British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Historic Droughts

Evidence for change in the nature of groundwater drought in the UK since 1890

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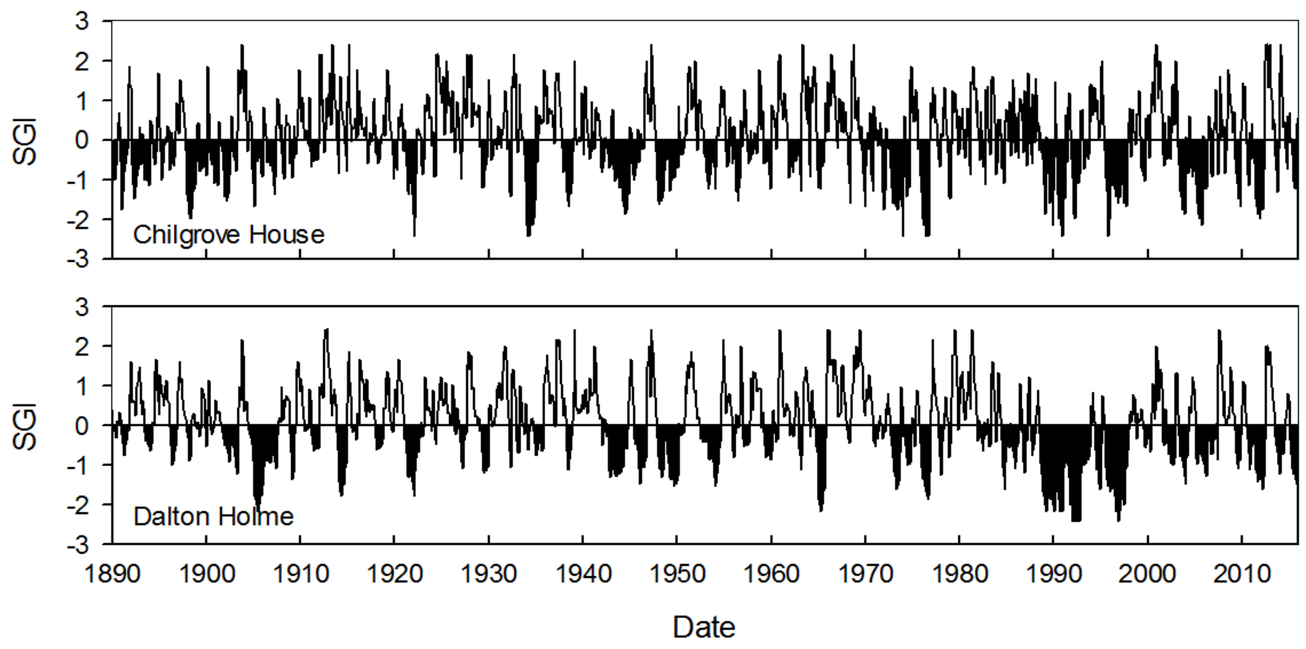
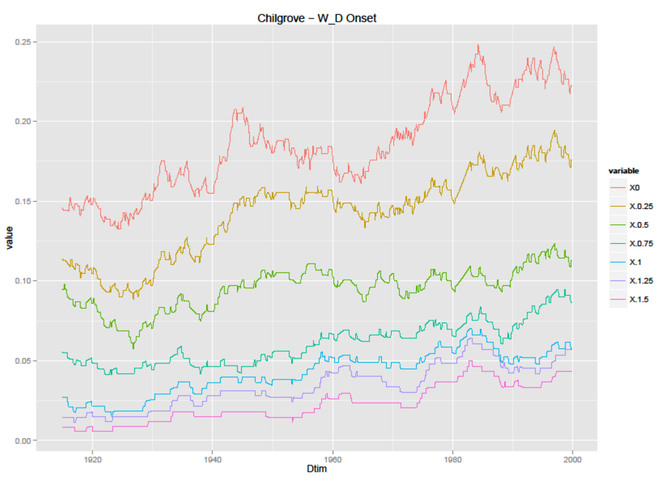
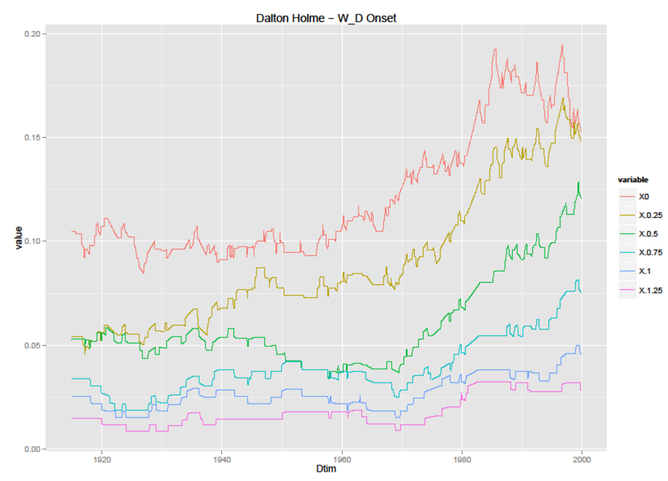
The need to characterise changes in groundwater droughts

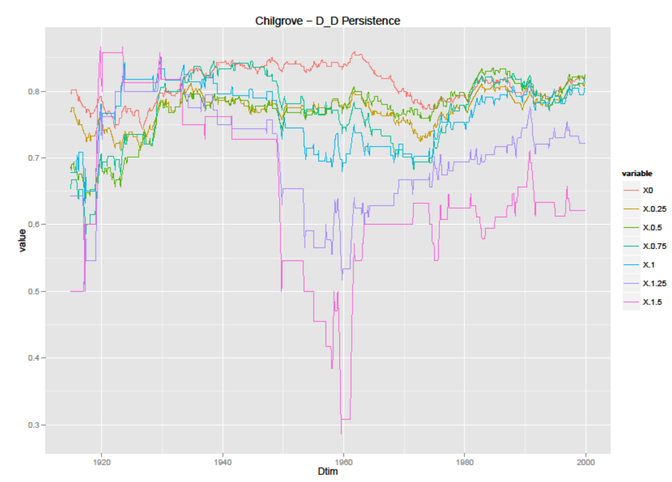
Groundwater is an important source of water for public supply, agricultural irrigation, and industry, as well as sustaining ecological flows to rivers, and it can be affected by drought. Groundwater droughts are characterised by lowered groundwater levels, reduced yields from boreholes, reduced baseflow and shortening of ephemeral streams. Episodes of historic drought are commonly used to benchmark and/or model future groundwater resources and for water resource management and drought planning purposes. Consequently, in order to prepare more effectively for future groundwater droughts, there is a need to better understand groundwater droughts from the recent past and to identify if and how features of groundwater droughts may have changed with time. Here we present the results of a preliminary analysis of the Standardised Groundwater level Index (SGI) for the UKs two longest groundwater level time series from Chilgrove House, Sussex, and Dalton Holme, Yorkshire (top right), to investigate if and how groundwater droughts have changed since the 1890s.

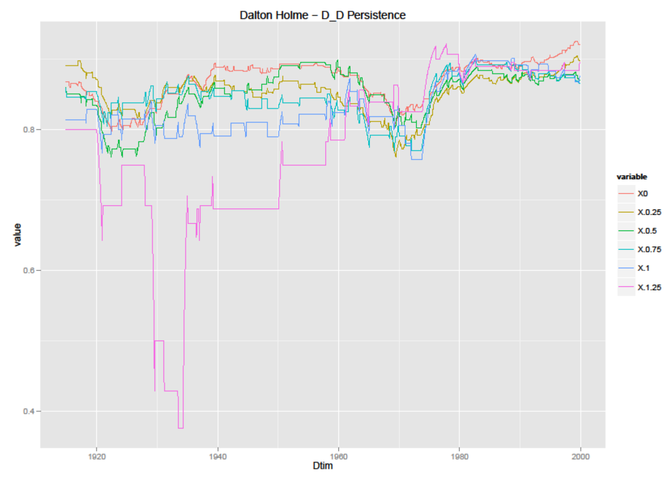






Probability of a 'non-drought : drought' Markov transition, i.e. drought onset, for various SGI thresholds, probabilities derived from a moving 30 year window of observations (data plotted against the centre of the 30 year window) .





Probability of a 'drought : drought' Markov transition, i.e. drought persistence, for various SGI thresholds.

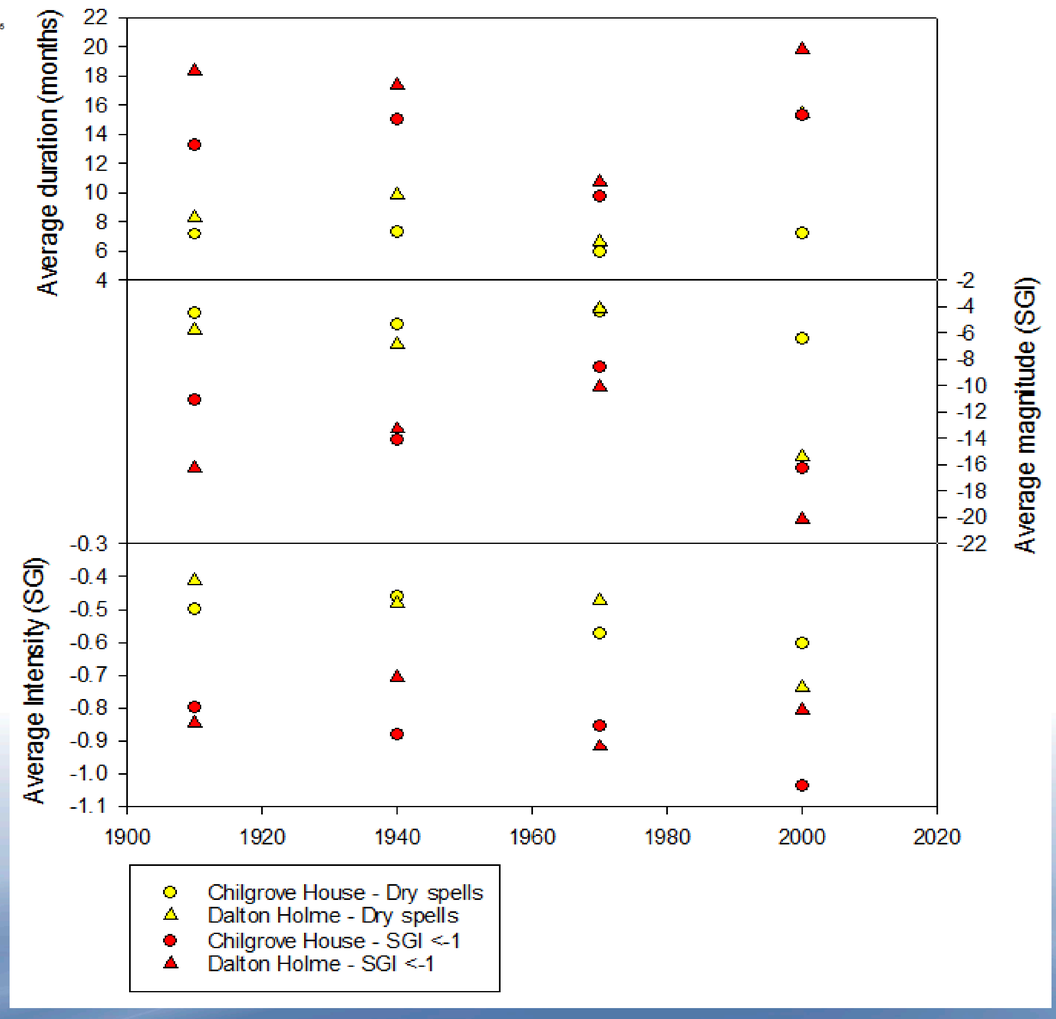
Methods

Linear regression models and non-parametric trend tests of the SGI time series and of descriptors of drought events, such as event duration, magnitude and intensity, cannot be easily applied for a number of reasons, including autocorrelation in the time series and the irregular and sparse nature of drought events. Instead, we simply describe the distribution and characteristics of dry episodes (SGI <0) and droughts (SGI <-1) across four 30-year windows on two SGI time series and use Markov modelling (described below) to investigate changes in the onset and persistence of groundwater droughts.

The average dry spell and drought event a.) duration, b.) magnitude and c.) intensity are shown for each 30 year period (see below). Markov models representing the probability of a change from +ve to –ve SGI, i.e. dry spell or drought onset, and of –ve to –ve SGI, i.e. groundwater drought persistence, have been estimated for both Chilgrove House and Dalton Holme for a range of dry spell and groundwater drought magnitudes (see left).

Results

- There is generally good agreement between the two sites on the average dry spell and drought event characteristics (see right).
- There is evidence for variability in both dry spell and drought event average durations and magnitudes across the four sample periods with notably short average duration and small event magnitudes during the period 1955 to 1984, and the longest average event durations and largest magnitudes occurring in the last 30 years, from 1985 to 2015 (see right).
- Overall there appears to be a trend for increasing intensity of both dry spell and groundwater drought events across the whole record at both sites, i.e. from 1890 to 2015 (see right).
- The Markov modelling indicates that both sites exhibit an increasing probability of entering a drought episode from the 1960s to the present regardless of the magnitude of the drought event (see above). There is a less consistent story regarding persistence of groundwater droughts, although it appears that since the 1980s probabilities of groundwater drought persistence are historically high, particularly at Dalton Holme.



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