

Introduction

The nature of rainfall over the Severn Estuary has changed over the last 30 years. Rainfall patterns are projected to continue showing changes, with seasonality of rainfall becoming more important. This has potential consequences for river and groundwater levels and possible issues related to catchment management and land use in the future. However, the UK exhibits high levels of year on year changeability in storm and rainfall patterns and, as yet, there are no clear trends of change in annual mean rainfall levels.

Current rainfall trends

Mean annual rainfall totals for the UK have not changed significantly since 1766 when rainfall records began. However, trends in seasonality are apparent and show a decrease in mean summer rainfall and an increase in mean winter rainfall between 1961 and 2006 ⁽¹⁾ (see Figures 1 and 2). It is important to monitor and recognise these seasonal patterns of change, which could potentially have the greatest social, economic and environmental impacts, but annual mean rainfall has shown no overall clear trend.

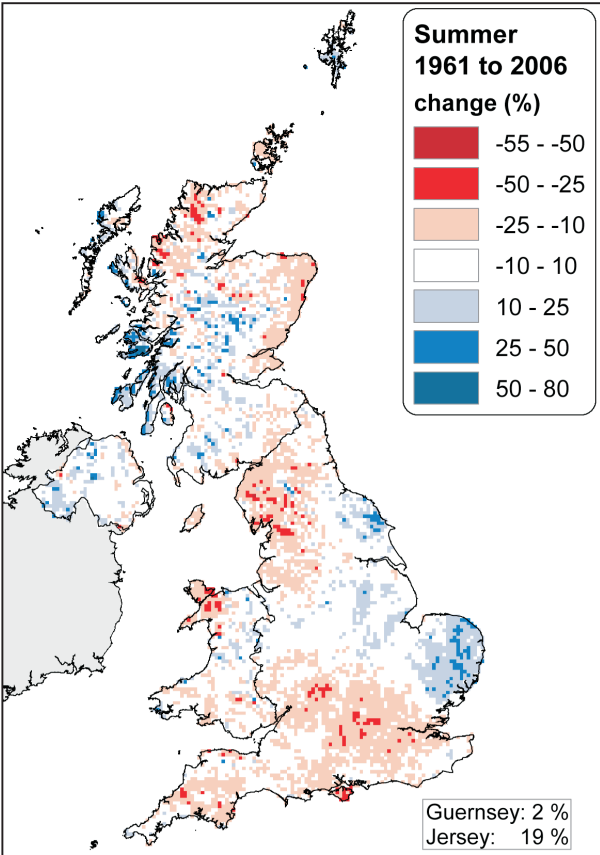


Figure 1: Percentage (%) change in mean summer precipitation 1961-2006 (source: UKCP09)

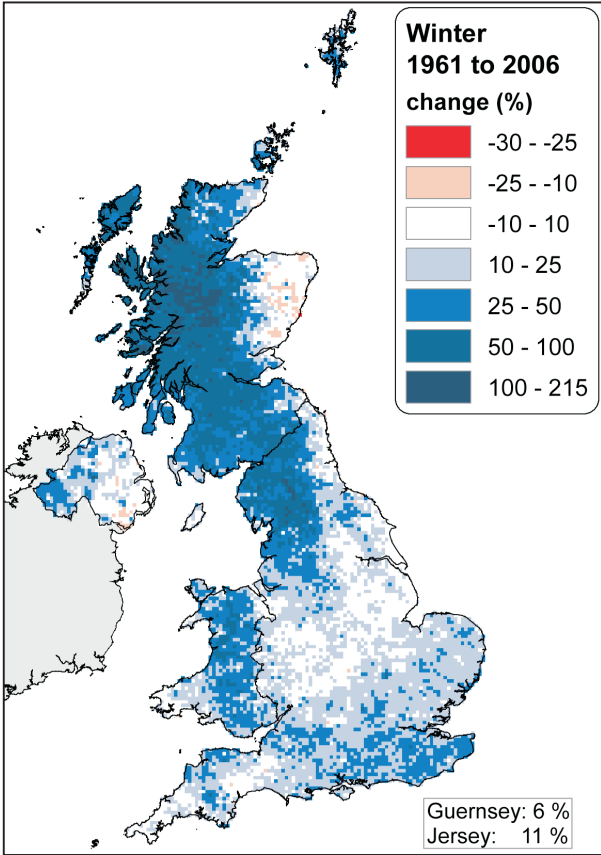


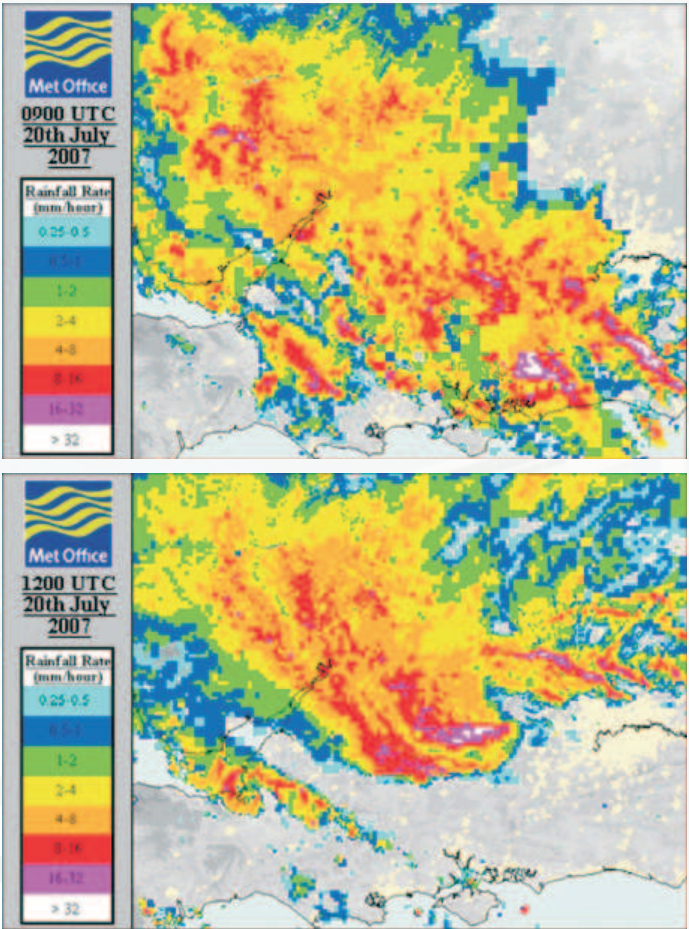
Figure 2: Percentage (%) change in mean winter precipitation 1961-2006 (source: UKCP09)

There is no specific information readily available for the Severn Estuary. However, precipitation trends have been analysed for the Severn River Basin, which includes large areas of east Wales, the west Midlands and south west England. For Wales the picture is similar to the UK overall trend, with increases in winter rain days and decreases in summer rain days. Averages for the areas analysed above show summer total precipitation has decreased by 15-20% over the 1961-2006 time period, which is statistically significant. Winter mean precipitation trends show a general increase in mean precipitation by about 10-15% over the same time period. The west Midlands shows a similar precipitation pattern. South west England shows similar trends with increased heavy winter precipitation and decreased summer precipitation ⁽²⁾ (Figure 3).

All regions of the UK have seen an increase in the contribution from heavy rainfall events during winter. Research has indicated that there has been little change in the regularity of extreme rainfall events in western parts of the UK, which includes the Severn Estuary, during the 1990s ⁽³⁾.

Heavy rainfall events in the Severn Estuary region

In July 2007 heavy rainfall fell over the Midlands, southern England and south Wales causing extensive flooding, especially in the Severn Valley⁽⁴⁾ (Figures 4 and 5). The impacts of this flooding on property and infrastructure was severe, widespread and in some cases, very long-lasting⁽⁵⁾. However, detailed analysis of the rainfall and river flooding events of July 2007 concluded that the rainfall was unlikely to be due to climate change⁽⁶⁾. This was because the UK climate is highly variable from year to year and such singular events cannot be associated with long term climate change directly.



In September 2008 it was reported⁽⁷⁾ that over a month's rain had fallen in just 24 hours (about 74.6mm) over the Severn River Basin, causing widespread disruption and damage to property in south Wales and the south western Midlands.

Such severe and sudden events cause wide-spread urban drainage (pluvial) and river (fluvial) flooding as well as significant damage to commercial and residential assets. Many of the areas affected, including Gloucester, had not yet recovered from the extreme rainfall events of July 2007 thereby prolonging the social and economic impacts those floods had already had on the region.

Figures 4 and 5: Rainfall intensities over the Severn Estuary, derived from the weather radar network. Rainfall intensity is measured in mm/hour. The colours orange, red and purple indicate where the rainfall was heaviest for the 20th July 2007 between 0900 and 1200 hours. The images highlight that parts of south Gloucestershire, Bristol and south east Wales experienced severe rainfall over a very short time period, causing flash floods. (source: Met Office in Prior and Beswick (2008))

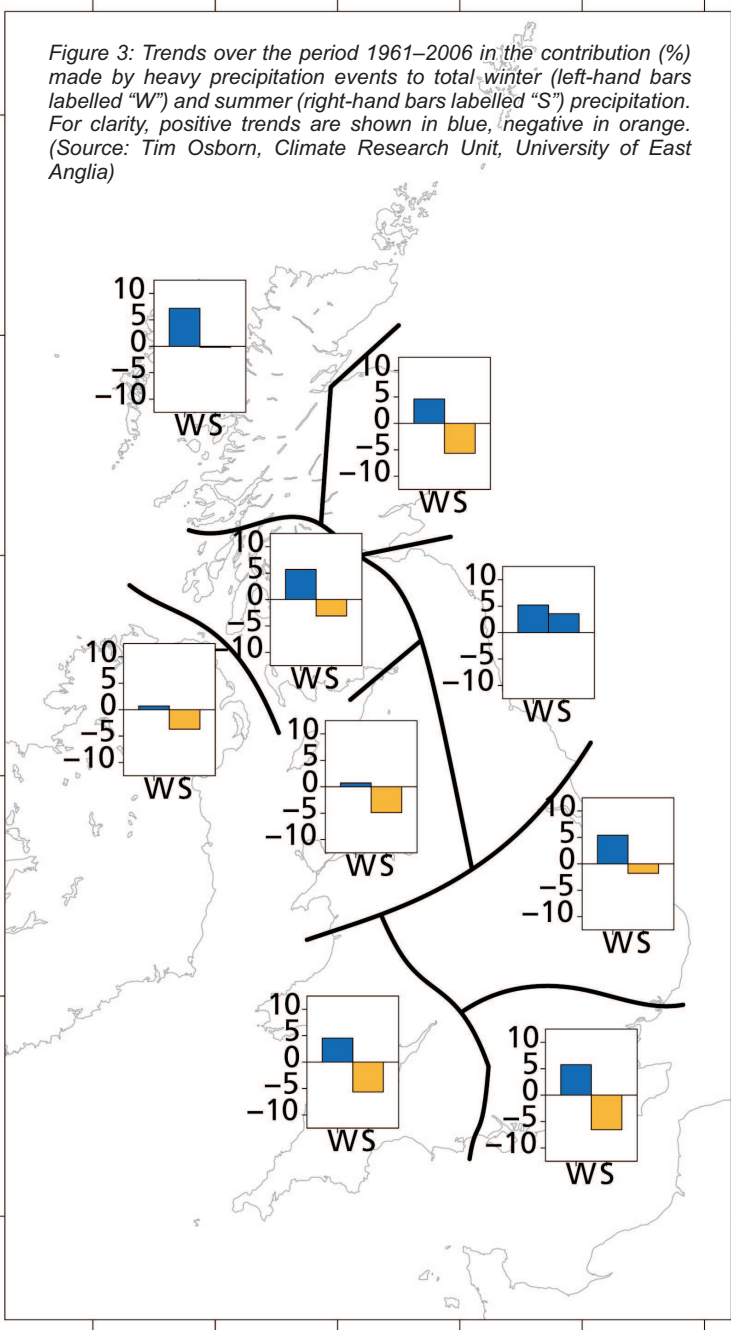


Figure 3: Trends over the period 1961–2006 in the contribution (%) made by heavy precipitation events to total winter (left-hand bars labelled “W”) and summer (right-hand bars labelled “S”) precipitation. For clarity, positive trends are shown in blue, negative in orange. (Source: Tim Osborn, Climate Research Unit, University of East Anglia)

Predicted trends for the Severn River Basin 2040 2069 period

The UK Climate Projections 2009 (UKCP09) ⁽⁸⁾ show that the trend toward wetter winters and drier summers is likely to continue throughout the Severn River Basin area (which includes parts of Wales, west Midlands and south west England). More specifically, winter precipitation is expected to increase by about 12% and summer precipitation is expected to decrease by about 18% for the 2040 69 time period* (as highlighted in Figures 6 and 7).

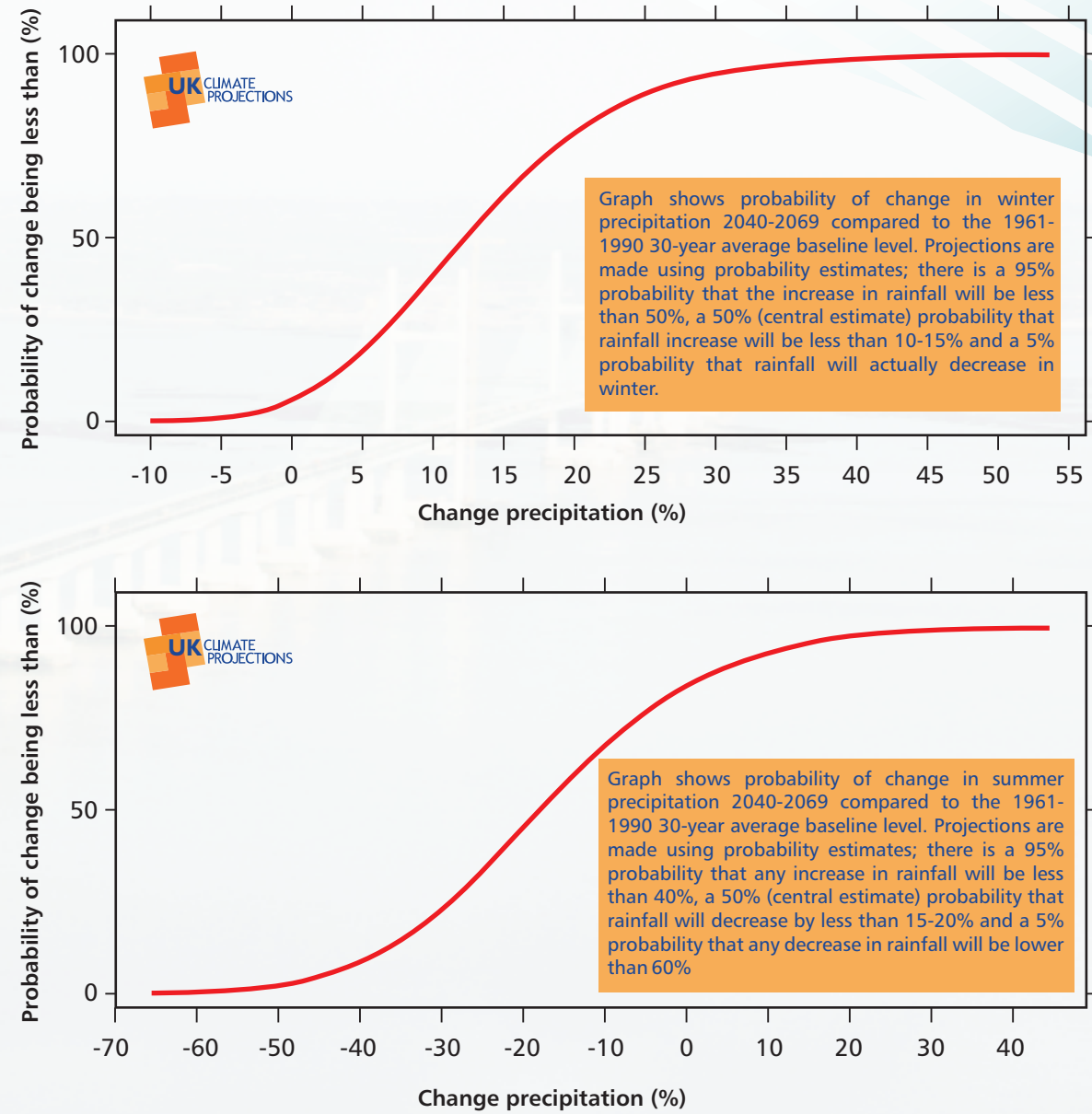
UKCP09 projections also indicate that there will be an increase in precipitation on the wettest day, which suggests that when it does rain, amounts will be higher. In addition, the projections suggest no significant change to the amount of rainfall on wet days in the summer months.

These projections are based on model results for the Severn River Basin but if an average of south Wales, south west England and the Severn River Basin is used, the results are slightly increased. This could be a more accurate depiction of the Severn Estuary locality. They show that an average increase in winter mean precipitation of about 23% whilst during the summer a decrease of about 24% is projected.

Note: Precipitation projections here all assume a medium greenhouse gas emissions scenario, central estimate.
**Precipitation projections are determined using the 1961 to 1990 30 year average baseline level.*



Figures 6 and 7: Probability graphs showing winter and summer climate change projections for rainfall over the Severn River Basin, 2040-2069 time period. (Source: UKCP09 user interface output)



Regional Climate Model (RCM) trends of extreme rainfall events

European scale climate models indicate that for northern Europe in winter, where an increase in precipitation is expected, the amount and frequency of extreme rainfall events is also expected to increase^(9,10). In addition, for the UK, research has concluded⁽¹¹⁾ that the return periods of extreme rainfall events will decrease as greenhouse gas concentrations increase. This work included an analysis of the Severn River catchment near Shrewsbury. The future projection of extreme rainfall events for the UK in summer is still unclear, with indications of a decrease in average and extreme rainfall overall⁽¹²⁾.

By contrast, there is some evidence⁽¹³⁾ to suggest an increase in extreme rainfall events in parts of Europe. Trends for the Severn Estuary area can be estimated from the above but interpreting RCM information at local scales must be done with great care. It is not yet possible to forecast the exact nature, timing and frequency of a single meteorological event at Estuary level, with a reasonable degree of accuracy, beyond a couple of days.

References

- ^(1,2)Jenkins, G.J., Perry, M.C., and Prior, M.J., (2008) The Climate of the United Kingdom and Recent Trends, Met Office Hadley Centre, Exeter, © Crown copyright
- ⁽³⁾Fowler, H.J. and Kilsby, C.G. (2003). A regional frequency analysis of United Kingdom extreme rainfall from 1961 to 2000. International Journal of Climatology, 23(11), 1313-1334
- ^(4,6)Marsh, T. and Hannaford, J. (2007). The summer 2007 floods in England and Wales – a hydrological appraisal. Centre for Ecology & Hydrology, 32pp.
- ⁽⁵⁾Prior, J. and Beswick, M. (2008) The exceptional rainfall of 20 July 2007 in Special Issue, Summer 2007 in the UK, Weather, Vol. 63, No. 9 pp261-267
- ⁽⁷⁾Met Office, Case Study: http://www.metoffice.gov.uk/corporate/verification/case_studies_08.html
- ^(8,16)Murphy, J.M., et al (2009) UK Climate Projections Science Report: Climate change projections, Met Office Hadley Centre, Exeter, © Crown copyright
- ⁽⁹⁾Solomon, S., et al (editors) (IPCC) (2007). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change
- ⁽¹⁰⁾Fowler, H. (2006). 'Extreme rainfall' incidents increasing in parts of UK. Newcastle University press release, © 2010 Newcastle University
- ^(11,14)Huntingford, C. et al., (2003). Regional climate-model predictions of extreme rainfall for a changing climate. © Royal Meteorological Society and Crown copyright, 129, pp. 1607-1621
- ⁽¹²⁾STARDEX. (Statistical and Regional dynamical Downscaling of Extremes for European regions). 2005. <http://www.cru.uea.ac.uk/cru/projects/stardex/>
- ⁽¹³⁾Christensen, J. and Christensen, O. (2003). Climate modelling: Severe summertime flooding in Europe, Nature 421, 805-806
- ⁽¹⁵⁾Wilby, R. and Dessai, S. (2010) Robust adaptation to climate change, Weather, Vol. 65, No. 7

Summary

- Mean summer precipitation levels are projected to decrease by around 18% between 2040 and 2069.
- Mean winter precipitation levels are projected to increase by around 12% between 2040 and 2069.
- Projected changes in mean annual precipitation levels are uncertain as there has been no clear pattern in total annual amounts during the 1961 to 1990 30-year average baseline level.
- Both warmer, drier summers and milder, wetter winters will have significant impacts on national, regional and local social, economic and environmental dynamics.

Regional Climate Model uncertainty

It is not yet possible to use RCMs to predict the exact cause of precipitation processes, intensity or timing⁽¹⁴⁾. The ability to reduce uncertainty will depend on an improvement in the knowledge of the science⁽¹⁵⁾. In addition, UKCP09 recognises the following as causes of uncertainty⁽¹⁶⁾:

- Climate modelling due to incomplete understanding of the climate system
- Natural climate variability
- Greenhouse gas emissions and difficulties in predicting future amounts
- Issues with downscaling data and translating it to regional and local scales
- Extreme scenario projections

Contacts and further information

Produced by C. Hovey and N. Rodgers, Cardiff University Marine and Coastal Environment Research Group (MACE), as part of the IMCORE project (Innovative Management for Europe's Changing Coastal Resource).

For more information please visit: www.imcore.eu

Or contact: School of Earth & Ocean Sciences, Cardiff University, Main Building, Park Place, CF10 3YE Or email: imcore@cardiff.ac.uk

