# Applying probabilistic flood forecasting in flood incident management

Project Summary SC090032/S

A set of reports illustrates how probabilistic flood forecasting could be used to help decide on whether to take action when a flood is forecast. The information is mainly aimed at professionals responsible for monitoring and responding to the risk of flooding.

Flood forecasts are uncertain. Unlike conventional, deterministic forecasts, probabilistic flood forecasts try to quantify and represent this uncertainty. The most common way of using probabilistic forecasting involves generating multiple forecasts of peak water levels, or rainfall intensities, based on slightly different starting conditions in prediction models. While this additional information can improve flood incident management by enabling people to respond at an earlier stage and in a more proportionate way to the risk of flooding, it raises the question:

*What action should be taken when some of the forecasts predict flooding, while others do not?*

In recent years, a number of probabilistic flood forecasting techniques have been developed and used with some success in the UK and worldwide. Quantitative precipitation forecasting, probabilistic storm surge and flood modelling can generate additional information on flood forecasts. However, more information does not necessarily improve decision-making, particularly where the probabilistic forecasts are likely to contain conflicting predictions. For probabilistic forecasts to be used effectively, a number of approaches have been developed to help managers and operators to make confident and timely decisions.

This report describes a practical framework for using probabilistic flood forecasts to support decision-making in flood incident management. Three proof-of- concept decision-support methods have been developed and tested on case studies from fluvial, coastal and surface water environments. The report explains how these methods could be applied to a variety of forecasting situations of different complexity and at different lead times ahead of a potential flood.

The three methods developed take account of the risk involved explicitly and are as follows:

- *Basic method* – use a probability threshold based on judgement and local knowledge.
- *Simplified method* – use a probability threshold based on the 'costs and benefits' in a wider sense of taking action (flood impacts avoided).
- *Detailed method* – use a water level-impact relationship to determine whether the average flood impact of the forecast water levels is greater than the cost of action. This makes fuller use of probabilistic forecast information than the other methods and allowing for forecast extremes.

All three methods allow for other factors to influence the decision. These factors can include local knowledge, recent flood history or historic forecast performance.

The methods are designed to be proportional to both the level of potential flood impact and the flood incident management action and are applicable at different lead times ahead of a flood event. They build on flood risk management concepts already used in the Environment Agency.

In the majority of cases, it is envisaged that users are likely to opt for more simple, judgment-based approaches whilst having the opportunity to move to more detailed approaches in locations of higher risk.

This is an active research and development area and we expect novel approaches to become available over time. The approaches described here should therefore be seen more as illustrations how probabilistic flood forecasts could be used to support decision making and not as fixed and definitive operational procedures to be followed.

In the report, case studies were used to examine:

- different flood environments (coastal surge, fluvial flow or rainfall depth for surface water flooding) in which probabilistic flood forecasts could be used;
- varying lead times in which probabilistic forecasts could operate;
- situations where probabilistic flood forecasts would be particularly useful;
- suitable performance measures for probabilistic forecasts;
- data and resource requirements for operational use.

A pilot study was also undertaken to demonstrate how the methods could be configured onto the National Flood Forecasting System (NFFS).

The use of probabilistic forecasts for coastal surge flood risk is relatively simple as the forecasts are of peak water level at, or near, the site of flood risk and reliable forecasts are already available. For fluvial situations, there is additional uncertainty due to the translation of rainfall forecasts into peak water level forecasts at the site of interest. For surface water flooding, much of the flood risk can be directly related to rainfall levels.

The reports also show that the methods can be employed successfully in the following situations, provided reliable probabilistic forecasts are available: closure of a structure such as a flood barrier; taking flood incident management actions at longer lead times and informing forecasts and risk information about surface water flooding.

Opportunities presented by the methods include:

- the ability to make decisions earlier in the timeline of the event;
- providing an audit trail for decision-making;
- avoiding subjective decision-making;
- taking calculated precautionary action;
- potential cost saving (and less disruption) by avoiding unnecessary flood incident management activities;
- having a range of methods from very simple to more detailed depending on the level of risk.

An accompanying illustrative guide, *Decision-making with probabilistic flood forecasts*, explains how to select and then apply a given method. This guide is aimed primarily at practitioners in Flood Incident Management, could also be of interest to anyone interested exploring how to use probabilistic flood forecasts to support with making decisions ahead of a flood events.

This summary relates to information from project [project number], reported in detail in the following output(s):

**Report:** SC090032

**Title:** Application of Probabilistic Forecasting in Flood Incident Management

**April 2013**

**Internal Status:** Released to all regions
**External Status:** Publicly available

**Project manager:** Stefan Laeger, Evidence Directorate

**Research Contractor:** Halcrow; Murray Dale

This project was funded by the Environment Agency's Evidence Directorate, which provides scientific knowledge, tools and techniques to enable us to protect and manage the environment as effectively as possible.

Further copies of this summary are available from our publications catalogue: http://publications.environment-agency.gov.uk or our National Customer Contact Centre: T: 08708 506506
E: enquiries@environment-agency.gov.uk.