ISSUES, PRIORITIES, DIRECTIONS

EXTREME WEATHER

AND COASTAL

HAZARDS

A STATEMENT ON RESEARCH PRIORITIES FOR
NATURAL HAZARDS EMERGENCY MANAGEMENT IN AUSTRALIA

More than 85 per cent of Australia's population lives within 50 km of the coastline. Coastal proximity not only increases exposure to extreme weather events such as tropical cyclones, but also the additional hazards of storm surges, extreme waves, dangerous marine weather and coastal erosion. The impacts of these events can be further compounded by riverine flooding and infrastructure development pressure.

Advances in meteorology have substantially improved our ability to mitigate extreme weather and coastal hazards. These advances include:
• more accurate predictions from higher-resolution models and ensemble systems
• more comprehensive data from satellites and radars
• more sophisticated understanding of various phenomena
• better means of extracting information from our forecast support systems to generate useful products and services for vulnerable communities.

Extreme weather can be any weather event that includes strong winds, heavy or prolonged rain, high temperatures, extreme fire weather, large hail, cold outbreaks and drought. However, the term is most commonly used when the weather causes a significant impact; either damage to the natural and built environments, loss of life, significant injuries, or economic loss.

Most weather that causes significant impact is considered extreme because natural and man-made systems have led to more common environmental conditions, lessening the impact. Extreme weather can be the result of many different weather systems, including tropical cyclones, cold fronts and wind changes, severe thunderstorms, and east coast lows.

Despite progress, further work is required to meet the future challenges of:
• increasing and mobile populations, especially in vulnerable locations
• ongoing investment in infrastructure by government and industry
• heightened community expectations
• the effects of climate change and sea level rise.

Opportunities to better mitigate the numerous hazards associated with a particular event will be underpinned by advances in scientific understanding, technology, and service provision. While many of these advances apply to weather and ocean prediction as a whole, specific attention is needed to ensure value is maximised when applied specifically to the most damaging and severe events.

Throughout 2015-2017, emergency service agencies around Australia participated in workshops hosted by the Bushfire and Natural Hazards CRC to consider the major issues in natural hazards emergency management.

This publication on extreme weather and coastal hazards summarises the outcomes of one of these workshops and poses questions as a guide for a national research agenda in natural hazard emergency management.

Advances in service provision mean that forecasts and warnings can be more comprehensive, updated more frequently and cover more locations. Accuracy of weather and ocean forecasts is continually improving, driven by advancements in scientific knowledge and implementation in forecast and analysis systems and better observations and more powerful computers.

The potential impact of many severe weather and ocean events is increasing, due to climate change (including sea level rise) increasing the severity and geographic range of events, and demographic changes. Proper preparation for an event relies not just on our current best estimate of the event's magnitude, but also that we consider plausible alternative scenarios and their relative likelihood.

A primary aim of forecasting is to mitigate the impact of severe events on lives, property, business and the environment. Thus it may be appropriate to supplement forecasts of the hazardous phenomenon, such as height of storm surge or track of a tropical cyclone, with those of the impact, such as houses lost to a bushfire or extent of coastal erosion.

Quantitative predictions of the potential impact of an event require hazard predictions to be combined with data on community exposure and vulnerability, and hence there is a need for strong partnerships between agencies and community. Research questions that arise are:

- **What advances are needed to improve forecasts of the rapid intensification of an event to a catastrophic level, or for short-onset events such as severe thunderstorms or flash flooding?**
- **How can we improve early warning of the possibility of a severe event, or even multiple events close together in time, to better inform response action, including events that have low probability but very severe impacts (e.g. thunderstorm asthma)?**
- **How can we combine community exposure and vulnerability data with hazard predictions in order to make quantitative predictions of potential impacts of an event?**

The understanding and transfer of science to operations is becoming increasingly important, independent of the hazard type. Often the research and science behind a hazard is not fully applied in an operational context. This applies to key areas of emergency management, from planning right through to recovery. In particular:

- Coastal hazard assessments on properties and evacuation requirements that are based on good science are often passed over by the community and government authorities who allow continued high-risk development or limited mitigation
- Risks associated with multiple or coincident hazards are becoming more evident with climate change and with seasonal events that are exacerbated by climate change, such as El Niño and La Niña. It is important that planning and preparation by responders and communities translates this relatively recent science into emergency operations
- A greater understanding of the changing severity, frequency, movement and intensification of a hazard such as bushfire, heatwave and tropical cyclones is fundamental to operations and messaging to achieve better outcomes for communities.

- **How can we ensure that the right science is targeted for operations to be of value to emergency managers and the community?**
- **How can the wide and deep understanding of climate science be incorporated into operations and influence decision makers and the public?**

Successful mitigation of the threat of severe weather and coastal hazards requires operation over a wide range of time scales. At one extreme planning decisions must take account of the expected risk of a severe event over the next few decades or longer. At the other, frequently updated forecasts, as the event nears and then strikes, help to finalise the response and save lives. When warnings of a specific event are being issued the information flow should be continuous even though the precision of the forecast will change as the event nears.

As an event nears and additional information becomes available, the expected magnitude or location of the event will change. Consistency in messaging is important as sudden major changes reduce user confidence and hamper preparation. The technologies underpinning forecasts should aim to minimise abrupt changes as far as is consistent with the provision of accurate information.

- **What opportunities are there for improved earlier warning of specific events (e.g. multi-week prediction of tropical cyclone or fire events)?**
- **How can we better manage rapid onset events and the rapid intensification of events close to impact time?**
- **How can we enhance the accurate prediction of events to enable mitigation planning?**
- **How can we best ensure that the forecast information is consistent as the event approaches across different levels of user needs and through various communication media?**

Data collection is becoming richer and more complex with rapidly increasing depth, with greater measurement detail and accuracy, and breadth, with sources ranging from satellites to social media.

New technologies and advanced numerical analysis of past weather can be combined more effectively with crowd data sourcing in the future. A number of agencies are very experienced in this role and new social communities can add to the data availability across a range of hazards. Major challenges will include the ability to integrate and match data across a wide range of sources, using the data for early automated alerting of emergency managers and the public; and improving risk analysis and understanding of probability associated with hazards.

These ever-expanding data sources must be harnessed and exploited to the maximum extent possible by scientists and emergency managers to support providing the most effective outcomes for the community. At the same time, the availability of information itself can support community resilience through its accessibility and transparency.

- **What data sources are the highest priority for providing the most effective contributions to extreme weather and coastal impact science and operations over the next 5-10 years?**
- **Where can partnerships, such as sharing of fuel and curing data bases, be most effectively combined and/or maintained?**
- **How should this exploitation and integration of data sources be made readily accessible to the emergency services, political decision makers and the community, targeted for planning and response? Should these methods of access be built on the same platforms?**
- **Major changes in crowd sourcing and social media must be consistently exploited and in-cluded in the full end-to-end emergency value chain and shared across jurisdictions. How?**

National research priorities for natural hazards emergency management

What are the most significant natural hazard emergency management issues Australia faces over the next 10 years?

This was the question posed to emergency service agencies around Australia in a series of workshops hosted by the Bushfire and Natural Hazards CRC throughout 2016.

This publication is an outcome of one of these workshops and part of a broader national research agenda in natural hazards emergency management being developed by the CRC.

The workshops provided an exploration of major issues that would benefit from the support of research at a national level. There was no attempt to solve any of the issues or problems raised nor was there any discussion on the details of specific research projects. The participants discussed the issues they believed were relevant to the specific topic under discussion, the relative importance of the issues and the reasons underpinning their relative importance.

This series of publications summarises the outcomes of the workshops conducted so far – more will take place in 2017. They provide a guide for future research activities by identifying national priorities across major themes. The workshop outcomes have also influenced the evolving research agenda of the CRC.

This statement has been developed with the assistance of the Bureau of Meteorology and its stakeholders. The Bureau of Meteorology hosted a workshop with key natural hazard stakeholders in Melbourne and by video conference in all other Australian states on 5 August 2016.

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CONTACT US

Bushfire and Natural Hazards CRC
Email: office@bnhcrc.com.au

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