



Met Office

Executive Summary of the report on Hydrological Overload Flooding

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Executive Summary

Welsh Water (WW) has recently sought funding to reduce the incidence of sewer flooding in Wales. WW is intending to use this funding to support activities that are over and above “normal” levels and are therefore commissioning a report to provide further evidence to support their business case for this work. They are particularly concerned with the hydrological overload flooding (HOF) events and they would like to understand where their operational area sits in a national context on a range of hydrological and topographical factors that may influence sewer flooding and identify how climate change may impact storm intensity and resilience of their network over the next 30 years.

The report consisted of two phases:

Phase 1 - to identify the major meteorological events that have an impact on HOF events in context for the whole region and sub-divisions (high-level postcodes) historically (Phase 1a) and to compare the WW area with England; Scottish data were not available at the time of analysis (Phase 1b).

Phase 2- to account for the effects of climate change upon the future rainfall regime in Wales.

Phase 1a

An analysis of HOF events showed that the CF (Cardiff) and CH (Chester) areas had the greatest number of flooding events, reflecting the more populated areas. An analysis of monthly data for the whole of the WW region and also on high-level postcode areas masked the necessary detail so an analysis of daily data is likely to be more useful. To account for the differences between the dates of the meteorological rain day (09:00 – 09:00 GMT) and the flood reporting dates (usual calendar day), a 2-day total was calculated (named the ‘event’ total) to ensure that the correct rainfall for the right date was captured correctly.

The best results from an analysis of the event rainfalls were obtained by isolating “very wet days” to identify trigger thresholds of at least 20mm. More detailed insights were obtained by analysing sub-daily data for two sites in south and north-east Wales, St. Athan’s (10 km south-west of Cardiff) and Hawarden Airport (5km west of Chester) to represent the north-east of Wales, i.e. the two areas with the largest number of events.

This work has identified various triggers:

- 'general' conditions (days > 50mm south Wales and >40mm in north-east Wales), regardless of 'event' length. Note the different thresholds for the two areas but these equate to similar return periods of about once a year event.
- 'wet' conditions – 30 antecedent days > 175mm (south Wales) and 30 antecedent days > 100mm (north-east Wales) both followed by a day > 20mm
- 'dry' conditions – 30 antecedent days < 50mm followed by a day > 20mm (both areas)

Phase 1b

Similar analyses described above were also produced for the other Water Companies in England. In terms of annual average rainfall, WW is the wettest region in England and Wales. In terms of the number of days with rainfall above high thresholds of 20mm and 30mm, Welsh Water is generally the wettest region closely followed by South West Water and to a lesser extent United Utilities (NW England). This reflects the westerly locations of these regions which are prone to rain-bearing storms from the Atlantic. In terms of the number of days with rainfall above the higher threshold of 40mm the situation becomes more complex and patterns are harder to identify. This is because such high totals will be more likely to be associated with thunderstorms which are less dependent upon a westerly location. The south-east of the UK tends to be more prone to thunderstorms from the continent.

Analysis of hourly rainfall data for various locations in England and Wales shows that Cornwall and Cumbrian locations to be the most prone. The St. Athan's site may be more sheltered than these two English sites as the analysis does not indicate it be significantly worse than the other sites. However, Cornwall and Cumbria would be representative of the northern and western part of Wales.

Phase 2

Using a combination of Extreme Value Analysis (EVA) (a branch of statistics that enable estimates of extreme events with associated return periods beyond that of the data record) and the latest Met Office climate projections, UKCP18, estimates of future extreme daily rainfall totals and frequency of events, are made. Developing previous Met Office work concerning seasonal maximum rainfall on a 25km grid, estimates of daily rainfall have been made for the whole of the UK, comparing present-day conditions for different future emission scenarios in the 2090's, i.e. the return periods for 20mm and 40mm daily rainfalls and the daily rainfalls likely to occur once in 30 and once in 50 years.

Estimated return levels for 30-year and 50-year return frequencies for the 2090s, and absolute and relative change in return level with respect to the present day were calculated for the UK. There is a tendency in the amount of rainfall associated with these return frequencies to increase in the future, due to increases in global mean temperature. However, some locations in the UK, largely in the east, are expected to see a decrease in extreme daily rainfall in the 2090s, relative to the present day.

Return periods have been estimated for daily rainfall totals of 20mm and 40mm, for the present day and the 2090s under different emission scenarios. The return period of 20mm rainfall can be up to around 60 years for the present day, decreasing to around 40years for the high emission scenario (RCP8.5) in the 2090s. The return period of 40mm rainfall can be up to around 1000 years for the present day, decreasing to about 750 years for RCP8.5 in the 2090s. Return periods tend to be lower at higher altitudes, roughly equivalent to an east/west effect; lower return periods equate to more frequent events.

Overall, extreme daily rainfall totals are expected to be greater in the west and at higher altitudes. The relative change in extreme rainfall in the 2090s is also expected to be greatest in the west. The size of the change is dependent on emission scenarios.

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