A wetter future? – new UKWIR research on 21st century rainfall intensity estimates for sewer design

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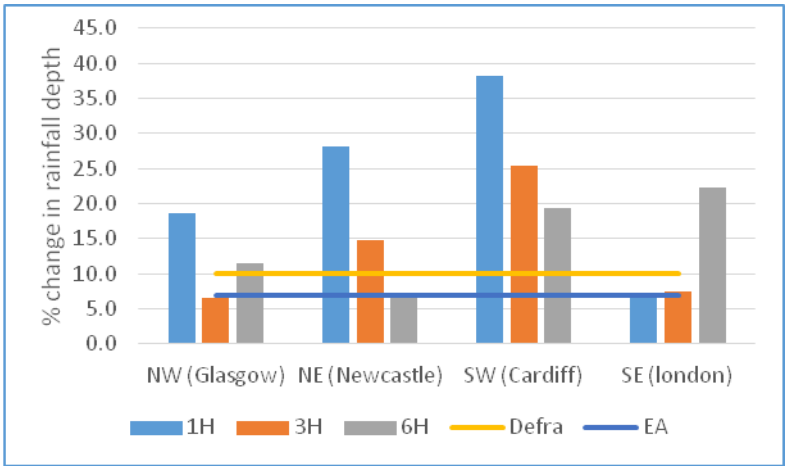
Introduction

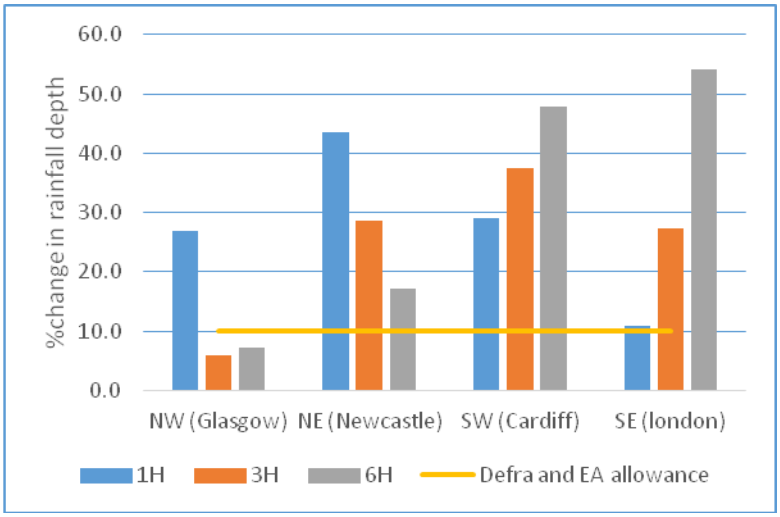
Water and sewerage companies do not have a way of assessing the growing risk of customer flooding based on the climate science. The original project for UKWIR[1] on this subject produced estimates of future rainfall intensity change for the UK for design durations pertinent to sewer design. This research was based on the best available climate science of the time (UKCIP98 and UKCIP02). This research, and further research since this time, continued to use regional climate models (RCMs) to infer short duration rainfall intensity changes in the future.

The fundamental problem with using RCMs for this purpose is that the main type of rainfall resulting in sewer flooding events is **convective** – a type of rainfall caused by the vertical movement of an ascending mass of air that is warmer than its environment. Although only around 30% of sewer flooding arises from sewer capacity problems, most of the sewer flooding resulting from hydraulic under-capacity occurs as a result of convective rainfall that is generally of higher intensity than other rainfall types. UKCP09 does not quantify changes in convective, localised and intense rainfall events because such processes occur on a much finer scale than the RCM resolution (25km) used in UKCP09. The general message of drier, hotter summers and milder wetter winters coming from UKCP09 relates predominantly to the frequency of large scale (frontal) rainfall events that occur at a spatial scale that climate models can simulate quite realistically. Existing Environment Agency guidance (2011) for 'extreme rainfall' refers to increases in intensity of between 10 and 40% in the future, but at daily resolution only – these values were drawn from UKCP09.

UKWIR Project – information on approach and results

Addressing the above issue, a recent UKWIR project, Rainfall Intensity for Sewer Design, (ref. 15/CL/10/16) has produced estimates of rainfall intensity change over different parts of the UK using a combination of two approaches: using climate analogue data[2] and a high-resolution (1.5km) climate model developed by the UK Met Office[3],[4] – both approaches capturing or resolving convective rainfall events. The resultant rainfall intensity change estimates are, in general, higher than existing UK guidance suggests, as shown in Figure 1. These estimates have been derived from the approaches mentioned above. Full details of the method to achieve these estimates, and the wider range of low and high estimates are provided within the UKWIR Technical Report (ref. 15/CL/10/16-1).





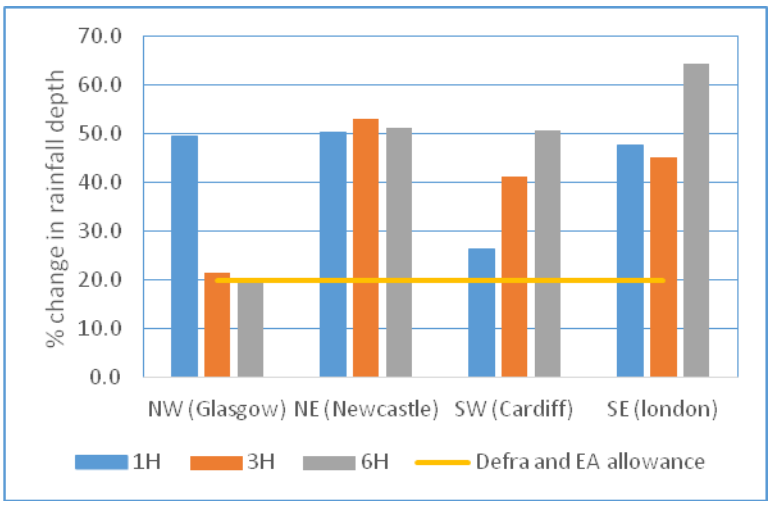


Figure 1 – Central estimate uplifts (percentage change in rainfall depth) for 4 UK locations derived from high-resolution climate model and climate analogue approaches (top 2030s, centre 2050s, bottom 2080s). Results are compared with Defra and Environment Agency central estimate climate change allowances for daily rainfall.

Impacts of rainfall changes on sewer systems

The UKWIR project has also assessed the impact of the estimated changes in rainfall on total flooding volume using design storms and on CSO spill volume and frequency using time series rainfall from the 1.5km resolution climate model. Analyses were undertaken in a selection of UK sewer catchments from different parts of the UK. The results of these analyses have indicated that total flooding, CSO spill volume and frequency of spills (>50m^3) are also likely to increase in the future. Headline results from the sewer modelling have shown that:

- In four models percentage increases in total flooding are greater than percentage increases in the rainfall depth and, in general, are close to the square of rainfall depth increase, though this relationship varies from model to model
- For one location, time series rainfall from the 1.5km Met Office climate model showed that spill freqency doubles and spill volume quadruples in the future (in this case future = 2100), despite very little change in annual average rainfall

[1] Climate change and the hydraulic design of sewerage systems CL10 (UKWIR) (2001-4)

[2] Blenkinsop S, Chan SC, Kendon EJ, Roberts NM, Fowler HJ (2015) Temperature influences on intense UK hourly precipitation and dependency on large-scale circulation, Environmental Research Letters, submitted

[3] Kendon, E. J., Roberts, N. M., Senior, C. A. & Roberts, M. J. (2012) Realism of rainfall in a very high resolution regional climate model. J. Clim. 25, 5791- 5806

[4] Kendon, E.J., Roberts, N.M., Fowler, H.J., Roberts, M.J., Chan, S.C. and Senior, C.A. 2014: Heavier summer downpours with climate change revealed by weather forecast resolution model. Nature Climate Change, 4, 570–576, doi:10.1038/nclimate2258.