recharge is yet evident, the increasing pressures on groundwater resources, and the associated stress on the environment, remains a considerable challenge for UK water management.

Empirical evidence for hydrogeological controls on variations in the spatial and temporal extent of groundwater droughts in the UK

John P Bloomfield[1], Andrew McKenzie[1], Murray Lark[1] and Rob Ward[1]
[1] British Geological Survey

The EU Watch Programme and other related studies have recently documented and quantified the spatial and temporal evolution of droughts in river flows. However, until now, no such similar work has been undertaken to systematically investigate groundwater droughts as a phenomenon: how they evolve spatially and temporally, and which, if any, geological and hydrogeological factors affect their development. In this presentation, following a brief review of features of groundwater droughts and of the few previous studies of groundwater drought in the peer-reviewed literature, we introduce a new index (the Groundwater Level Index, GLI, based on the Standardised Precipitation Index commonly used to quantify meteorological droughts) to characterise groundwater drought. The GLI is used in combination with wavelet techniques to investigate spatio-temporal trends in groundwater levels and drought across multiple aquifers over England and Wales back to 1900.

The degree of autocorrelation in a given groundwater level hydrograph appears to influence the susceptibility of groundwater levels at that site to drought. Based on this observation, a simple regression model is described that enables investigation of which catchment characteristics or aquifer properties appear to be the most important controls on groundwater drought susceptibility. Aquifer diffusivity is found to be significantly correlated with groundwater hydrograph autocorrelation and hence is inferred to be a significant control on groundwater response to drought.

Groundwater level changes in the Chalk across two drought events, 1975-76 and 1988-90, are analysed using geostatistical techniques to investigate spatial variations in drought response in the Chalk aquifer. Consistent, significant regional variations are observed and it is inferred that the resulting spatial variation in the response of groundwater levels to drought reflects, at least in part, the underlying storage structure of the Chalk at the national scale.

The presentation is concluded with an outline of knowledge gaps and future research requirements related to groundwater and drought.

Climate change in water resource planning

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Groundwater plays a key role in maintaining water supply, particularly in areas of south east England where there is significant storage in Chalk aquifers. Previous assessments, completed for the 2009 water resources management plans, indicated that groundwater supplies were less sensitive to future climate change than run-of-river abstractions, small upland reservoirs and larger pumped storage schemes. However in the current drought and in specific areas, groundwater levels have been lower than previously recorded while surface water reservoir levels have been maintained or have since recovered. This presentation will provide an overview of the impacts evidence (including the recently published Future Flows research), review how water companies are using the latest climate projections in their water resources plans and highlight some of the challenges of estimating future

groundwater yields. It will present preliminary research outputs from the EPSRC ARCC-Water project for sources in the south east of England and suggest ways of improving impacts assessment for future water resources management plans.

Sources of more information

http://www.bgs.ac.uk/research/groundwater/change/futureFlows/home.html

http://www.tyndall.ac.uk/research/water-and-landuse/arcc-water

Overview of current drought research and its relevance to the challenges we face

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Developing methodologies to simulate future climate change impacts on groundwater resources, for example the magnitude, frequency and persistence of droughts, is without doubt challenging. Several scientific disciplines must be combined to downscale from global circulation models (GCMs) to regional climate models (RCMs) and to include output from these in recharge and groundwater models. Researchers are presented with a significant uncertainty issue, commonly known as 'the cascade of uncertainty'. Additional challenges are the scale of enquiry, from local to global, and the increasing requirement to combine climate and land use change scenarios as determined by socio-economic factors. In tackling these issues, this presentation will review current research approaches to including groundwater as part of an integrated assessment of future environmental conditions.