Many unhappy returns

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The Harbour Cafe suffered severe damage. The inside was full of alluvial silt.
© David Flower

Recent storms were the most severe to hit parts of the UK since 1822, while the flooding of Boscastle in September 2004 brought previously unimaginable devastation to the Cornish village. People whose lives have been seriously affected by these extreme events now want to know: is this going to happen again? And if so, when?

2005 began with another 'exceptional' meteorological hazard hitting the UK. A series of deep depressions sweeping in from the Atlantic brought widespread chaos to northern regions between 9th and 13th January. Carlisle experienced nine inches of rain in a matter of hours on January 9th, causing The River Eden's flood defences to be overwhelmed (*The Guardian*, 15 January 2005). Many buildings, including the civic centre, were flooded while two people drowned.

Elsewhere in Britain, severe storms also took their toll, notably in the Hebridean island of South Uist, where a family of five were tragically killed in a 120mph gale when their car was swept into the sea. (*The Guardian*, 14 January 2005). Lives were lost in Bradford and Moray, while a sea ferry was driven aground in 100mph winds in Loch Ryan (*The Guardian*, 10 January 2005). Nationwide, three drivers were killed as storm winds reached 140mph.

When will it happen again?

These were the worst storms for nearly 200 years to be experienced by some parts of the UK. So does this mean that it will be another 200 years before events of this magnitude will occur again in Carlisle? Or could they recur sooner? Hazard researchers normally calculate estimated levels of future risk by analysing historical records. Using past data, they can work out the expected **return period** for natural hazards of varying magnitude. However, global climatic change may be making their estimates increasingly unreliable.

What is a 'return period?'

The return period of a natural hazard of a certain magnitude is a statistical estimate of the average time interval before it re-occurs. The higher the magnitude of the event, the longer the return period.

Analysis of historical records allows the average time-interval between similar sized events to be calculated. For instance, meteorological records may show that an area is subjected to one metre depth of river flooding once every ten years on average. This is known as a ten-year flood (1:10). The same area may be flooded to a greater depth of two metres once every fifty years, on average. This is known as a fifty-year flood (1:50). There will be more extreme events too, such as a one thousand-year flood: devastatingly deep water that can be expected to recur, on average, only once every thousand years (1:1000). Several important issues arise as part of this kind of risk assessment:

· Historical records may not go back far enough for extreme thousand-year events to have ever been recorded. As a result, we do not have perfect knowledge of the scale of hazards that can potentially occur.

· The pattern of events such as floods or droughts may be undergoing cyclic or long-term change, in which case the historical records cannot be used to make accurate predictions of future return periods.

· Just because two very large floods occur in the same decade does not necessarily mean that in the future we can expect the same flood to recur with the same frequency. We would need to examine a much greater spread of historical data to be sure. It is statistically *possible* for more than one hundred-year flood to occur within the same decade, for instance – but it is highly unlikely!

Many meteorologists are now arguing that the frequency of extreme events is actually increasing. For instance, the flooding that widely affected southern England in 2000 was also described as a 200-year event. Last summer's flooding of Boscastle was calculated to be an even rarer occurrence – only expected to recur once every 400 years. Are extreme events occurring more frequently than predicted? Could it be that hazard recurrence estimates based upon past climatic data are becoming increasingly unreliable? If the earth's climate is changing, as experts now strongly suggest it is, then this may be the case.

So how reliable are our defences?

All of this may mean that much of the UK could one day find itself with inadequate flood defences. Sea walls and river embankments that are designed to withstand the worst storms expected to occur every 100 years may, in future, only offer protection against the worst storms occurring every 50 years – meaning that flooding can be expected twice a century instead of just once. This is of particular concern in the case of The Thames Barrier, a moveable structure designed to protect London from North Sea storm surges. The barrier was originally designed to offer 1:1000 protection, meaning that it is only expected to be overwhelmed once every thousand years on average. This estimate is based upon knowledge of previous storm surges.

The Environment Agency still believes there is only a one-in-a-thousand chance of London being flooded in any given year, due to the barrier being overwhelmed. However, if global climate is changing then in future the barrier may no longer offer the level of protection it was designed to give. This would be worrying news for the population of London. If flooding did occur, Westminster would be under two metres of water, and 68 underground and Docklands railway stations would be flooded, as would 16 hospitals and 400 schools.

Meanwhile, London's total level of risk is growing all the time, as more people migrate there and new housing developments increase the total value of vulnerable property. With 200,000 new homes planned by the government below the high tide mark in the Thames Gateway area by 2016, the issue of dependable flood defence is likely to become a major concern for policy-makers. If climate change and sea level rise become much more severe, a new outer barrier may ultimately need to be built, at a likely cost of £20bn (*The Guardian*, 11 January 2005). However, scientists now claim that they will need to study at least another fifty severe floods in the UK over the next twenty years before they can produce more accurate predictions of future risk levels (*The Guardian*, 15 January 2005).

Here you can see the water level has now reached the first floor of the same building with the person still trapped. The white building beside it is now collapsing. The person at the window was one of the last to be rescued by military helicopter and was unhurt. © Mark Saltern

When will Boscastle flood again?

The Environment Agency has finished reviewing the facts about Boscastle, the Cornish village devastated by 203mm of rain in August 2004. The Agency advised that residents should be allowed to rebuild their demolished properties, following the key findings of an expert study, commissioned from specialist hydrologists, which quantified the risk of a flood of similar or greater magnitude recurring at Boscastle at just 400-to-1 in any given year.

The Agency said the Boscastle flood was among the most extreme ever experienced in Britain. The likelihood of such a severe flood recurring in the village, however, was very low. The peak flow of the River Valency was about 140 m3/sec (tonnes), between 5:00pm and 6:00pm, allowing 2 million tonnes of water to flow through Boscastle that day. The annual chance of this (or a greater) flood occurring in any one year is only about 1 in 400. By way of comparison:

- A flow of 77 m3/sec has an annual chance of about 1 in 100
- A flow of 64 m3/sec has a chance of about 1 in 75

Read more about the Boscastle flood in our In-depth Report

Other related items

Drought, what drought?

Wave goodbye to coastal defences?

Writing about hazards and environmental management at A-level

Improved understanding of return periods can be very helpful at A2 level, when exploring the human response to natural hazards, as in the following essays:

(1) Examine the effectiveness of prevention and protection schemes in the management of natural hazards.

- or -

(2) Examine the need for hazard management schemes in environments that you have studied.

In both cases, there is an opportunity for the A-level candidate to demonstrate more sophisticated understanding of hazards and risk assessment through reference to return periods. In essay (1), a low-scoring response is likely to simply contrast a scheme that 'worked' with one that 'didn't work' and to offer little real critical examination of the provision of 'effective' management, either structural or non-structural. A higher-scoring response might begin to explore the idea that no scheme can be 100% effective as there is always a statistical probability – no matter how small – of an occurrence of greater magnitude than the defences are designed to protect against. The 1:1000 Thames Barrier would be a useful example of this.

Similarly, in essay (2), it is important to move beyond a simple distinction between 'there is a need in place x' and 'there is no need in place y'. A cost-benefit analysis will often identify a need for protection along a stretch of coastline, for example, if it shows any signs of habitation. But what level of protection can be justified, given the varying costs of sea walls of different heights and thickness? If the coastline is sparsely populated, will only 1:10 sea walls be paid for? How densely populated should an area be before the higher cost of 1:1000 coastal defences can be justified? These are very difficult issues for hazard managers and need to be highlighted.

Students can investigate their own level of risk, to help support their essay writing. The Environment Agency's online flood risk map shows the extent of flood risk areas and the likelihood of flooding, classified as 'low', 'moderate' or 'significant' at http://www.environment-agency.gov.uk/news/944736