Reliability in Flood Incident Management Planning
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The Environment Agency plays a crucial role in flood prevention and, when flooding is unavoidable, helping to limit the damage to homes and businesses. During the major and widespread flooding in summer 2007, the Flood Incident Management (FIM) procedures used by the Environment Agency prevented far worse flooding in many areas which helped saved lives. A research project has now developed a range of analysis tools that will help the Environment Agency – and other organisations involved in flood planning – to identify where FIM could be improved.

Along with the obvious use of flood defences and other physical structures to control flood waters, the Environment Agency is responsible for a wide range of so called "non-structural" measures, such as flood detection and forecasting, issuing flood warnings, briefing residents and businesses in areas prone to floods, and working with other organisations to plan emergency procedures. FIM uses these non-structural measures alongside structural measures such as temporary defences to manage a flood event.

The Environment Agency has worked with universities and research consultancies to develop a number of prototype tools that can be used to see how reliable the FIM system is. The tools will help identify which parts of the process are reliable and likely work well and which are less likely to be successful.

To get a quick overview of the reliability of FIM processes, the researchers recommend performance matrices. Each element in a performance matrix (for example, 'readiness of trained staff' or 'internal communication') is categorised as 'good', 'adequate' or 'inadequate' based on collected evidence. Good performance is worth disseminating and applying where relevant to other areas; inadequate performance needs investigation and possible investment to improve. The performance matrices are based on the well known business analysis approach of a balanced scorecard.

The study also found that a technique called root cause analysis also provided a good overview of the reliability and general performance of FIM processes. Root cause analysis aims to highlight why a system fails by identifying all the sub-processes within the system where failure causes the entire system to break down.

These two approaches are somewhat rough and ready, but do provide a rapid assessment of the likely areas where improvements are required.

However, the study also tested out more detailed analyses using computer models of FIM systems and processes. In particular the researchers used a software application called *Perimeta*, that allows all the main FIM processes and all their sub-processes to be given specific measures of success and the degree to which failure or success may be propagated through the system. The *Perimeta* model makes it easier to see which processes must be made 'fail safe' and where the performance of processes is uncertain and therefore needing more investigation.

The researchers also recommend agent-based modelling. This technique models extremely complex and unpredictable systems – especially those involving human behaviour – to be simulated over time. 'Agents' (for example, people, vehicles, flood managers etc.) follow a set of probabilistic rules and their behaviour changes according to their environment. They may also adapt and learn from their experience.

The project built an agent-based model for the section of North Wales coast around Towyn that experienced severe flooding in 1990. It models traffic flows and the behaviour of people after they receive a flood warning and a call to evacuate the area. The model requires a lot of data, but is a powerful way to test what might happen in particular scenarios. In this case, the researchers were able to visualise which roads would be likely to become congested during an evacuation and where people were most likely to be trapped by flood water.

These tools will all provide the Environment Agency and other organisations involved in flood incident management to assess their plans and processes. They can be used retrospectively, using data from flood events to identify which aspects of FIM worked well and which did not. This information would help to identify where improvements in performance would be beneficial. The tools can even provide input into calculations of the economic and human benefits that would be gained by improved performance.

The *Perimeta* and agent-based modelling tools can also be used to simulate FIM performance in specific flooding scenarios and test plans and contingencies. Again this would help the Environment Agency to plan ahead, ensuring that its FIM activities are well prepared. The tools will help the Environment Agency see where it needs to invest to meet its service level targets for flood detection, forecasting and warning systems and will also be made available to other organisations involved in FIM, for example local planners and the fire and rescue services.