Strategic Management of Flood Risk

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Duncan McLuckie and Jaya Kandasamy, with Paul Sayers

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Foreword

Many communities are located on floodplains in proximity to rivers, a legacy of the past, as they provided a means of transport and water supply, and supported surrounding rural areas where the natural cycle of flooding replenishes soils and groundwater. However, communities on floodplains are exposed to the risk of flooding and vulnerable to its devastating, and often deadly, impacts.

Strategic management of flood risk to communities requires both an understanding of flood behaviour and the varying risks it poses to communities and an ability to provide input into and influence decisions that mitigate this risk.

This book provides a comprehensive understanding of how flood risk to communities can be managed strategically as well as an overview of how flood risk can be understood and advice on how it can be practically managed. It has been developed from the considerable experience of the authors in managing flood risk in government and consultancy and their experience in tertiary education. It builds on work done in conjunction with Floodplain Management Australia (FMA) to improve the understanding and management of floods and their roles in securing ongoing training for floodplain management professionals.

As President of the FMA and as Chair and member of the executive of its predecessors, I have had the pleasure of knowing and working with the primary authors to improve the knowledge and management of flood risk in Australia. I worked in partnership with them and other industry professionals with expertise in flood risk management, emergency management and land-use planning to facilitate, develop and deliver tertiary training in flood risk management at the University of Technology Sydney, which is the genesis of this book.

I commend this book to all those with an interest in the strategic management of flood risk to communities. It provides sound practical advice for flood risk managers, emergency managers, land-use planners, engineers and those who make decisions that affect flood risk to existing communities and future developments and the lives of those who occupy floodplains.

Ian Dinham
President, Floodplain Management Australia

Preface

The flood risk faced by communities is largely a feature of their location within the floodplain. The reasons for their particular location can vary substantially, but often stem from the need for access to water, river transport or fertile land. As communities grow, their exposure to flood risk also grows, and this increase in risk depends on a range of factors, including whether and how flood risk is considered in community decision-making.

Flooding is often considered the most manageable of all possible disasters. Studies can be undertaken to understand how flood-producing rainfall events can turn into catchment run-off and how this run-off flows across the landscape of the floodplain. Studies can identify areas of the floodplain with different flood functions and how the hazardous conditions caused by flooding can vary. Having this knowledge of the full range of potential flood events can help us to understand how severely and, on average, how often communities located in floodplains are exposed to the effects of flooding.

Studies into flood behaviour, as well as its impacts and management, need to be able to support informed decision-making across a range of areas that influence both the management of flood risk to the existing community and the growth of flood risk to future development. It needs to support efforts to prevent (or reduce) flood risk, prepare for, respond to and recover from flood events.

The information gathered from these studies can be used to understand and assess the consequences of flooding for the community, to examine options for managing the risk to the existing community, and to examine how to manage effectively the flood risk created by locating new development in the floodplain, whether to the new development or to the existing community.

Flood risk management is not done in isolation: it is not simply about reducing flood risk to existing communities by building protection works, or evacuating the community during a flood event, or putting in place development controls for new development that consider flooding – it is a combination of these, and more. This requires studies to consider a broad range of end users in a multidisciplinary approach to ensure that flood behaviour and its impacts can be understood and that flood information is available so that it can be practically considered in decision-making.

The management of flood risk can be a complex process, being influenced by many societal and individual decisions. To be effective, flood risk management needs a clear understanding of the implications that different decisions will have on flood risk now and into the future and be able to inform how these decisions are made. Being ignorant of the potential implications of flooding, ignoring these implications or treating flooding as a lower-order issue, such as a constraint to consider after decisions are taken to proceed with a project, can lead to risk being built into decisions that may not be able to be managed effectively, or at least not without significant additional work. The consequences of such decisions can be considered the legacy of flood risk that exists around the world today. These consequences are not generally solely due to a changing climate; however, a changing climate is predicted to influence the frequency and scale of flood events and their associated impacts on communities.

This book focuses on a strategic approach to the management of flood risk to communities and the ways in which this can be achieved. It builds on the experience the authors have gained in the flood risk management industry in Australia, and has been influenced by a wide range of both Australian and international industry professionals engaged in, or recently retired from, flood risk management, emergency management, land-use planning and climate science.

The authors were also influenced by enthusiastic students who have undertaken flood risk management studies at the University of Technology Sydney who enjoyed the challenges of the multidisciplinary nature of managing flood risk. This training was developed and is delivered by industry professionals who have been generous in committing their time to educating the next generation of industry professionals and flood risk managers.

While the primary authors are based in Australia, the lessons presented here are applicable to the management of flood risk globally, as they relate to practice and pragmatic approaches to management rather than any particular flood situation, any specific location or any specific governance arrangements.

The key influencers of this work are identified in the Acknowledgements and References and further reading sections. However, it is acknowledged that many others have also influenced, over decades, the thinking and approach that are the basis of this book.

Acknowledgements

This work stems from Duncan McLuckie's doctoral studies in flood risk management at the University of Technology Sydney supervised by Associate Professor Jaya Kandasamy and Distinguished Professor Saravanamuth Vigneswaran. It nonetheless draws on the experience Duncan gained from his other roles within the industry and government. The views and opinions in this book cannot be attributed to these roles and remain those of the authors.

This work draws on the authors' many years of experience as well as a wide range of collegiate work undertaken in the flood risk management industry in New South Wales and elsewhere in Australia by many groups and individuals. The list below is far from exhaustive. It is acknowledged that many others have also influenced the thinking and approaches that are the basis of this book.

- Members of the National Flood Risk Advisory Group in Australia and associated working groups who, as acknowledged in the Australian Institute for Disaster Resilience (AIDR) Handbook 7 series of documents, worked to develop national guidance.
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- A wide range of flood risk management professionals in government agencies, including: the NSW Office of Environment and Heritage, NSW State Emergency Service and the Australian Bureau of Meteorology.

I would also like to express my appreciation to my family for their infinite patience and support in the development of this book.

About the authors

Duncan McLuckie, BE, ME is considered an industry expert in flood risk management in Australia, and has worked in the field both in government and consultancy in Australia since the late 1980s. Duncan is an Honorary Fellow at the University of Technology Sydney (UTS) and is currently undertaking doctoral studies there. He also holds a floodplain risk management role within the government in Australia and is Chair of the National Flood Risk Advisory Group. He has a Bachelor of Engineering (Civil) from UTS, a Master of Engineering from Deakin University, a postgraduate Management Diploma also from Deakin University and Graduate Certificate in Public Sector Management from Flinders University. Duncan has provided industry leadership in education, establishing and being involved in Floodplain Management Australia (FMA) conference workshops and short courses since 2006, and has been a driving force in the development and delivery of the Flood Risk Management subject at UTS, which has run since 2008. He led and was the primary author of the update of national best practice guidance in Australia that resulted in the release of the Australian Emergency Management Institute Handbook 7 in 2013, supporting guidance in 2015 and the subsequent release of the AIDR Handbook 7 series in 2017. Since 2000, Duncan has been either the lead or a contributing author to numerous papers on a broad range of flood risk management topics aimed at improving understanding of flood risk and its management and the ability of flood risk managers to support and influence decisions in areas such as emergency response and land-use planning. He has also presented to numerous state, national and international conferences and audiences. Duncan recently received the Floodplain Management Australia (FMA) Allan Ezzy Flood Risk Manager of the Year Award for 2018. The content of this book has evolved out of Duncan's doctoral studies in flood risk management at UTS, and while it also draws on his experience from his various other roles, its view and opinions cannot be attributed to the latter.

Jaya Kandasamy, BE (Hons), ME, PhD is Associate Professor in the School of Civil and Environmental Engineering and a Core Member of the Centre for Technology in Water and Wastewater Treatment at the University of Technology Sydney. Prior to joining UTS, Jaya worked in the Government of New South Wales as a

senior water engineering technical specialist for 14 years. His principal activity was providing the department with high-level technical modelling capability in the area of flood hydraulics to support the government's programmes. During this time, he developed an advanced understanding of all aspects of water issues in NSW, including policy, implementation and industry aspects. Since 2006, Jaya has worked full time at UTS and undertakes research in water engineering.

Glossary

Annual exceedance probability (AEP): The likelihood of a flood of a given or larger size occurring in any one year, usually expressed as a percentage.

Australian height datum (AHD): This is a geodetic datum for altitude measurement in Australia that was adopted in 1971.

Average annual damage (AAD): The average damage per year that would occur for the nominated situation from flooding over a very long period of time. If the damage associated with various AEP events is plotted against their probability of occurrence, the AAD is equal to the area under the consequence–probability curve.

Average recurrence interval (ARI): A statistical estimate of the average number of years between occurrences of a flood of a given size or larger than the selected event.

Catchment flooding: Flooding due to prolonged or intense rainfall on the upstream catchment. Types of catchment flooding include: flooding from waterways, water flowing overland towards waterways (may also be called local overland flooding, particularly in urban areas) and groundwater flooding.

Catchment (upstream): The area of land draining to a particular site. It is related to a specific location and includes the catchment of the main waterway as well as any tributary streams.

Coastal inundation: Flooding due to tidal or storm-driven coastal events, including storm surges in lower coastal waterways. This can be exacerbated by wind waves generated by storm events.

Consequence: The outcome of an event or situation affecting objectives, expressed qualitatively or quantitatively. Consequences can be adverse (e.g. death or injury to people, damage to property and disruption of the community) or beneficial.

Defined flood event (DFE): An event that may be used as the basis for local development standards.

Design flood: The flood event selected for the design of a mitigation work.

Development: Development may be defined in legislation or regulation. This may include erecting a building or carrying out of work, including the placement of fill, the use of land (or a building or work) or the subdivision of land.

Effective warning time: The effective warning time available to a flood-prone community is equal to the time between the delivery of an official warning to prepare for imminent flooding and the loss of evacuation routes due to flooding.

Emergency management: This may include measures to prevent, prepare for, respond to and recover from flooding.

Flash flood: Flooding that is often caused by sudden local or nearby heavy rainfall. It is generally not possible to issue detailed flood warnings for flash flooding. However, generalised warnings may be possible. It is often defined as flooding that peaks within six hours of the causative rain.

Flood: Flooding is a natural phenomenon that occurs when water covers land that is normally dry. It may result from catchment flooding or coastal inundation, or a combination of the two.

Flood awareness: An appreciation of the likely effects of flooding, as well as a knowledge of the relevant flood warning, response and evacuation procedures.

Flood damage: The tangible (direct and indirect) and intangible (financial, opportunity and clean-up) costs of flooding. Tangible costs are quantified in monetary terms (e.g. damage to goods and possessions, loss of income or services in the flood aftermath). The intangible costs of flood damage are difficult to quantify in monetary terms and include the increased levels of physical, emotional and psychological health problems suffered by flood-affected people that are attributed to a flood.

Flood fringe: The extent of a flood outside the key flood function areas of flow conveyance and flood storage.

Flood function: The flood-related functions of the floodplain, including flow conveyance and flood storage.

Flood hazard: Potential loss of life, injury and economic loss caused by future flood events. The degree of hazard varies with the severity of flooding and is affected by flood behaviour.

Flood readiness: An ability to react to a flood event within the effective warning time.

Flood storage areas: The parts of the floodplain that are important for temporary storage of floodwaters during a flood passage, and loss of flood storage areas can increase the severity of flood impacts by reducing flood attenuation. Flood storage areas can change with the magnitude of the flood.

Flow conveyance areas: Those areas of the floodplain where a significant flow of water occurs during floods and, even if only partially blocked, would cause a significant change in flood behaviour due to flow redistribution or a significant increase in flood levels. They are often aligned with naturally defined channels and are often, but not necessarily, areas of deeper flow or areas where higher water velocities occur. They can vary with the magnitude of the event and can be areas where significant flood storage also occurs.

Habitable room: In a residential building, this refers to a living or work area, such as a lounge, dining room, rumpus (or recreation) room, kitchen, bedroom or workroom. In an industrial or commercial building, it refers to an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.

Hydraulics: The study of water flow in waterways – in particular, the evaluation of flow parameters such as water level, extent and velocity.

Hydrograph: A graph that shows how the flow or stage (flood level) at any particular location varies with time during a flood.

Hydrologic analysis: The study of the rainfall and run-off process, including the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.

Life-cycle costing: All of the costs associated with the project from the cradle to the grave. This usually includes investigation, design, construction, monitoring, maintenance, asset and performance management and, in some cases, decommissioning of a management measure.

Loss: Any negative consequence or adverse effect, financial or otherwise.

Management options: The measures that might be feasible for the management of existing, future and residual flood risk at particular locations within the floodplain. Preparation of a management plan requires a detailed evaluation of floodplain management options.

Mitigation: Permanent or temporary measures taken in advance of a flood aimed at reducing its impacts.

Peak flow: The maximum flow occurring during a flood event past a given point in the river system.

Probability: A statistical measure of the expected chance of flooding occurring.

Probable maximum flood (PMF): The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from the probable maximum precipitation (PMP) and, where applicable, snow melt, coupled with the worst flood-producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event.

Probable maximum precipitation (PMP): The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given-size storm area at a particular location at a particular time of year, with no allowance made for long-term climatic trends (WMO, 1986). It is the primary input to PMF estimation.

Rainfall intensity: The rate at which rain falls.

Residual flood risk: The risk a community is exposed to that is not being remedied through established risk management processes.

Risk analysis: The systematic use of available information to determine how often specified (flood) events occur and the magnitude of their likely consequences.

Risk management: The systematic application of management policies, procedures and practices to the tasks of identifying, analysing, assessing, managing and monitoring flood risk.

Run-off: The amount of rainfall that drains into the surface drainage network to become stream flow, also known as rainfall excess.

Stage: Equivalent to water level. Both stage and water level are measured with reference to a specified datum point.

Tidal anomaly: The difference between recorded storm surge levels and predicted astronomical tide levels.

Velocity of floodwater: The speed at which floodwaters move.

Vulnerability: The degree of susceptibility and resilience of a community, of its social setting and of the natural and built environments to flood hazards.

Abbreviations

AAD	Average annual damage
AEP	Annual exceedance probability
AHD	Australian height datum
ARI	Average recurrence interval
AUD	Australian dollars
DCP	Development control plan
DFE	Defined flood event
FPCC	Flood planning constraint category
FPL	Flood planning level
GDP	Gross domestic product
ICOLLs	Intermittently closed and open lakes and lagoons
LEP	Local environment plan
NFVI	Neighbourhood flood vulnerability index
NGOs	Non-governmental organisations
NPV	Net present value
NSW	New South Wales
PMF	Probable maximum flood
PMP	Probable maximum precipitation
PPRR	Prevention, preparation, response and recovery
SERCON	State Emergency Recovery Coordinator
SES	State Emergency Service