Preface

In the media, the term ‘flash flood’ often conjures up images of a wall of water arriving out of nowhere in a previously dry river bed. Floods of this type do occur, particularly in arid and semi-arid regions, and can present a considerable risk to people and infrastructure. However, the scientific definition is rather wider and is often presented in terms of the time delay between heavy rainfall and the onset of flooding. Several related types of rapid onset or ‘short-fuse’ events are usually included, such as debris flows and the flooding caused by ice jams, dam breaks, levee breaches and surface water in urban areas.

To reduce the risk from flash floods, warning systems are widely used alongside structural measures such as flood defences or levees. For example, an accurate and timely warning can alert people to move to safer locations and provide civil protection authorities with more time to prepare an effective response. When telemetry-based flood warning systems were first introduced several decades ago, a catchment response time of six hours was typically quoted as the minimum for providing operationally useful warnings. However, in many countries, technological and procedural improvements now allow a warning service to be provided where times are shorter than this.

However, despite these advances, there are still many opportunities to reduce time delays further and to improve the accuracy and coverage of warnings; for example through improvements to flood forecasting models and faster warning dissemination techniques. For natural hazards, wider community involvement is now also seen as essential to improve the effectiveness of warning systems, using what is often called a people-centred, total or end-to-end approach.

This book provides an introduction to these various topics. The warning process is often considered to consist of monitoring, forecasting, warning and preparedness components and that format is adopted here. Part I discusses the main techniques which are used whilst Part II considers a range of applications. Some general background is also provided on approaches to flood risk management. The topic of emergency response – in itself a major subject – is also discussed briefly where this impacts on the approaches used for providing flash flood warnings.

The use of lower cost, less technically advanced systems is considered throughout; for example, the use of community-based warning systems in rural areas.

Within the general area of monitoring, precipitation measurement often plays a key role, including raingauge, weather radar and satellite-based observations. For example, some recent developments which are considered include dual polarization weather radar and multi-sensor precipitation estimates. Methods for monitoring catchment conditions are also discussed, including river gauges and techniques for estimating snow cover and soil moisture.

To help improve warning lead times, flash flood forecasting models are also widely used. The first operational applications were often empirically based, using river level correlations and tabulated relationships between rainfall and flows. However, nowadays more options are available and the types considered include conceptual, data-driven and physical-conceptual rainfall-runoff models and hydrological and hydrodynamic flow routing techniques. Simpler rainfall threshold and flash flood guidance approaches are also discussed. Rainfall forecasts are also useful in providing early indications of the potential for flash flooding and, in recent years, there has been a step change in the spatial resolution and accuracy of model outputs. Several recent developments are therefore discussed including probabilistic nowcasting techniques, mesoscale data assimilation and decision support systems for severe storms.

The two remaining components in the warning process – flood warning and preparedness – are closely linked and some key principles are introduced. These include procedural issues such as developing flood response plans and performance monitoring, and technological developments such as the use of social media and multimedia systems when issuing warnings. Web-based decision support tools are also increasingly used to share information between flood warning and emergency response staff. Taken together, these developments help to make it possible to issue flash flood warnings more quickly than in the past and to more people, who in turn have a greater awareness of the actions to take.

The application of these techniques is discussed in Part II. This considers flash floods from a number of sources, including rivers, ice jams, debris flows, urban drainage issues, dam breaks, levee breaches and glacial lake outburst floods. The general principles used are the same throughout but with some additional technical and operational challenges specific to each type of flooding. These include the development of techniques for monitoring debris flows and assessing the flood risk in urban areas, and for estimating the impacts of dam breaks and levee breaches. Several examples of operational systems are also discussed.

The final chapter provides a brief summary of some current research themes relevant to flash flood forecasting and warning systems. These include monitoring techniques such as phased array weather radar, adaptive sensing and particle image velocimetry, and a range of more general developments in rainfall and flood forecasting. Several recent advances in probabilistic forecasting are also discussed, including the issue of how best to communicate the outputs to decision-makers. Overall, these developments raise a number of intriguing possibilities for further improvements in the flash flood warning process in future years.

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