The InfoRM – January 2006

Flood Models in the Service of the Risk Manager

Justin Butler

Floods affect more people and cause more damage each year than any other natural hazard, and the nature of flood risk is changing. It is no longer safe to assume that if you have not been flooded before, you will not flood in the future. Flood modelling is a tool of increasing value to the manager of property risks.

As the predicted effects of climate change become more apparent and development continues in areas of the natural floodplain (such as the Thames Gateway in East London), risk managers will increasingly need to provide answers to the following questions:

- WHERE is at risk of flooding and to what extent?
- WHAT assets could be at risk from floods and how can they be protected?
- HOW can I mitigate the risk of flood damage to my people and property?
- WHICH tools and methods are available for me to assess flood risk?

This article provides an overview of the changing nature of flood risk and the importance that tools such as flood risk mapping and modelling can play in helping risk managers to answer these and related questions.

From a risk management perspective, the issues surrounding flood risk are complex. Flooding affects business interests in a variety of ways including:

- Site and asset location/acquisition
- Life and health
- Disaster planning and evacuation
- Property damage – buildings and contents
- Business interruption
- Insurance and finance – (e.g. premiums and mortgage applications)

Risk is a function of hazard and vulnerability. Hazard is a function of the physical properties of an event, such as flooding, and the likelihood it will occur. Vulnerability can be expressed in terms of the resilience or susceptibility of built structures and people to that hazard. Events such as Hurricane Katrina and, on a smaller scale in the United Kingdom, the flooding in Carlisle, Cumbria a year ago and Boscastle. Cornwall in 2004 has demonstrated the changing nature of international flood risk in terms of both hazard and vulnerability.

As climate change alters the spatial variability, intensity and frequency of rainfall, the nature of flood hazard is also likely to change. High magnitude flood events are seen to occur more often, and areas that have not experienced flood events before are becoming affected. The concept of 'return period' to describe the annual probability of a flood of a given magnitude, expressed in terms of, for example, a '1-in-100 year' or '1-

in-1,000 year' event, is becoming redundant as '100 year flood events' are seen to occur every 50 or even every 20 years. Whether or not this is due to climate change is a topic of heated debate. However, in some cases, it may be more appropriate to adopt a 'worst-case scenario' approach to help identify potential flood risks and losses to life and property.

The financial and insurance industries are increasingly aware of the potentially catastrophic nature of flooding, and the availability and cost of flood cover in high risk areas may become less of a certainty in the future. As such, it may not be sufficient to rely upon state and financial systems in the future to manage your flood risk effectively.

Key Point

Flood risk can be thought of in terms of:

- **Flood hazard** – flooding is a potentially damaging physical event, with a given probability of occurrence, and for which 'worst-case scenarios' can be modelled

- **Flood vulnerability** – i.e. the susceptibility of people and property to flooding. Although defences and financial systems can be used to mitigate flood risk, a holistic approach to flood risk management and prevention may be more appropriate.

Flood modelling for beginners

Computational flood modelling is a tool which is taking on a more prominent and widespread role in risk management. In simple terms, a computational flood model can be used to determine **where and how much** water would be expected to go during a flood event. Depending on the scope and complexity of the model, the extent, depth, velocity and duration of the flood waters can also be estimated. Most flood models process information relating to some or all of the following factors: precipitation, rainfall-runoff relationships, river flows and channel/floodplain topography.

Hydraulic modelling, a key component for flood risk mapping, involves simulation of the flow of water within a river channel, over a floodplain or along a coastline. This type of model can also be extended to identify subsequent overtopping/breaching of banks and defences which may lead to flooding within the floodplain. These results can be used to map flood risks for a given area, even down to the level of individual buildings.

Hydraulic models often involve two key components: a digital elevation model (DEM) representing topography, and some form of mathematical procedure to simulate the flow of water across the floodplain surface. The latest generation of high detail urban flood models incorporate information relating to the urban fabric. For example, the inclusion of building location and height data can be used to enable the simulation of the extent, depth, duration and velocity of flood water around individual buildings for a single site, group of sites (such as an industrial park), or even for an entire city. Risk managers can then use this information to identify, for example, which areas are at risk from flooding, what is the degree of flood risk and how to use mitigation strategies to reduce that risk.

The lay of the land

Unlike other hazards such as earthquakes and hurricanes, flood modelling requires very detailed topographical information. The lay of the land, as well as obstructions such as bridges, culverts, river banks, etc., will greatly affect the flow path(s) of any simulated flood. Topographic data, as represented by a DEM, can be captured either from traditional site surveys, which can be expensive and time consuming for large areas, or from remote sensors, such as satellites or aircraft. The use of techniques such as LIght Detection And Ranging (LIDAR), which is the optical equivalent of radar or sonar, now enables high detail topographic models to be created more quickly and cost effectively than previously. Mounted underneath a light aircraft, LIDAR can provide elevation information at sub-metre accuracy which is ideally suited to high detail flood modelling.

Using sophisticated image processing techniques, the LIDAR data can be processed to create three dimensional (3-D) digital models of buildings and natural structures within the DEM. This enables the effects of the urban fabric to be incorporated into hydraulic and flow calculations. Results from the model can be displayed and visualised in the form of maps, plans, reports, risk ratings and fly-through simulations. Furthermore, digital flood maps can be incorporated into corporate Geographical Information Systems (GISs) to build upon existing IT and management systems.

Conclusion

Flooding is now a serious issue for risk managers. The effects of flooding impact upon a variety of business decisions and issues, including asset location, insurance, acquisition of new industrial/commercial sites and personal liability. As the nature of flood risk continues to change, risk managers will come to rely more upon computer-based models for understanding flood risk, rather than solely relying upon traditional methods of risk transfer such as insurance.

Flood models differ in their degree of complexity but generally involve topographic data and a water flow modeling or simulation component. However, only models which incorporate high resolution topographic information and detailed building data, coupled with reliable and accurate computer simulation techniques will provide the ability to understand flood risk at a detailed level.

Dr Justin Butler is Managing Director of Ambiental Technical Solutions.
justin.butler@ambiental.co.uk
www.ambiental.co.uk