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TOPICS IN THIS EDITION | EXPOSURE | FLOOD | MITIGATION

## IMPROVING RISK MITIGATION THROUGH BETTER SCENARIO MODELLING: A COASTAL INUNDATION CASE STUDY

### ABOUT THIS PROJECT

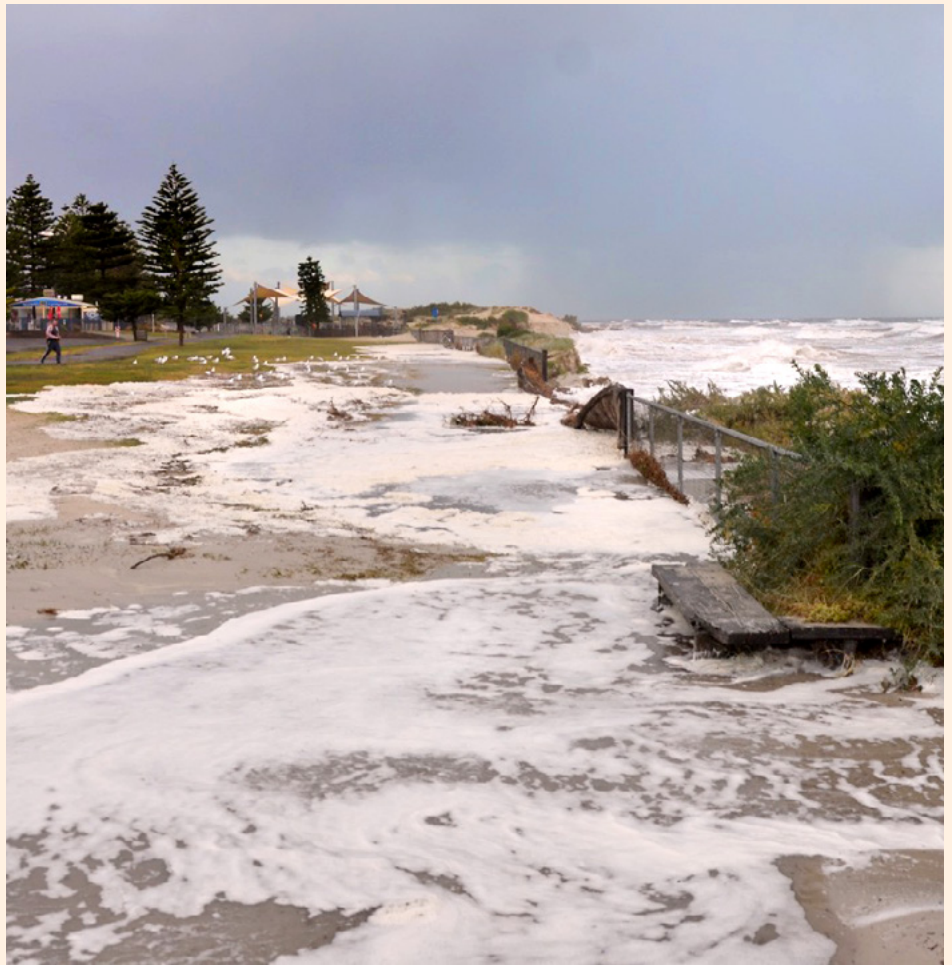
This research was conducted as part of the Bushfire and Natural Hazards CRC's *Improved decision support for natural hazard risk reduction* project, part of the economics and strategic decisions cluster.

### AUTHORS

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### SUMMARY

This project trialled the application of decision support software developed by the research team, called UNHaRMED – Unified Natural Hazard Risk Mitigation Exploratory Decision system – in a mitigation and planning exercise. The exercise, conducted in August and September 2019, brought together a diverse multi-agency team to explore future coastal inundation risk at the City of Port Adelaide Enfield in South Australia. The trial explored the ways in which the likelihood and consequence of coastal inundation risk at the port could change in future decades. UNHaRMED was crucial in focusing attention on the key policy issues to be addressed and resolved to mitigate future risk.



▲ **Above:** THIS RESEARCH EXPLORED WAYS IN WHICH THE LIKELIHOOD AND CONSEQUENCE OF COASTAL INUNDATION RISK WILL CHANGE IN FUTURE DECADES AND WHAT CAN BE DONE TO MITIGATE THE CHANGING RISK. PHOTO: ANTHONY VIRAG, COASTAL MANAGEMENT BRANCH, SOUTH AUSTRALIAN DEPARTMENT OF ENVIRONMENT AND WATER

### CONTEXT

Community risks are constantly evolving, driven by a range of factors, including demographic change, land use developments and climate change. This means it is essential that decision making about ways to treat risk is based on a sound understanding of costs and benefits.

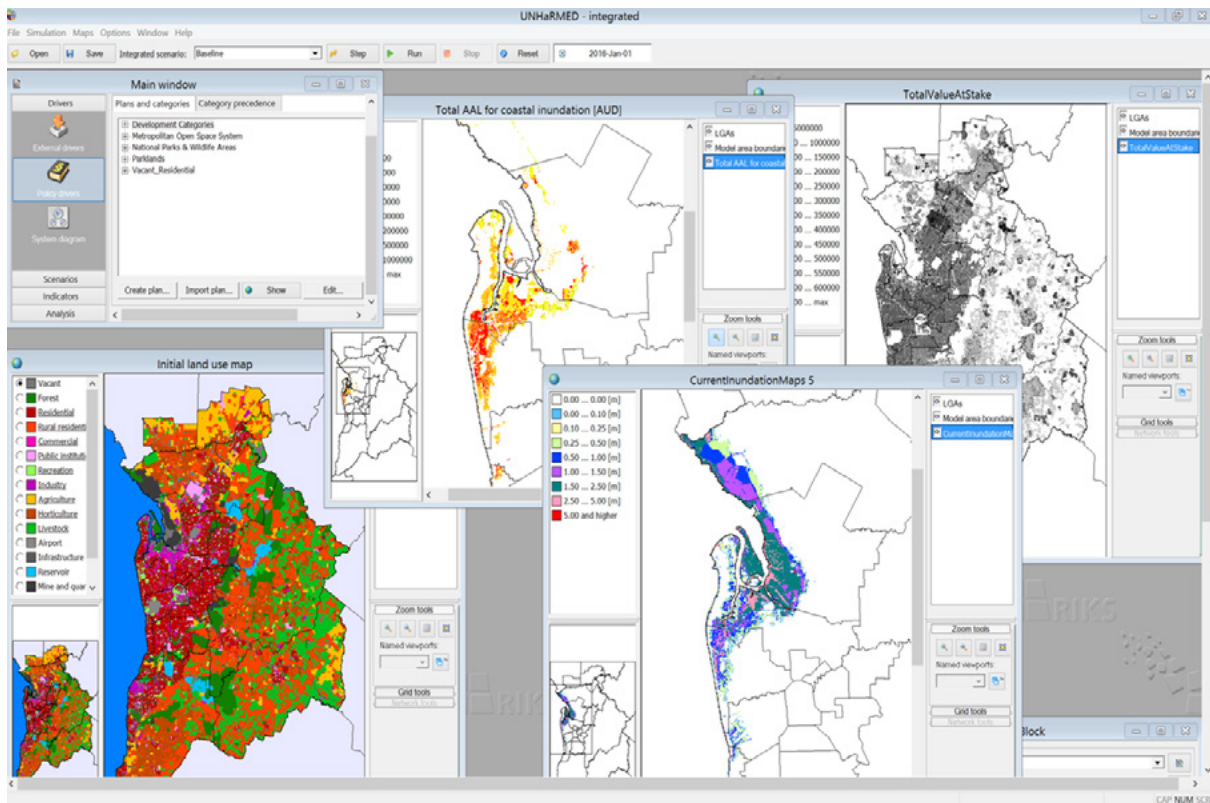
Understanding plausible future risks using different 'what if' scenarios, and identifying

the most appropriate strategies for reducing these risks, requires the contribution of many organisations across all tiers of government, as well as the local community and the private sector. The development of different mitigation options must consider current risk, an understanding of how risks evolve over time, and an analysis of the trade-offs across investment options. An understanding of current and projected

risk requires context setting exercises and a platform for open discussions.

### BACKGROUND

The City of Port Adelaide Enfield in South Australia has an existing risk from coastal inundation flooding. The 2016 Port Adelaide Enfield coastal flood inundation event affected dozens of homes. Without the implementation of risk mitigation measures, the number of



▲ Above: UNHARMED SOFTWARE WAS USED TO ASSESS THE COASTAL INUNDATION RISK AT PORT ADELAIDE ENFIELD, SOUTH AUSTRALIA. SOURCE: UNIVERSITY OF ADELAIDE.

properties affected by coastal flood inundation will grow steadily from dozens to many thousands by 2100, due to land subsidence and climate-change-related sea level rise.

Risk mitigation will most likely require the application of a combination of options, including:

- changes in floor levels in buildings (raising them above the inundation) and other practices to reduce building vulnerability
- structural defences (sea walls etc.)
- land use planning – development of exclusion overlay and coastal retreat.

Effective implementation of risk reduction options depends on the identification of the key policy issues to be addressed and the critical stakeholders to be engaged. The treatment of the risk of coastal inundation flooding will require integrated action by a range of organisations.

## BUSHFIRE AND NATURAL HAZARDS CRC RESEARCH

UNHARMED is an integrated decision support system that was developed by the CRC in partnership with the University of Adelaide and the Research Institute for Knowledge Systems.

It is a tool that measures mitigation benefits over extended periods, enabling future changes to land use, building stock, demographics, climate and mitigation

options to be explored (or quantified) using dynamic spatial modelling, developing projections of consequences arising from different hazards, and how these impacts affect risk – an essential element of planning for disaster risk reduction.

Close consultation with stakeholders ensures that the system can provide the analysis required by policy and planning professionals in emergency and disaster risk management fields. It is a decision support tool – and provides an important input into risk reduction planning. By producing estimates on future exposures, and using damage curves and a variety of other policy metrics in a spatial and temporal format, UNHARMED can assess the effectiveness of a range of risk mitigation options and enable a cost benefit analysis for each of the different risk mitigation options.

For this project, UNHARMED was used to:

- develop projections of consequences arising from coastal inundation (for example, emergency evacuation requirements, home contents damage, waste disposal, disruption to Flinders Port, impacts on vulnerable people)
- identify future damage losses arising from projected sea level rise
- identify the effectiveness of a range of risk mitigation options
- perform cost benefit analysis of a range of risk mitigation options.

Using UNHARMED, three scenarios were modelled for analysis:

1. Future losses under current conditions: based on the 2016 coastal flooding storm event, current land elevation, current sea levels and current land use.
2. Future losses under projected conditions: based on future losses under the 2016 coastal flooding storm event, projected land subsidence, projected sea level rise expected by 2050 and land use based on population and economic projections (see Figures 1 and 2 on page 4 for examples of projected inundation and economic damage).
3. Future losses under accelerated conditions: based on future losses under the 2016 coastal flooding storm event, projected land subsidence, accelerated sea level rise by 2050 based on 2100 projections (from the United Nations' Intergovernmental Panel on Climate Change) and modelled land use based on population and economic projections.

## RESEARCH FINDINGS

UNHARMED was used as a key component of a mitigation and planning exercise in August and September 2019 to explore coastal inundation risk in future decades at the City of Port Adelaide Enfield in South Australia. Participating organisations included local councils, South Australian and

## END-USER STATEMENTS

“This collaboration facilitated complex discussions that highlighted the need for interconnected planning across agencies and sectors to achieve effective mitigation that also take into account the social acceptability of proposed solutions. Participants agreed that the flexibility of the UNHARMED tool allows it to be easily applied to different hazards and geographic areas, limited only by the availability of access to appropriate data.”

**Brenton Keen, Director Emergency Management, South Australia Fire and Emergency Services Commission**

“UNHARMED is a useful product that helps provide visual representations of interacting data sets that may not otherwise be

intuitively evident to key decision makers. The ability to run multiple scenarios and produce outputs on both numeric and visual bases provides users of UNHARMED the tools required to influence both left-brain and right-brain decision makers easily and effectively.”

**Matthew Kildea, Project Manager, City of Charles Sturt council**

“The UNHARMED tool and this exercise were great tools to bring together all relevant stakeholders and facilitate a coordinated and informed approach to dealing with a flood risk. The Department of Environment and Water is currently also involved in utilising the UNHARMED tool to work through flood mitigation options for the Gawler River. Key strengths of the tool are the ability to

work through a number of scenarios and test different management options and compare these in terms of damages and costs. It allows for a much more informed debate about flood management options.

Good flood study information and information about damages is key to providing quality outputs. Utilising the tool to engage with communities to explore levels of acceptable risk and mitigation options could be a useful next application in the flood space. Opportunities to have a more dynamic approach to flood study information where projected changes in land use also feedback to changes in flood risk would be valuable.”

**Ingrid Franssen, Manager Flood Management, Department of Environment and Water South Australia**

interstate emergency service agencies, South Australian government departments, the Bureau of Meteorology, port management, power companies and the research team.

For the exercise, UNHARMED produced projections of future disaster losses from water inundation, and the effectiveness of different mitigation strategies, allowing participants to:

- better understand the extent of current and future risks
- assess the effectiveness and net benefit that could be achieved with risk mitigation options
- assist in prioritising expenditure on risk mitigation options
- develop a localised multi-decade risk mitigation implementation roadmap.

Risk information generated using UNHARMED provided insight into changes in land use and hazard exposure, linked to the consequences

and associated costs and savings that could be achieved from selected risk reduction options under different scenarios of climate change and sea level rise.

Participants identified a range of strategic response and recovery issues that required attention, including the need for effective strategies for:

- warning and communications
- evacuation, including vulnerable persons
- long-term accommodation for residents whose homes are uninhabitable
- building sustainable surge capacity for emergency services
- recovery from disasters
- property owners, associated with lost property values, lack of insurance options and liveability issues
- UNHARMED was also crucial in highlighting that the capacity of emergency services will become increasingly stretched as the flood

depth increases and the occurrence of simultaneous coastal inundation across multiple locations becomes more likely.

## HOW IS THIS RESEARCH BEING USED?

The exercise, accompanied by the high-quality projections provided by UNHARMED, was very useful for end-user participants to:

- build a common understanding of the type and scale of existing and potential risks
- explore the magnitude of benefits and issues associated with a range of risk mitigation measures
- identify the policy issues that need to be resolved to achieve implementation of risk mitigation initiatives
- identify the breadth of stakeholders that need to be engaged in this discussion and planning
- develop a risk mitigation implementation roadmap.

### The range of community resilience-building initiatives identified by participants included:

- creating a risk informed community
- creating a prepared community
- enhancing the community's understanding of warnings
- developing more robust evacuation plans
- developing shelter in place plans
- conducting relevant exercises with emergency services
- enhancing business continuity planning by the business sector
- developing forward-looking recovery plans.

### Participating organisations included:

- Bureau of Meteorology
- Bushfire and Natural Hazards CRC
- City of Charles Sturt
- City of Port Adelaide Enfield
- Department for Environment and Water, SA
- Department of Human Services, SA
- Department of Planning, Transport and Infrastructure, SA
- ElectraNet
- Emergency Management Victoria
- Flinders Ports
- Queensland Fire and Emergency Services
- Department of the Premier and Cabinet, SA
- SAFECOM
- South Australia Health
- South Australia Housing
- South Australia Local Government Association
- South Australia Power Networks
- South Australia Police
- South Australia State Emergency Service
- University of Adelaide
- University of Melbourne

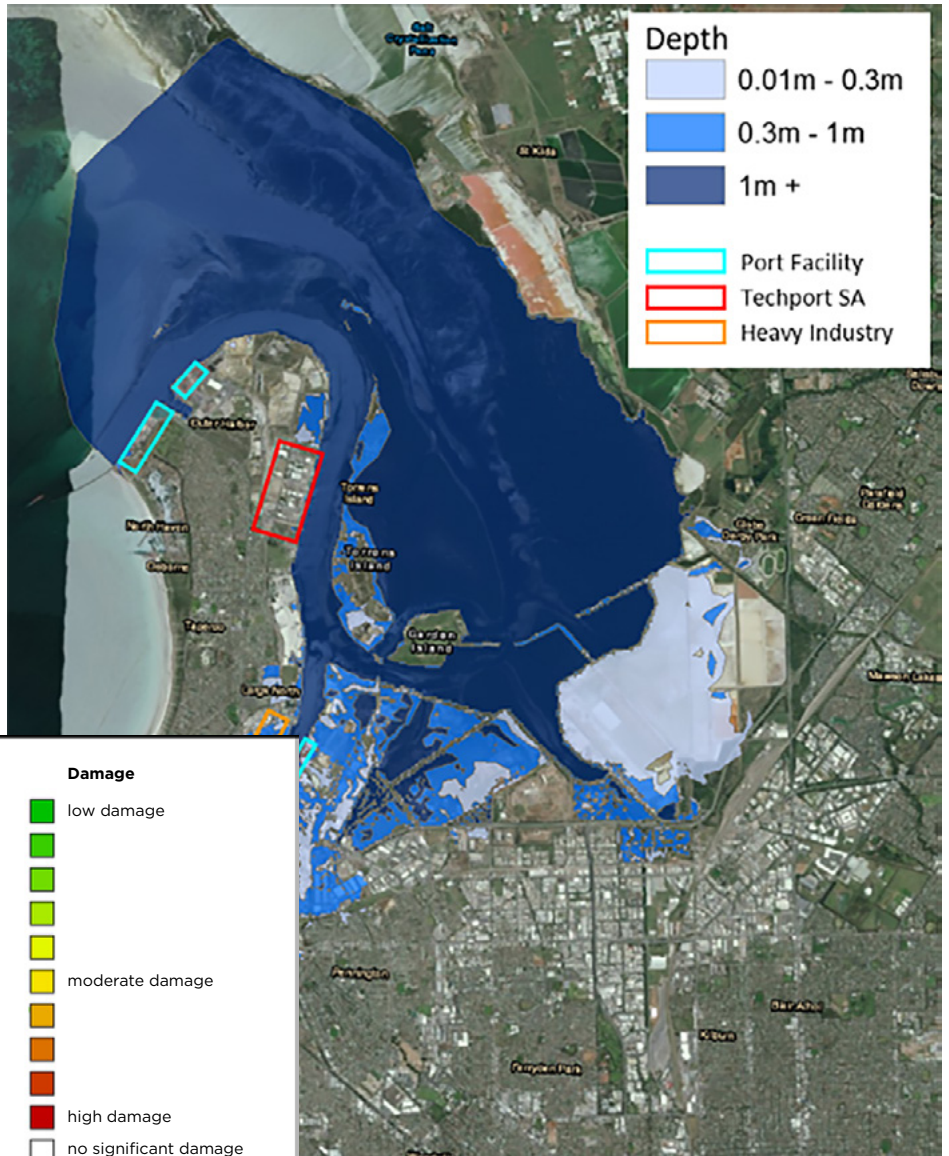
The research informed robust discussions and comparisons of risk mitigation options, with the ability to estimate costs and benefits with UNHARMED critical. The information produced by UNHARMED quickly focused participants' attention on the key policy issues to be resolved.

**FUTURE DIRECTIONS**

Participants identified many other hazards that would benefit from the application of UNHARMED in multi-agency exercises. These hazards included flooding, bushfires and earthquakes.

▶ **Figure 1:** 1-IN-100-YEAR FLOOD INUNDATION OF FLINDERS PORT AREA IN THE YEAR 2050, INCLUDING THE PROJECTED 300MM OF SEA LEVEL RISE (SCENARIO 2). SOURCE: UNIVERSITY OF ADELAIDE.

▼ **Figure 2:** CALCULATED DAMAGE TO CAPITAL STOCK IN FLINDERS PORT AS A RESULT OF A 1-IN-100 YEAR FLOOD INUNDATION IN THE YEAR 2050 (SCENARIO 2). DAMAGE IS REPRESENTED FROM LOW TO HIGH, MEASURED IN COST, WITH RED SHOWING THE MOST DAMAGED AREAS OF THE PORT. SOURCE: UNIVERSITY OF ADELAIDE.



**FURTHER READING**

Riddell GA, van Delden H, Dandy GC, Maier HR, Zecchin AC, Newman JP & Newland C (2015) *Futures Greater Adelaide 2050: an exploration of disaster risk and the future*, Bushfire and Natural Hazards CRC, Melbourne.

Riddell GA, van Delden H, Maier HR, Zecchin AC (2019) *Exploratory scenario analysis for disaster risk reduction: considering alternative pathways in disaster risk assessment*, International Journal of Disaster Risk Reduction, 39, doi.org/10.1016/j.ijdr.2019.101230.

The Bushfire and Natural Hazards CRC is a national research centre funded by the Australian Government Cooperative Research Centre Program. It was formed in 2013 for an eight-year program to undertake end-user focused research for Australia and New Zealand.

*Hazard Notes* are prepared from available research at the time of publication to encourage discussion and debate. The contents of *Hazard Notes* do not necessarily represent the views, policies, practises or positions of any of the individual agencies or organisations who are stakeholders of the Bushfire and Natural Hazards CRC.

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