Crisis response and climate change

Every year scores of people die and countless are displaced as a result of natural disasters. This has always happened but, says **Dave Robinson**, under some plausible climate change, these disasters will occur more often and – in some regions – may be more severe

'TIMES THEY ARE a-changing' – It is a cliché, but an apt one when you look at what is happening, and what we are predicting will happen to the world's climate. Climate change is already taking place. Stress will be caused to areas that have previously escaped its impact, as a result of greenhouse gas emissions from recent decades and climate change in the future.

Predictions

Complex computer models, with detailed representations of the atmosphere ocean and land surface, are the only tools that can independently predict changes in climate averages and extremes over the planet. The predictions of future climate from these models are increasingly being used to estimate ecological and socio-economic impacts, and to plan adaptive responses. Modellers routinely work with contingency and planning experts to help authorities and society as a whole to plan for these changes. The devil is in the detail but, using models, the climate scientists at the Met Office's Hadley Centre in the UK have some preliminary results:

- The basic picture for the UK for example, is that winters are predicted to become milder and wetter, with rain leading to saturation of the ground more often and, potentially, more flooding. Even during the summer months, which are forecast to become generally drier and warmer, heavy, localised storms could become more frequent with increased risk of flash floods;
- There is a 90 per cent probability of global average temperatures rising between 2.4°C and 5.4°C by 2100;
- At many locations, seasonal average temperatures will continue to rise. Warming will vary from one location to another; the land is expected to warm more than the ocean, and the greatest warming is predicted in the north. For example, the seasonal average temperature in India is predicted to rise by between 1.5°C and 4.5°C, by 2100;
- At some locations, seasonal average rainfall is predicted to decrease, while the intensity of extreme rainfall will increase. For example, in the north-west of India and Pakistan, less rainfall is predicted. However, more rainfall is predicted over central India, Bangladesh and Myanmar. In some areas less rainfall could lead to decreased crop yields, droughts and increased risk of damage to building foundations owing to ground shrinkage; and
- The impact on known climatic variations, such as El Niño, is the subject of continuing research.

The Hadley Centre climate model is a mathematical description of the Earth's climate system, broken into a number of grid boxes over both ocean and land. Above these grid boxes the climate system is also represented at different levels in the atmosphere in order to produce a 3-D grid covering the whole world. At each of these grid points equations are solved, which describe the large-scale balances of momentum, heat and moisture. In all, there are about a million grid points in the model. At each of these grid points equations are solved every half hour of model time throughout a model experiment which may last 250 or, in some cases, 1,000 years.

Uncertainties

All predictions of future climate change contain uncertainties, but the most serious effects of future climate change are likely to be caused by changes in extremes. Even under most optimistic emission scenarios – which could only be achieved if the world as a whole were to make a concerted move to alternative energy sources – climate change will continue for several decades, possibly even centuries. There are some potentially high-impact climate events for which we cannot yet accurately estimate the risk. However, we can investigate their potential and provide emergency planners with possible worst case scenarios.

The European heat wave of 2003 (See *CRJ* Vol.1 Issue 4) was the hottest in the northern

The incidence and severity of coastal flooding is predicted to worsen under climate change. Sea levels will change due to the expansion of oceans as they warm, and to the influx of water from the melting of glaciers and other snow and ice, especially the ice sheets in Antarctica and Greenland photo: Greenpeace / Morgan

hemisphere since official records started in 1860, and unofficial records suggest it was the hottest since at least 1500. The summer temperature over Europe was 2.3°C above average, and in many places searing maximum temperatures affected people for days on end. It is conservatively estimated that 25,000 more excess deaths occurred, along with forest fires and large scale agricultural losses. France suffered the worst losses, with more than 14,000 people dying from the heat. When the body is subjected to extreme heat, it struggles to maintain its core temperature of 37°C.

Cooling mechanisms

The body attempts to do this by sweating and pumping blood closer to the skin, but high heat and humidity can confound these cooling mechanisms. If the internal body temperature rises above 40°C, vital organs are at risk and if the body cannot be cooled, death can follow, especially in the most vulnerable, such as the old or the very young.

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Despite strong indications, the 2003 heat wave cannot be linked directly to climate change – in fact no single event can reasonably be linked to climate change. However, in the future similar extreme heat events are likely to be become more frequent as a result of man-made climate change. In fact, we predict that by the 2040s more than half of all European summers are likely to be warmer than that of 2003, and by the 2060s a 2003-type summer would be unusually cool.

The impact of heat waves on the emergency services could be massive. In 2003, while the French medical services were struggling to cope with huge numbers of heat-related illnesses, firefighters, soldiers and rangers were struggling with forest fires across Spain, Portugal and Italy.

The best way to deal with the increasing risk of heat waves is to improve preparedness and early warnings. For example, in the UK, during the heat wave, the Met Office worked very closely with the NHS and Department of Health, and set up a service called Heat-Health Watch. Each summer the service now issues warnings to health professionals when there is an increased risk of temperature thresholds – as set by the health community – being reached. These warnings are also issued to the general public using the Met Office website.

Rain and flooding

More intense rainfall events will inevitably lead to more incidences of flooding, both pluvial and fluvial; landslides and avalanches.

In an ideal world, flood defences would one day be perfect, able to deal with every rainfall event, but because of climate change, that is never going to happen. Flood defences are designed to provide a standard of protection considered appropriate to the damages caused by flooding. Confidence in the accuracy of the standard of protection relies on historic rainfall and climate records, and simulation of future climate scenarios.

The incidence and severity of coastal flooding is also predicted to worsen under climate change. Sea levels will change due to the expansion of oceans as they warm, and to the influx of water from the melting of glaciers and other snow and ice, especially the ice sheets in Antarctica and Greenland. It is predicted they could rise by at least 0.5m over the next 100 years.

The main consequence of sea level rise will probably come from an increase in extreme high water levels, arising from storm surges as depressions or tropical storms and cyclones track across the area. The effect of sea-level rise on storm surges around the British Isles could be extreme. One scenario modelled by climate scientists found that high water events at Immingham, a port in the northeast of England, which currently happen on average every 100 years, are predicted to occur as often as every seven years by the 2080s.

Unfortunately, we cannot prevent storm surges from occurring, but we can now forecast them with much-increased accuracy and put our flood barriers in place as early as possible.

If the Greenland ice sheet were to melt completely, it would raise the global average sea level by around seven metres. Without upgraded sea defences, many major cities around the world would disappear under water.

Looking at the worst case scenario, in which carbon emissions are increased to four times pre-industrial levels and then stabilised, shows that the ice sheet would almost disappear over a period of 3,000 years; with most of the melting taking place in the first millennium.

The increase in fresh water would not only change the face of the Earth's landscape but could also have a serious impact on the Gulf Stream. This is part of the ocean's conveyor belt – the system of ocean currents that is responsible for transporting heat from the warm tropics to higher latitudes. Without this heat transportation the climate at mid and high northern latitudes, eg the UK, which is at the same latitude as Alberta in Canada, would be much colder than at present.

Hadley Centre scientists have simulated a world in which the Gulf Stream has been artificially and rapidly shut down. The result was that in the 10 years after shutdown the whole of the northern hemisphere cooled down, with the cooling being particularly obvious in the Arctic Ocean. Under this scenario the UK was predicted to cool by between 3°C and 5°C, and extremes, for example winter minimums, would be very marked. This would obviously have a major impact on everything from the country's infrastructure to food production.

Gulf Stream

There is strong evidence that the Gulf Stream has switched off more than once over the last ten thousand years, due to natural causes. However, it must be borne in mind that currently most climate scientists do not believe there is significant evidence to suggest an imminent shutdown, and it is important to reinforce that the Hadley Centre's experiment only achieved a shutdown of the Gulf Stream artificially. CRJ

Part II of this article looks at how meteorological services help to monitor elements of climate change and phenomena caused by disasters – natural and man-made. It will look at modelling and monitoring of: tropical storms; chemical and nuclear pollution; marine pollution; volcanic ash; flooding; and severe weather.