Flood Forecasting for England and Wales

Will Lang, Flood Forecasting Centre, Met Office, UK

Summary

In the UK, the organisations responsible for flood prediction and warning have joined forces to deliver joined-up flood forecasting services to government and to emergency responders. In the Flood Forecasting Centre, a team of experienced and multi-skilled operational hydrometeorologists from the Met Office and the Environment Agency has been created to aid the design of and to use new models, tools and techniques in flood forecasting for England and Wales.

Background

The summer of 2007 saw unprecedented rainfall across the UK. 13 people died in the resulting flooding, which also caused billions of pounds worth of damage to communities, homes and critical infrastructure. The subsequent independent review of these events – the Pitt Review - highlighted the need for a much more integrated response to flooding across both national and local government and the other agencies responsible for warning for and responding to flood risk. In particular, the review recognised the importance of creating a joined-up operational flood forecasting service between the Met Office – responsible for weather warnings for the UK – and the Environment Agency (EA) – responsible for flood warning in England and Wales[1]. The Pitt Review also recommended that probabilistic approaches to flood forecasting should be employed, using warnings with longer lead times to allow a proportionate and risk-based response.

At the same time, the Met Office was restructuring its Public Weather Service to ensure its alignment with the requirements of the UK Civil Contingencies community at both national and local levels. There was a move towards use of impact-based warnings and advice, instead of just pure meteorological guidance.

The Flood Forecasting Centre (FFC) was created in 2009. Now located at the Met Office headquarters in Exeter, the Centre is run and operated by both Met Office and EA staff and provides a focus for the hydrometeorological forecasting and development within both organisations. A 24/7 operational roster is staffed by EA hydrologists who have been trained as meteorologists, and by Met Office forecasters who have undertaken flood forecasting training; all are now regarded as hydrometeorologists, who are skilled in both disciplined. They form a highly effec-

Figure 1
The Flood Forecasting Centre, based within the Met Office Operations Centre

1 - Separate arrangements exist for Scotland and for Northern Ireland. For example, the Met Office works with SEPA in Scotland to deliver the Scottish Flood Forecasting Service.

tive communication and decision-making link in the flood forecasting process.

The Role of the Flood Forecasting Centre

Until recently, ultimate responsibility for flood forecasting as a whole was unclear in the UK. The EA issues Flood Warnings and Alerts for sections of rivers and coasts, but there was no national-scale monitoring, modelling or forecasting. The Met Office issued heavy rainfall warnings, though these were issued based on accumulation threshold exceedance rather than the expectation of flooding from surface water. In Summer 2007, both sources of flooding were significant, and it was unclear who was responsible for a consistent message.

So a principle strategic aim of the FFC is to provide a centre of expertise and authoritative advice for **all** sources of flooding; from the rivers, the sea, groundwater, and from 'flash flooding'; associated with intense rainfall.

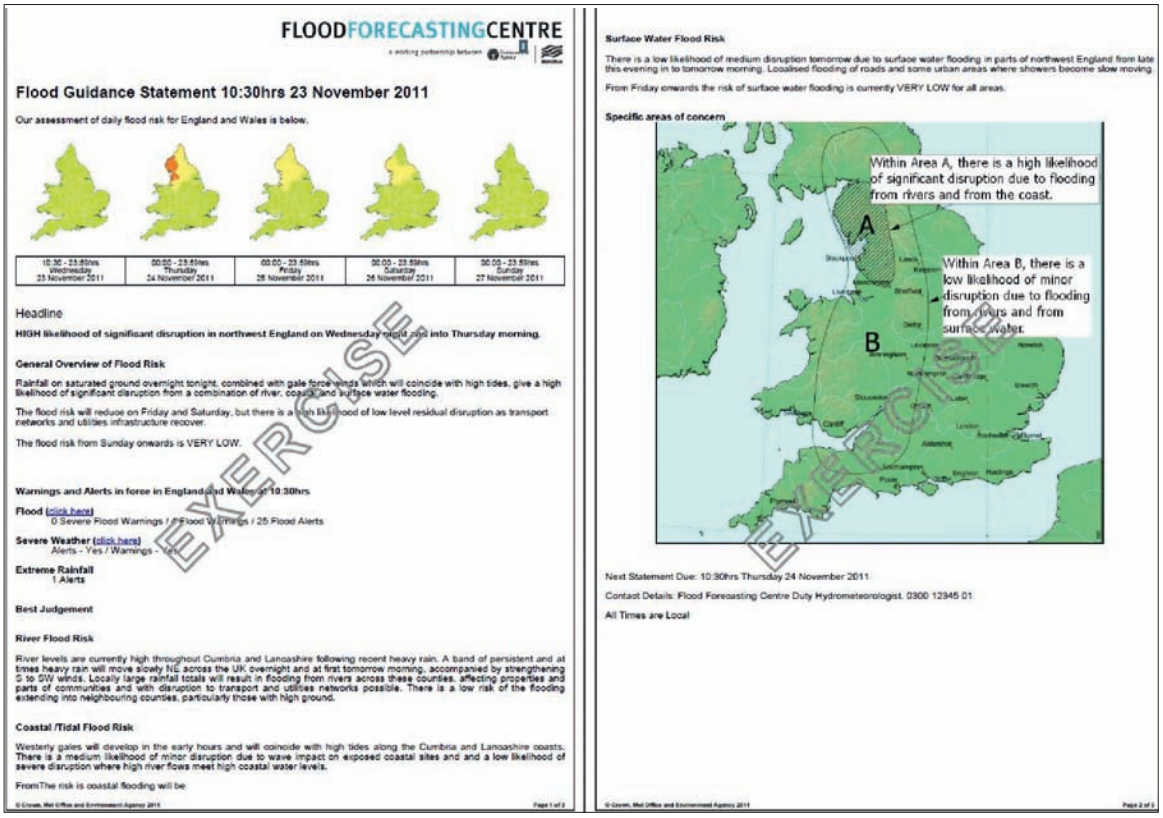
This is an ambitious objective, which has become reliant on building a very strong partnership between the two organisations involved. And now the strength and effectiveness of this partnership is being used as a model for further and more complex collaboration across government and science bodies, notably the UK's Natural Hazards Partnership (NHP).

In addition to operational activities, the FFC's Services team seeks to work across both organisations to co-ordinate development and implementation of new flood forecasting science and systems. Their work has proved invaluable in acting as an 'expert customer' which can steer science and technical strategy in the wider EA and Met Office.

Services for Emergency Responders

Given the diversity of the emergency responder customer base, FFC flood risk products are designed to be as simple and useful as possible. The Flood Guidance Statement (fig 2) consists of 'traffic-light' coloured maps of England and Wales for the next five days, accompanied by explanatory text and (when necessary) graphics. Each local authority or county is assigned a flood risk of either GREEN, YELLOW, AMBER or RED for each day, consistent

▼ *Figure 2*
An example Flood Guidance Statement


FLOODFORECASTINGCENTRE

Flood Guidance Statement 10:30hrs 23 November 2011

Our assessment of daily flood risk for England and Wales is below.

Headline

HIGH likelihood of significant disruption in northwest England on Wednesday night and into Thursday morning.

General Overview of Flood Risk

Rainfall on saturated ground overnight tonight, combined with gale force winds which will coincide with high tides, give a high likelihood of significant disruption from a combination of river, coastal and surface water flooding.

The flood risk will reduce on Friday and Saturday, but there is a high likelihood of low level residual disruption as transport networks and utilities infrastructure recover.

The flood risk from Sunday onwards is VERY LOW.

Warnings and Alerts in force in England and Wales at 10:30hrs

Flood (click here)
0 Severe Flood Warnings / 0 Flood Warnings / 25 Flood Alerts

Severe Weather (click here)
Alerts - Yes / Warnings -

Extreme Rainfall
1 Alerts

Best Judgement

River Flood Risk

River levels are currently high throughout Cumbria and Lancashire following recent heavy rain. A band of persistent and at times heavy rain will move slowly NE across the UK overnight and at first tomorrow morning, accompanied by strengthening S to SW winds. Locally large rainfall totals will result in flooding from rivers across these counties, affecting properties and parts of communities and with disruption to transport and utilities networks possible. There is a low risk of the flooding extending into neighbouring counties, particularly those with high ground.

Coastal /Tidal Flood Risk

Westerly gales will develop in the early hours and will coincide with high tides along the Cumbria and Lancashire coasts. There is a medium likelihood of minor disruption due to wave impact on exposed coastal sites and and a low likelihood of severe disruption where high river flows meet high coastal water levels.

FromThe risk is coastal flooding will be

EXERCISE

Surface Water Flood Risk

There is a low likelihood of medium disruption tomorrow due to surface water flooding in parts of northwest England from late this evening in to tomorrow morning. Localised flooding of roads and some urban areas where showers become slow moving.

From Friday onwards the risk of surface water flooding is currently VERY LOW for all areas.

Specific areas of concern

EXERCISE

Next Statement Due: 10:30hrs Thursday 24 November 2011

Contact Details: Flood Forecasting Centre Duty Hydrometeorologist, 0300 12345 01

All Times are Local

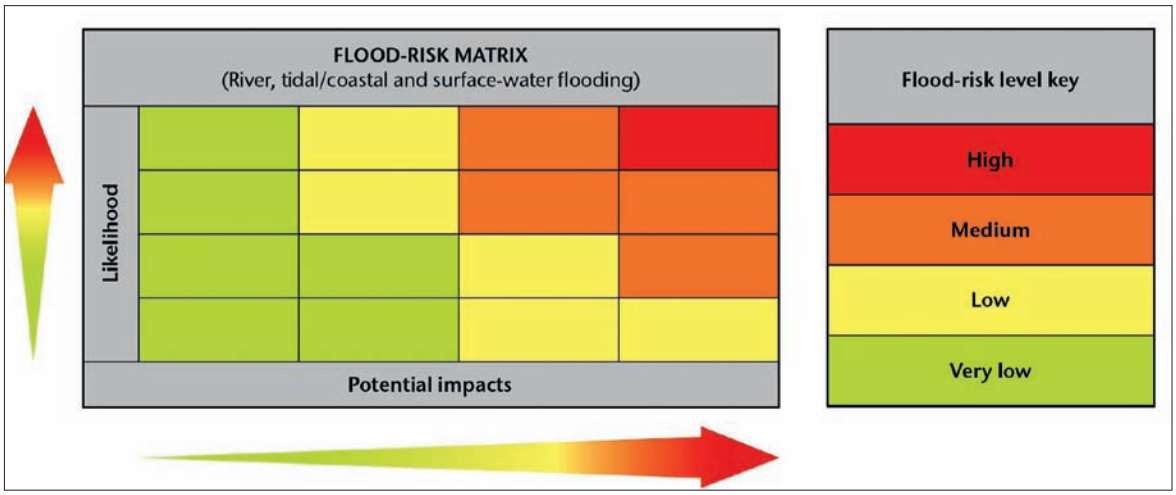


Figure 3

with NSWWS warnings issued by the Met Office. The FGS is issued routinely at 1030 local time each day, but its content is under constant review and can be updated and reissued when ever flood risk is deemed to have changed significantly. The product is issued in PDF format, either by email directly to a customer, or to be viewed via 'Hazard Manager', the Met Office's web portal available to emergency responders.

Flood risk is calculated using a matrix of likelihood versus impact (fig 3). Note that there are times in which the FGS colour state will not in itself distinguish between 'low likelihood, high impact' and 'high likelihood, low impact' events. In these cases there is need for careful clarification and communication of the nature of the risk.

Hydrometeorological Forecasting and Impact Assessment

FFC Hydrometeorologists ('Hydromets') are trained in both operational meteorology and hydrology, and therefore are able to contribute their expertise throughout the flood forecasting process. They are often able to advise the Chief Forecaster on quantitative precipitation forecasting, particularly in situations which can give rise to intense or prolonged rainfall. They are also familiar with the mechanisms by which coastal flooding occurs, and are trained to identify potential storm surge scenarios many days in advance.

Having influenced the meteorological aspects of the forecasting process, the Hydromets then take responsibility for determining the likelihood of flooding. A range of tools are available to guide their assessment.

For river flooding, the FFC makes use of the Grid-to-Grid (G2G) model developed at the UK's Centre for Ecology and Hydrology. G2G uses gridded NWP and observational data in a grid-based runoff and routing model, allowing 1km resolution river flow forecasting anywhere in England and Wales, even for ungauged catchments. High resolution NWP data are now available to 5 days ahead, and high resolution ensemble data blended with radar output now offers the prospect of reliable probabilistic rainfall forecasts for use in hydrological models.

In the case of coastal flooding, the FFC uses surge and wave models in conjunction with astronomical tide predictions to derive changing sea levels at a number of reference ports. These forecasts are then used by regional flood forecasting teams to assess the potential for flooding and the need to activate flood defences.

For of surface water flooding, or for 'flash flooding' from rapidly responding small catchments, the FFC looks to combine access to the best observational and forecast data with conceptual models and with tools calibrated using past events. The ability to identify a location particularly at risk from very heavy rainfall, and to distinguish between mere 'heavy rain' situations and those conducive to intense rain and flooding is paramount – especially when this guidance can be communicated as soon as possible to local responders.

Knowledge the likelihood of extreme rainfall or of increased river or sea levels only represents parts of the FFCs forecasting process. As with NSWWS, most FFC forecasts and warnings rely on an assessment of impact. Prior to an event, there will be extensive consultation with regional EA flood forecasting teams and their Met Office counterparts to discuss and agree the effects of flooding at a local level. This dialogue is informed by reference to standardised definitions of impacts related to factors such as number of properties affected or by areal extent of disruption.

During a flood event, it can be difficult to make an objective assessment of impact, so FFC staff undertake real-time monitoring of news reports and social media to accurately gauge the scale of events as they unfold. This information is stored along with forecast and observational data to aid the post-event review process.

Future Developments

The FFC Development Programme has oversight and influence over new model and observational capabilities and aims to exploit them as soon as possible. A challenge in the coming year will be to make best use of high-resolution ensemble NWP models in both river and surface water flood forecasting. A new wave ensemble capability will soon enhance our coastal forecasts too.

We aim to further empower our Hydromet team, increasing their expertise and influence so they are recognised as leaders in the field of hydrometeorology, both in the UK and internationally.

A greater understanding of impacts remains a key goal for the Centre, with the view to developing a more rigorous and objective method of impact assessment.

Looking further ahead, the FFC is contributing to a Joint Forecasting Strategy between the EA and Met Office, which looks to further integrate national-scale models and services, and to extend this joined-up modelling capability to include multiple natural hazards.