Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

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The July 2007 floods in England and Wales – A preliminary appraisal issued by the Centre for Ecology & Hydrology

Issued 26th July 2007: 1500GMT

The weather conditions experienced across much of the UK throughout the summer of 2007 have been truly exceptional. The jet stream (which influences the paths taken by weather systems in the North Atlantic) has followed an abnormally southerly track and the extension of the Azores high pressure cell across the UK – which brings settled weather conditions in most summers – has failed to become established. Correspondingly, a sustained sequence of rain-bearing low pressure systems has produced outstanding 12-week rainfall totals, and a series of flood events culminating in widespread severe flooding in late July.

Rainfall

The combined May and June rainfall total is the highest on record for the UK (in a series from 1914) by a considerable margin and the exceptional weather conditions continued into July. Provisional data indicate that the May-July period will be the wettest for England and Wales in a series from 1766 with many areas registering more than twice the long term average – remarkable for a three-month period.

As warm and very moist air moved north from France, the volatile July weather patterns culminated in an extremely wet episode on the 20th. Outstanding storm rainfall totals were reported across much of southern Britain. These included 145mm in Pershore (Hereford and Worcestershire), 111mm at Chieveley (Berkshire) and c120mm at Brize Norton (Oxfordshire).

Statistical analyses confirm the extreme nature of such storms – on the basis of historical data they would be expected to occur, on average, only once in several hundred years (longer in the case of the Pershore event). Thundery interludes contributed to substantial spatial and temporal variations in rainfall intensity but catchment rainfall totals were exceptional over wide areas. Localised storms of tropical intensity are a feature of many English summers but a distinguishing characteristic of the July 2007 storms was the spatial extent of the extreme rainfall totals.

Characteristics of the flooding

Normally, flood risk during the summer is substantially diminished by dry soil conditions. Following the record late spring and early summer rainfall, accompanied by widespread flooding in June, soils were close to their wettest on record (for mid-summer) in early July across much of England. This rare circumstance left many catchments vulnerable to further significant rainfall.

The exceptional rainfall on the 20th July triggered a sequence of relatively distinctive flood episodes: localised (mostly urban) flash floods, extremely high flows in small responsive (impermeable) catchments and, subsequently, extensive floodplain inundations as the runoff concentrated in the major rivers of southern Britain (including the Severn, Warwickshire Avon, Bedford Ouse, Trent and Thames).

Initially, the intense rainfall overwhelmed many urban drainage systems producing localised but severe flash floods. The emergency services were widely deployed to rescue stranded individuals and organise evacuations from the most severely affected localities. These contributed to massive and extensive transport disruption across southern Britain, exacerbated by the volume of holiday traffic (the 20th being the end of the school term in many areas). Subsequently, floodplain inundations caused extensive crop damage and the need to move livestock to higher ground. The sustained high levels in the major rivers also hampered the drainage of flood waters away from the urban areas inundated on the 20th.

River flows

Preliminary data suggest that a significant minority of rivers across southern Britain exceeded their previous maximum recorded flow and many eclipsed previous maxima for the summer half-year (April-September) – often by very wide margins.

In the worst affected areas (e.g in the lower parts of the Severn and Warwickshire Avon basins and some upper reaches of the Thames catchment), flood flows may have exceeded those of March 1947 - the most severe flood in southern Britain in over 100 years (note however that the 1947 event was primarily the result of rapid snowmelt over still-frozen ground and its overall impact was substantially more severe than the current flooding).

An historical perspective on the July floods

An indication of the rarity of the hydrological conditions experienced this summer is provided by the recent increases in groundwater levels in some parts of eastern and southern England. Generally, groundwater levels decline over the May to September period, due to an absence of natural replenishment (recharge). This summer, groundwater levels in the Cotswolds rose rapidly in mid-July and by the 24th stood above normal winter levels; this is reflected in the exceptionally high recent flows reported for many spring-fed streams. In the 19th century, significant summer recharge was recorded in a number of years (e.g. 1860 and 1879) but examples of significant and widespread summer recharge in the 20th century are very rare.

Episodes of extensive summer flooding may be found in the historical record (e.g. in 1875) – particularly in the nineteenth century when summer half-year (May-Oct) rainfall often exceeded that for the winter half-year. There are, however, no close modern parallels to the scale of the summer flooding experienced this year. It has served to underline our continuing vulnerability to very exceptional summer rainfall and to, as yet poorly understood, changes in the position of the Jet Stream.

Outlook

In the medium term (2-4 months) it is likely that soil conditions will remain wetter than the seasonal norm. This will encourage an early onset of the seasonal recovery in river flows and groundwater levels in the autumn. Correspondingly, an extended flood season throughout the autumn and winter of 2007/08 may be expected.

How influential is climate change?

By their nature, individual extreme flood events cannot be linked directly to climate change. If they form part of a developing pattern or emerging trend, then a causative association becomes more plausible. In England and Wales, evidence for long term increases in fluvial flood magnitude is elusive – one factor here is that in a warming world snowmelt (a primary cause of the 1947 flood) is very likely to decline as an exacerbating factor as temperatures increase. Warmer, drier summers would also tend to produce very dry soil conditions which, unlike this year, should help moderate fluvial flood risk. On the other hand, more intense summer rainfall would increase the risk of localised flash flooding – with associated drainage problems, particularly in urban areas.

Further information concerning the impact of climate change on flood risk in the UK is given below.

Climate change and flood risk – Position statement issued by the Centre for Ecology & Hydrology

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Future climate change will potentially affect all aspects of the rainfall regime in the UK. The precise nature of these changes is uncertain, particularly for those extreme events, whether of short or long-duration, which tend to lead to flooding. Increases in rainfall at all scales will increase the risk of flooding to a greater or lesser extent, depending on how these increases manifest themselves in space and time and of the rainfall-runoff characteristics of the catchment in question.

Possible future changes in precipitation can be ascribed to broad-scale changes in the annual or seasonal regimes, changes in the nature of both short and long-duration events, or changes in precipitation variability.

The impact of any given rainfall event on a catchment is a function of the catchment's physical characteristics and the antecedent hydrological conditions. For larger, slow-responding catchments a sequence of rainfall events is critical to replenishing any soil moisture deficits and establishing conditions so that any subsequent rainfall contributes mainly to runoff. For smaller, urban, or other fast-responding catchments, it is the characteristics of the specific rainfall event that are critical, as these catchments do not have the hydrological "memory" of larger catchments. Understanding the possible changes to both long and short-duration rainfall, such as the temporal and spatial structure and sequencing of frontal events and convective storms, is critical to the understanding of how flood risk might change in the future. Changes in these types of rainfall statistics remain highly uncertain and it should be noted that these changes will take place against a back-drop of (changing) natural variability.

Note

A more comprehensive analysis of the floods will appear in the July edition of the Hydrological Summary for the United Kingdom which will be released in mid-August by the Centre for Ecology & Hydrology and the British Geological Survey.