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IMPROVED DECISION SUPPORT FOR NATURAL HAZARD RISK REDUCTION

Annual project report 2017 - 2018

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research institute for knowledge systems

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EXECUTIVE SUMMARY

Natural hazards are an unavoidable component of life in Australia. Analysis shows the average cost of natural hazards in 2015 totalled $9.6 billion, and this figure is projected to increase to $33 billion by 2050. These figures correspond to a substantial impact and coupled with the social and environmental impacts of disasters, paint a bleak picture. However, tomorrow's risk is a function of today's decisions, and with effective adaptation planning there is significant scope to minimise tomorrow's impacts. To support improved understanding of future risks and testing of adaptation solutions this project is working on mechanisms to better inform decision making with quantitative tools by working with multiple government agencies.

The key outcome of this project is the software application UNHaRMED, which as part of the research work, has been developed for and applied to three case-studies, Greater Adelaide, Tasmania, and Greater and Peri-urban Melbourne. UNHaRMED aims to enable planners and policy makers to develop risk reduction plans for the changing threats of multiple natural hazards in a systematic, transparent and consistent manner. This takes the form of a spatially and temporally dynamic decision support system (DSS) designed with the input of multiple government agencies across state jurisdictions in Australia. UNHaRMED provides agencies 1) an evidence base for risk reduction plans, 2) a method for SWOT analysis for future requirements based on a changing climate and economic/population developments and 3) a platform for collaboration across agencies for effective planning and policy responses.

The focus of 2017-2018 has been on the completion of the applications for each of the case-studies, as well as exploring and implementing utilisation activities to support the implementation of existing applications within regions and government organisations, as well as initiate new applications of UNHaRMED both within Australia and internationally. This has seen a new project begin in Western Australia supported by NDRP funding and multiple State Government agencies, as well as proposals under review to support local government decision making.

The other focus of the year has been on publishing methodologies and results on the development and application of the software. This has seen five journal publications either published or submitted along with multiple reports providing details on engagement processes, future regional risks and utilisation pathways for the project's outcomes.

END-USER STATEMENT

Ed Pikusa, *Department of Environment and Water SA*

This project's software platform, named UNHaRMED, continues to find interest in its application both within and outside the emergency management sector. In particular, it has generated interest at natural resource management and climate change adaptation conferences.

End users continue to show interest to investigate its application. These include recent queries from Western Australia, Queensland, and the Bureau of Meteorology.

This year, a version of the product was delivered to the SA Department for Environment and Water to assist in planning its prescribed burning program. It is hoped that versions of the product, tailored to individual end user needs, will continue to roll out between now and the end of the CRC to assist in strategic planning into the future.

INTRODUCTION

The challenges facing policy makers grow increasingly complex and uncertain as more factors that impact on their ability to manage the environment and its risks need to be considered. Due to a large number of influencing environmental and anthropogenic factors, natural hazard risk is difficult to estimate accurately, and is exaggerated by large uncertainty in future socio-economic consequences. Furthermore, resources are scarce, and the benefits of risk reduction strategies are often intangible.

Consequently, this project looks to develop various processes and software applications to assist managers with better understanding disaster risk, which offer significant advantages with regard to strategic policy assessment and development. The key output of the project is the software application UNHaRMED. This system allows for the dynamic understanding and assessment of all three components of risk; exposure, vulnerability and hazard, in line with recent recommendations from the World Bank's Global Facility for Disaster Reduction and Recovery (Fraser et al, 2016). UNHaRMED thus allows policy makers to better understand the drivers of risk and the impact of their policies on risk profiles now and into the future. This enables policy makers to account for climate change, urbanisation, population increases and future environmental conditions in risk assessments.

Accompanying the system is a framework that facilitates its development and supports its uses by organisations such that it (i) is able to deal with complex problems in a systematic and transparent manner; (ii) makes best use of available sources of data and information; (iii) is adaptable/flexible; (iv) deals with multiple, competing objectives; (v) identifies mitigation options that represent the best possible (optimal) trade-offs between objectives; (vi) deals with uncertainty; (vii) caters to a large number of potential solutions; (viii) enhances understanding of the side effects and impacts of different combinations of policy options; and (ix) adopts an interdisciplinary approach across various policy fields.

This report provides information on the various elements of the project including:

- Key summaries of developed approaches for developing and using decision support systems for natural hazard risk reduction, optimizing risk reduction strategies over long planning horizon, and enabling better understanding of societal elements of risk.
- An outline of critical outcomes of the project including the software application UNHaRMED and its application across different States.
- An overview of utilization activites including new applications of outcomes and approaches and on-going proposals.

BACKGROUND

DISASTER LOSSES ARE SIGNIFICANT, AND CAN BE REDUCED

The impacts from natural disasters are staggering in terms of human and economic losses. While the immediate and post-crisis response to disasters is extremely important, mitigation activities before a natural disaster occurs can be extremely effective in reducing potential losses — for every dollar spent on mitigation, a saving of one and a half to five dollars in recovery costs can be expected (Rose et al., 2007). However, developing and implementing mitigation can be extremely difficult in practice, because of the difficulty of convincing decision makers of the advantages of spending money on mitigation works compared with the short-term benefits offered by other potential projects and activities. In addition, because disasters are relatively infrequent, the people influencing mitigation activities may have little personal experiences to guide their evaluation of risk, or the relative benefits of alternative mitigation options. Furthermore, mitigation budgets are generally limited, and given the difficulties mentioned above, the selection of an optimal set of mitigation options is very difficult when many alternative mitigation options are available.

HOW UNHARMED CAN HELP SOLVE THE PROBLEM

Because of these difficulties, the use of decision support systems (DSS), in the case of this project the developed DSS – UNHaRMED -, is advantageous, as such systems (1) are transparent and can quantify the expected benefits of mitigation investiture across multiple criteria, enabling strong arguments for the selection of particular mitigation options to be made, (2) can be used to assess the likelihood and consequences of natural disasters across multiple criteria, resulting in less bias when assessing the relative benefits of mitigation options, and (3) can make use of formal optimization techniques to find optimal or near-optimal portfolios of mitigation options. However, DSSs for natural disaster mitigation have tended to focus on disaster preparedness and the immediate and post-crisis response to emergencies. Of those DSSs that have focused on mitigation, none have considered, simultaneously, both (1) temporal non-stationarity in climate or land use, and (2) the use of optimization to identify suitable mitigation portfolios. These aspects are important, as natural disasters are likely to become more frequent with climate change, and because consequences of natural disasters are highly sensitive to the land uses at the location of the natural disaster.

RESEARCH APPROACH

The research approach developed to enable the required outcomes is broken into several streams to enable prototype software applications to be developed with users and tested by them in shorter time periods taking a co-creation approach; technical solutions to be developed to support specific tasks using high performance computing for optimisation and new research directions to be identified and pursued based on stakeholder responses.

The following sections outline the key frameworks developed to support the research approach, including:

- Co-creation to support strategic disaster risk management through developing a generic approach for the development and use of a decision support system for risk reduction planning
- Enhancing the effectiveness of risk reduction spending through optimisation
- Enabling a more sophisticated understanding of societal elements of risk.

Each of these frameworks is developed to support development and implementation of UNHaRMED, as well as stakeholder needs in the emergency management, planning and risk reduction domains with regard to improving their understanding of risk and their ability to better justify risk reduction activities through providing an evidence-base for policy and investment decisions.

CO-CREATION FOR DEVELOPING AND USING DECISION SUPPORT SYSTEMS FOR DISASTER RISK MANAGEMENT

The project has developed and tested an approach to developing generic disaster risk management (DRM) DSSs that enables the dynamic assessment of future risk and risk reduction options and maximises their use potential. The approach is underpinned by separate but linked processes for development and use based on the principles of co-creation. This involves various *end-users*, *stakeholders*, *scientists*, *modellers*, *IT-specialists*, and *facilitators* throughout the entire process. Co-creation enables the DSS to be jointly developed and used by the actors involved in the processes, allowing the outcomes to be owned by all involved.

The main aim of the *development process* is to deliver a generic DSS that provides support for DRM and is sufficiently generic and flexible to be customised and applied to various regions/jurisdictions and policy/investment contexts. Such a generic DSS incorporates an integrated simulation model with a model library consisting of spatially-explicit and dynamic model components for hazard, exposure, vulnerability and risk, exposed through a user-friendly and intuitive graphical user interface.

As part of the *use process* the generic DSS is tailored to the region and questions of interest. The main aim of the *use process* is to provide support to the DRM process by analysing how risk changes over time and in space, how risk reduction portfolios (groups of risk reduction options) impact on risk, what the wider

consequences of those options are, and where win-win situations can be created, or trade-offs are required. The *use process* focuses on how to best provide this support with information the DSS can provide –but is not limited to the information the DSS provides– and emphasises the importance of connecting modelling with relevant policy contexts and processes.

Figure 1 provides an illustration of the approach, with the *development process* shown on the left-hand side and the *use process* on the right-hand side. As mentioned previously, this iterative approach focuses on the co-creation of (1) a generic DSS that incorporates an integrated multi-hazard modelling framework along with (2) case specific support to disaster risk management by developing a case specific software application and embedding this in a process for assessing risk and risk reduction options.

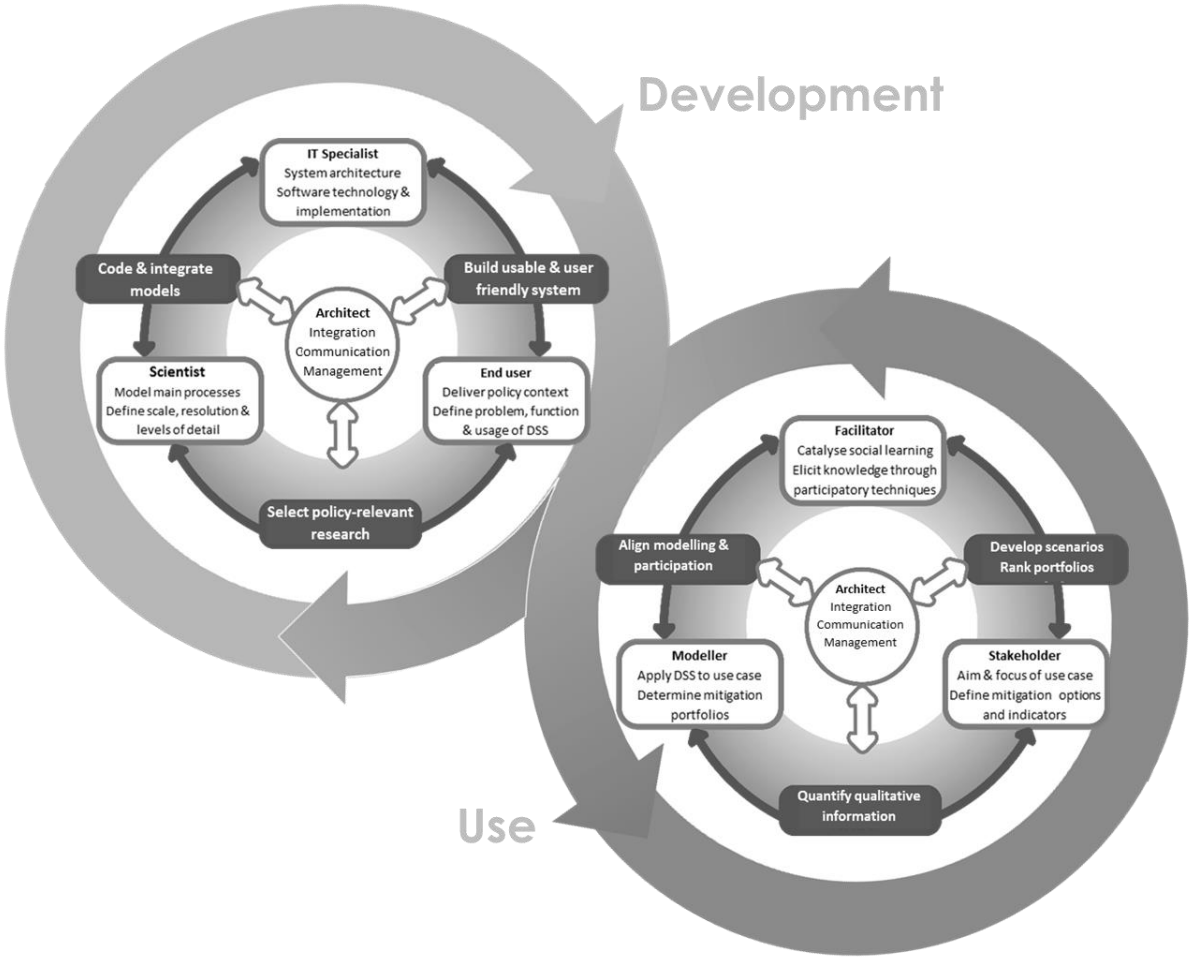


FIGURE 1 - THE DEVELOPMENT AND USE PROCESSES OF A DSS AS SEPARATE, BUT CLOSELY LINKED PROCESSES

Further details of the approach are documented in:

Van Delden H, Riddell GA, Maier HR, Newman JP, Zecchin AC, Dandy GC, 2018. UNHaRMED – Framework for the development and use of decision support systems for disaster risk management through co-creation. Bushfire and Natural Hazard CRC.

Van Delden H., Riddell G.A., Maier H.R., Newman J.P., Zecchin A.C., Dandy G.C. and Vanhout R. Co-creation to support strategic disaster risk management: A generic approach for the development and use of a decision support system

for risk reduction planning, Socio-Environmental Systems Modeling, (invited paper – submitted).

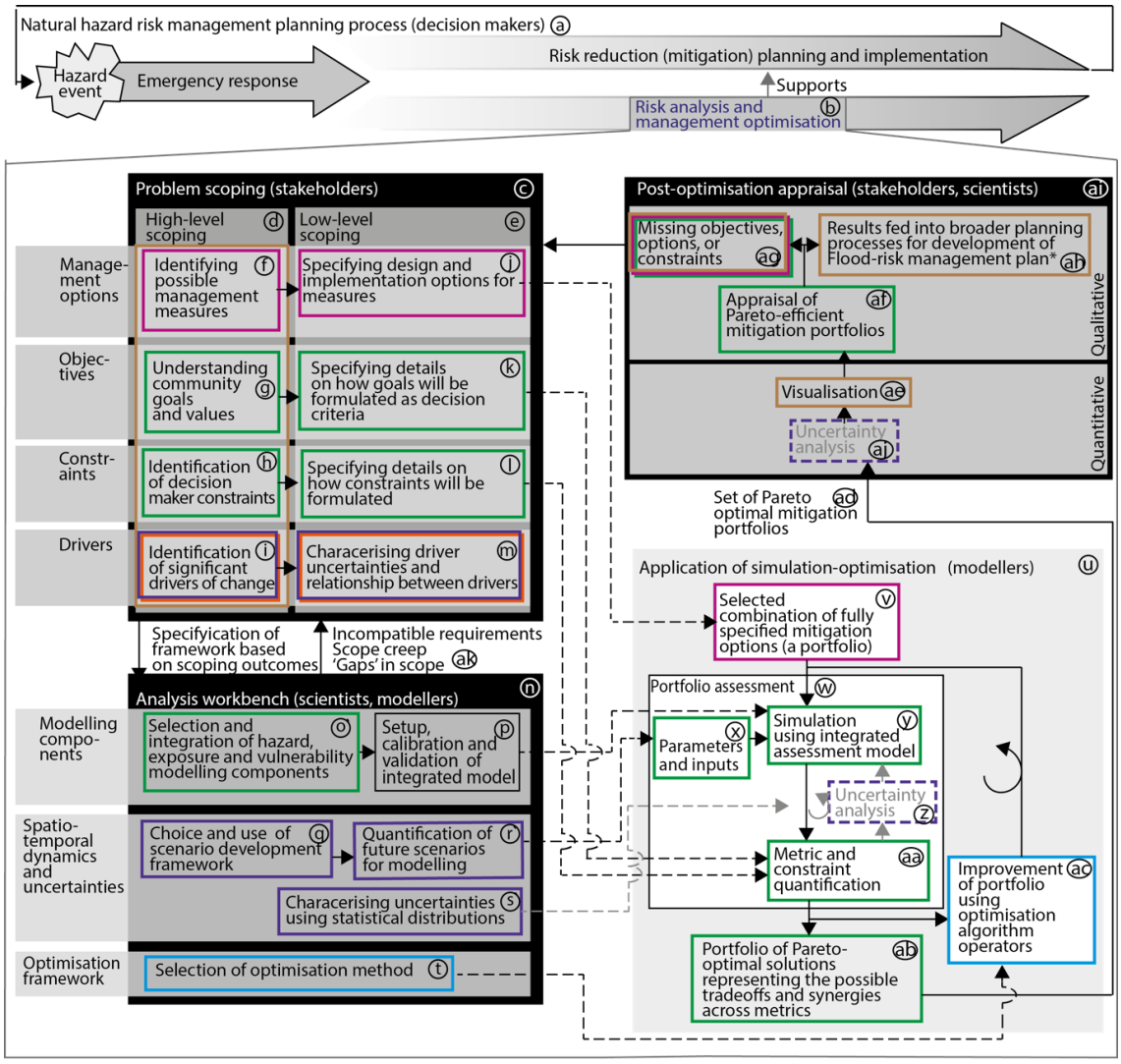
ENHANCING THE EFFECTIVENESS OF RISK REDUCTION SPENDING THROUGH OPTIMISATION

An approach has been developed highlighting how UNHaRMED can be used in conjunction with optimisation to assist decision makers in planning and implementing disaster risk reduction policies and investments. The 'simulation-optimisation' approach to natural hazard risk assessment has immense value for the management of natural hazard risk because:

1. Natural hazard risk is significant, is increasing if left unabated through time, but can be managed through mitigation, emergency and recovery planning;
2. Despite the benefits of managing natural hazard risk through planning processes, there are challenges in: (1) assessing the comparative effectiveness of different management options, and (2) in sifting through and identifying the best performing portfolios of management options;
3. Simulation is immensely valuable for characterising the nature, extent and magnitude of risk across space and time, as it provides a quantitative and transparent, repeatable and defensible basis for assessing many criteria pertinent for understanding the effect of different management options; and
4. Optimisation is immensely valuable for sifting through and identifying best performing management options, as it provides an automated technique to consider a wide range of management options that are too numerous for manual trial-and-error approaches.

The proposed framework for the complementary use of both optimisation and simulation, incorporating integrated assessment modelling, for natural hazard management is shown in Figure 2. This framework (1) searches for the best-performing portfolios of management options, selecting from the (2) broadest range of management options, based on (3) a diverse set of risk and other non-risk economic, social and environmental goals and constraints by means of an integrated multi-criteria assessment. In doing this, the framework also considers (4) uncertainty and (5) how risk changes through long-term planning horizons, for example due to climate change, population growth, and changes to demographics and development patterns. The framework achieves this while ensuring that the analysis of portfolios is (6) integrated within natural hazard management/planning processes via participatory approaches with stakeholders and decision makers. In doing this, the framework's purpose is to help decision makers and planners formulate natural hazard risk strategies that

outline what types of options will be used to manage risk in a particular region to which the framework is applied.



Key to coloured boxes, highlighting features of the framework

Sifting through and identifying best performing mitigation measures | Integrated multicriteria assessment | Considering uncertainty

A broad range of mitigation measures | Considering nonstationarity | Integration within flood management planning processes

Dashed lines represent a mapping of scoping and analysis workbench components to optimisation processes as the optimisation runs

Solid lines show dependencies between components of the simulation-optimisation development and use process

FIGURE 2 - PROPOSED HIGH-LEVEL FRAMEWORK FOR A SIMULATION-OPTIMISATION APPROACH FOR TEMPORALLY AND SPATIALLY DYNAMIC NATURAL HAZARD RISK ASSESSMENT AND PLANNING. THIS FRAMEWORK USES OPTIMISATION TO SIFT THROUGH THE LARGE NUMBER OF POTENTIAL PORTFOLIOS OF MANAGEMENT OPTIONS, CAREFULLY BUILDS A MODEL-CHAIN TO APPROPRIATELY REPRESENT MANAGEMENT OPTIONS AND CALCULATE DECISION CRITERIA, CONSIDERS UNCERTAINTY AND NONSTATIONARITY IN RISK DRIVERS AND PROCESSES, AND SELECTS APPROPRIATE MODELLING COMPONENTS AND OPTIMISATION APPROACHES THAT ADEQUATELY BALANCE THE TRADE-OFF BETWEEN SIMULATION ACCURACY AND COMPUTATIONAL COST, WHILST BEING FOCUSSED ON SUPPLYING USEFUL INFORMATION TO ENRICH DIALOGUE AND DECISION MAKING WITHIN RISK MANAGEMENT PROCESSES.

This approach has been applied to the Greater Adelaide region, and incorporated the use of the regional application of UNHaRMED along with stakeholder engagement process that informed the optimization process. Results of the analysis can be found in:

> *Newman, J. P., Dandy, G. C., Zecchin, A. C., Maier, H. R., van Delden, H., Newland, C., and Riddell, G. A. (2018) Simulation Optimisation for Natural Hazard Risk Management, Bushfire & Natural Hazards CRC*

Summaries of the stakeholder engagement process can be found in:

> *Riddell, G. A. Van Delden, H., Dandy, G. C., Maier, H. R., Zecchin, A. C. and Newman, J. P. (2017) Greater Adelaide Multi-hazard Mitigation Planning: Stakeholder problem formumation. Bushfire & Natural Hazards CRC.*

ENABLING A MORE SOPHISTICATED UNDERSTANDING OF SOCIETAL ELEMENTS OF RISK

Based on extensive engagement over the previous four years of this project it was highlighted that research was required into improving organisations' understanding of the societal elements of risk, and what could be done from a policy/program level to influence individuals' behaviour. Therefore, within the research 'refresh' for this project, scope was included to improve the functionality of UNHaRMED by trialling alternative methodolodies and including new data and models focused on improving the consideration of socio-economic factors of risk, and better inclusion of risk reduction options focused on behaviour.

Two primary components of this research have been scoped, and research work begun in terms of literature review and methodological development. The first component will be trialled for the Greater and Peri-urban Melbourne application focused on capturing improved consideration of the dynamcis of vulnerable populations. Instead of assuming a uniform population with a uniform behaviour and risk profile, the *activity based model* allows for improved consideration of societal groups and associated vulnerabilities by modelling the spatial and temporal dynamics of specific demographics groups' locational choices. This model builds on the existing land use component of UNHaRMED, by allowing for population layers to be added to the land use layer, thus allowing simulation of the density of different societal groups in a spatially explicit manner. Population and demographic data will be collected and a household typology developed based on social characteristics relevant for vulnerability assessments, such as elderly, families with young children, migrants, etc. Next, the data sources will be processed to grid layers. These historical data will then be used to set up and calibrate the model and subsequently the model will be dynamically linked with the existing UNHaRMED application.

The second component to improve understanding of socio-economic risk factors will see the addition of *Agent Based Modelling* capability to the DSS framework to cater to improved consideration of the impact of behavioural choices, experiences and risk reduction options on bushfire risk. This approach will help to better understand the impact of social characteristics on bushfire vulnerability, including the experience people have with bushfires and the time they have spent residing in the country or urban environments. It will also aim to enhance the understanding of various risk reduction options. Qualitative and quantitative data will be collected from existing sources, which will be complemented with interviews. The data will be used to set-up and calibrate an *agent based model*, which will then be used in conjunction with, or integrated within, UNHaRMED for Greater Adelaide informing bushfire risk analysis.

Over the next few months researchers will be working on the background analysis needed for tackling these new research questions. It is planned to submit

publications focused on reviewing literature in both areas by the end of this year. These will be used as a solid foundation for developing and implementing the proposed approaches, as well as proposing new research directions to the academic community to better inform our understanding of societal elements of risk, and developing models to better simulate the influence of behaviour and policy interventions on natural hazard risks.

KEY OUTCOMES

The project has resulted in the development of a generic decision support system for nautral hazard risk understanding and reduction planning, UNHaRMED, which has been applied to three case-study areas. The following section provides an overview of the software along with descriptions of the three applications and what the next steps for each of them is.

UNHARMED

UNHaRMED is the University of Adelaide and RIKS' spatial Decision Support System (DSS) for natural hazard risk reduction planning, funded by the Bushfire and Natural Hazard Cooperative Research Centre (CRC). The software consists of a dynamic, spatial land use change model and multiple hazard models to consider how risk changes into the future, both spatially and temporally.

UNHaRMED was developed through an iterative, stakeholder-focussed process to ensure the system is capable of providing the analysis required by policy and planning professionals in emergency management and risk fields. The process involved a series of interviews and workshops with members of the various State Government agencies, aligning risk reduction measures to be included, policy relevant indicators and future uncertainties, such that the system can sit within existing policy processes. This resulted in a tool that considers how land use changes through time, how various hazards interact with these changes, and what the effectiveness of a variety of risk reduction measures is.

Land use changes are simulated based on a number of different drivers. First there are external factors such as population growth or the decrease of natural area that determine the demand for different land uses. The land uses for every location are determined based on socio-economic factors (e.g., *will a business flourish in this location?*), policy options (e.g., *are there policy rules in effect that restrict new housing development in this location?*) and biophysical factors (e.g., *is the soil suited for agriculture here?*). Natural hazards are included as the specific application is set up, hazards can include bushfire, earthquake, coastal inundation, riverine flooding and extreme heat. Each hazard is modelled differently dependent on its physical processes and further details on each is provided within relevant reports.

UNHaRMED's land use component, Metronamica is calibrated on historic land use changes, which is extrapolated to simulate land use developments into the future. After that, planners can experiment with scenarios, policy options and external influences such as spatial zoning plans, expansion of the road network or population growth scenarios, and assess the effect compared to the baseline scenario. Other risk reduction options are also included within UNHaRMED allowing planners to compare the effectiveness of different measues in their ability to reduce risk.

UNHaRMED is developed in the Geonamica software environment. It comes as a stand-alone software application. The system includes the Map Comparison Kit for analysis of model results. Both tools use data formats that are compatible with standard GIS packages such as ArcGIS.

Greater Adelaide Application

UNHaRMED has been applied to the Greater Adelaide region, as defined by the ABS's Greater Capital City Statistical Area. Incorporated within the application is hazard risk modelling of riverine and coastal flooding, bushfire and earthquake. Key agencies involved in the development of the application were the Department of Envrionment and Water (DEW), along with the SA Fire & Emergency Services Commission and SA SES. Ongoing engagement is still being sought with the Country Fire Service and Department of Planning, Transport and Infrastructure.

Currently multiple users have been trained in the software from various agencies, and the software is installed on the Department of Environment & Water's server. Next steps involve continued support to the Department's staff, specifically around bushfire prescribed burn planning and application to flood risk management in particular catchments.

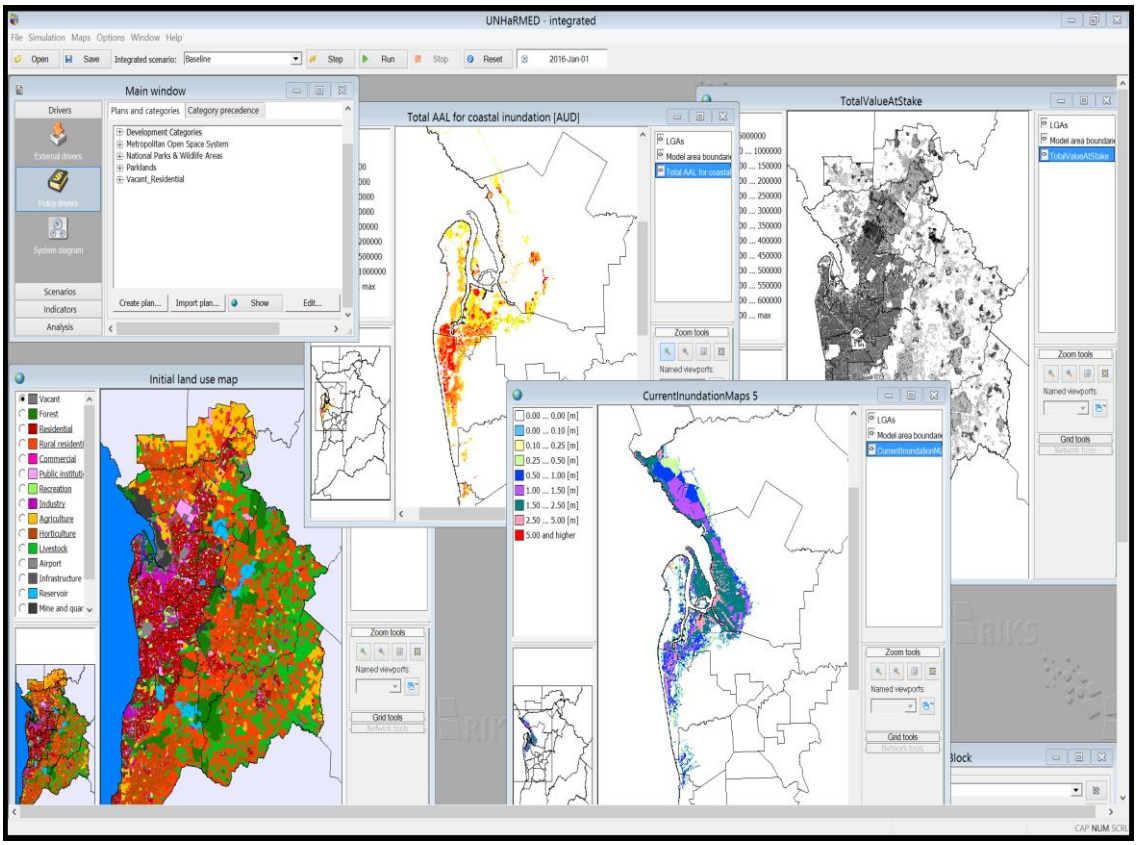


FIGURE 3 - SCREENSHOT OF GREATER ADELAIDE UNHARMED APPLICATION

Greater and Peri-Urban Melbourne Application

The UNHaRMED application for Greater and Peri-urban Mlebourne covers 41 local government areas of Victoria and the main growth areas from an expanding metropolitan Melbourne. The application was submitted as a deliverable at the end of 2017, and incorporates bushfire, earthquake, coastal and (limited) riverine flooding hazards. Data inputs in the hazard area will continue to be refined with input from involved agencies.

Critical to the application's development has been input from the Country Fire Authority (CFA) and the Department of Environment, Land, Water & Planning

(DELWP). Over the last year these agencies have been vital in the provisioning of data to implement and calibrate the application along with providing guidance on future use, and tailoring the outputs to enable organisation integration and improved risk understanding and planning.

Next steps for the coming financial year include the completion of modelling for multi-hazard risk scenarios and the training of users across multiple agencies to support their use of the software application.

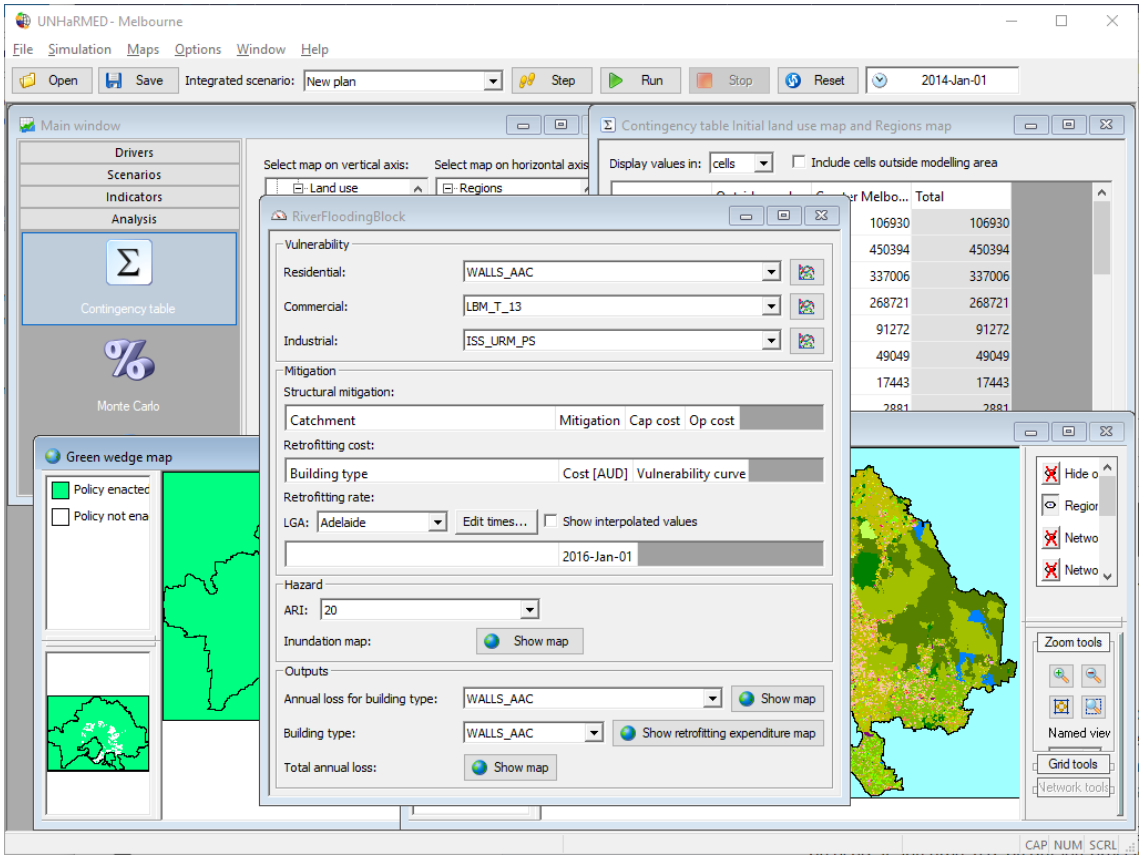


FIGURE 4 - SCREENSHOT OF GREATER & PERI-URBAN UNHARMED APPLICATION

Tasmania Application

The UNHaRMED application for Tasmania covers the entirity of Tasmania's main island, as well as King Island, Flinders Island and Cape Barren Island. The application was submitted as a deliverable at the end of 2017, and incorporates bushfire, earthquake, and coastal flooding hazards. Riverine flooding will be included in the refresh of the CRC project following the development of a State-wide flood model for Tasmania. Data inputs in the hazard area will continue to be refined with input from involved agencies.

Key agenices in the development of the Tasmanian application have been the Department of Premier and Cabinet (DPaC), Tasmanian Fire Service (TFS) and the Tasmanian Planning Commission. Similar to Victoria, next steps for the application involve the completion of modelling for multi-hazard risk scenarios and the training of users across multiple agencies to support their use of the software application.

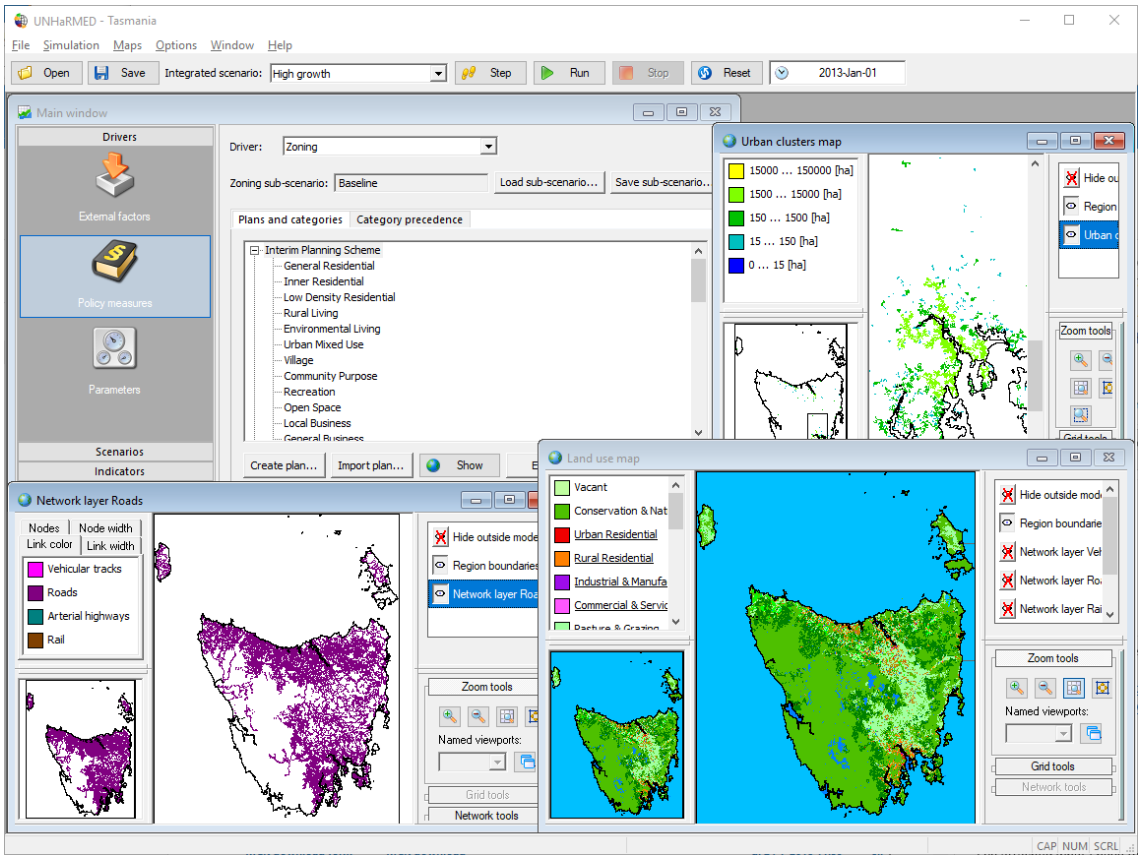


FIGURE 5 - SCREENSHOT OF TASMANIA UNHARMED APPLICATION

UTILISATION OUTPUTS

Utilisation has been a key focus of the project from its conception, as evidenced by the incorporation of user needs through the development and use process of UNHaRMED (see *Research Approach – co-creation for developing and using decision support systems for disaster risk management*). There are currently three main streams to utilisation that the project is pursuing:

1. Supporting the implementation of existing applications with users in different state agencies across SA, VIC, and TAS.
2. Developing new applications for regions working with public and private organisations.
3. Providing consulting services using existing applications (or developing them for internal use) for public and private organisations in terms of risk assessment and planning.

Key activities undertaken in the previous year aligned with these streams of activity are summarised below.

DSS IMPLEMENTATION FOR SA

To support the implementation of UNHaRMED for South Australia, utilisation activities have been undertaken to support the system's application, especially for use by DEW's Fire & Flood team. Training has been provided to multiple representatives of the agency, along with on-going support. Documentation of training exercises, and technical specifications of the application have also been developed and provided to users of the software. See:

> Van Delden H, Riddell GA, Vanhout R, Newman JP, Maier HR, Zecchin AC, Dandy GC, Daniell J, Schaeffer A. 2017. UNHaRMED – Unified Natural Hazard Risk Mitigation Exploratory Decision Support System, Technical Specification Version 1.0. Bushfire and Natural Hazard CRC.
>
> Riddell GA, Van Delden H, 2017. UNHaRMED – Unified Natural Hazard Risk Mitigation Exploratory Decision Support System, User Manual Version 1.0. Bushfire and Natural Hazard CRC.
>
> Van Delden H, Riddell GA, Vanhout R, Newman JP, Maier HR, Zecchin AC, Dandy GC, Daniell J, Schaeffer A. 2017. UNHaRMED – Unified Natural Hazard Risk Mitigation Exploratory Decision Support System, User Training, Version 1.0. Bushfire and Natural Hazard CRC.

A workshop was also held to discuss utilisation pathways within South Australia, supporting multiple agencies with risk understanding and reduction planning. See:

> Riddell GA, Van Delden H, 2017. UNHaRMED Greater Adelaide: Utilisation workshop report, July 2017. Bushfire and Natural Hazard CRC.

From this workshop key outputs were summarised between what could be done in the short and long term to support utilisation within South Australia. These points are presented below.

For short term (<year) support, the following activities are proposed:

- Installation of the system at user organisations:
    - DEW Fire: Prototype DSS
    - Natural Resourcess – Adelaide and Mt Lofty, demo version of Metronamica land use model component

Both organisations will receive support from the project team to help them use the DSS for answering their questions:

- DEW flood will be supported through use cases and presentations and is welcome to have the software installed upon request
- The project team will work on valuable uses cases in fire and flood management and try to engage the Department of Premier and Cabinet (DPC) and DPTI as part of these cases and/or use these cases to raise interest and show potential

To establish ongoing use beyond the lifetime of the project, the following are considered highly important:

- To develop a user group / community of practice across states
- To create a working group for interaction between the project team, DEW Fire, and Country Fire Service to look at data sharing and integration into the system for improved bushfire risk management
- To consider the form of the relationship between the developers and users, as well as the role of the CRC

Analysis has also been completed regarding the urbanisation expected in a significant floodplain to the north of Adelaide using the UNHaRMED application. This analysis highlights the role of urban growth in the dynamics of flood risk and highlights the role of integrated flood risk modelling in improving understanding and informing holistic risk reduction strategies. See:

> Riddell GA, Van Delden H, Maier HR, 2018. Urbanisation pressures & flood risk: Gawler River catchment and regional development. Bushfire and Natural Hazard CRC.

WA NDRP – DEVELOPING A DSS FOR WESTERN AUSTRALIA

Following discussions over previous years, a proposal was developed for NDRP funding to develop an application of UNHaRMED in the South West of Western Australia. This NDRP Grant was supported financially by the Department of Fire & Emergency Services (DFES), Office of Emergency Management (OEM), Department of Planning, Lands & Heritage (DPLH), and the CRC, along with in-kind support from agencies across WA. Formally, the project began 1/07/2017 and has been prorgressively engaging with agencies and stakeholders to developed UNHaRMED aligned with WA requirements.

The system will encompass earthquake, bushfire and coastal flooding risks (with scope if data are available to also incorporate riverine flooding). Land use, building stock and risk indicators will also be implemented for WA.

Following a request from DPLH and the WA Planning Commission, delivery of a first-prototype in early 2019 has also been added to the project, enabling faster delivery of a working system and increased opportunity to engage with system users in the following year of the project.

In the previous 12 months, data have been collected and processed to implement land use and bushfire hazard modelling. All hazard modelling is now on track to deliver prototype 1 by early 2019. A process of stakeholder engagement has also been initiated to inform the development and use of the system, as per the approach previously outlined. Details of progress thus far are given in:

> Riddell GA, Van Delden H, Bennett B, Maier HR, 2018. Western Australia – Developing a risk reduction planning DSS: Stakholder engagement stage 1 report, 2017. Bushfire and Natural Hazard CRC.

OTHER UTILISATION ACTIVITIES

Other utilisation activities have taken place and resulted in the development of multiple proposals, as well as engagement with new organisations interested in future risk understanding and reduction planning.

A proposal is currently under review for NDRP Grants in South Australia for the specific application of UNHaRMED to support the Gawler River Floodplain Management Authority (GRFMA) – a subsidiary of six local governments. The proposal was supported by the CRC, Department of Environment & Water Fire and Flood Management Unit and the Local Government Association of SA. The proposal, if successful, will see UNHaRMED used to assess multiple risk reduction strategies across the floodplain and contribute to the development of a catchment masterplan accounting for social, environmental, economic and risk factors.

Another proposal was developed for the Investors Group on Climate Change (IGCC) to apply UNHaRMED to assess the climate risk in five cities across Asia (Sydney, Hong Kong, Shanghai, Tokyo and Singapore). Although this proposal was eventually unsuccessful due to lack of funding availability, it did provide momentum to the project team to consider how to deliver a project at this scale, and provided significant exposure of the software to the private sector considering their risks from climate change into the future.

Members of the project team have also been engaged to support the Queensland Fire and Emergency Services develop a capability forecasting model, acting as subject-matter experts and reviewers for the developed model.

PUBLICATIONS LIST

JOURNAL PUBLICATIONS

Newman J.P., Maier H.R., Riddell G.A., Zecchin A.C., Daniell J., Schaefer A., van Delden H., Khazai B., O'Flaherty M.J. and Newland C.P. (2017) **Review of literature on decision support systems for natural hazard risk reduction: Current status and future research directions**, Environmental Modelling and Software, 96, 378-409, DOI:10.1016/j.envsoft.2017.06.042.

Newland C.P., Maier H.R., Zecchin A.C., Newman J.P. and van Delden H. (2018) **Multi-objective optimisation framework for calibration of Cellular Automata land-use models**, Environmental Modelling and Software, 100, 175-200, DOI:10.1016/j.envsoft.2017.11.012

Riddell G.A., van Delden H., Dandy G.C., Zecchin A.C. and Maier H.R. (2018) **Enhancing the policy relevance of exploratory scenarios: Generic approach and application to disaster risk reduction**, Futures, 99, 1-15, DOI:10.1016/j.futures.2018.03.006

Newland C.P., Zecchin A.C., Maier H.R., Newman J.P. and van Delden H. **Empirically derived method and software for semi-automatic calibration of Cellular Automata land-use models**, Environmental Modelling and Software (submitted).

Van Delden H., Riddell G.A., Maier H.R., Newman J.P., Zecchin A.C., Dandy G.C. and Vanhout R. **Co-creation to support strategic disaster risk management: A generic approach for the development and use of a decision support system for risk reduction planning**, Socio-Environmental Systems Modeling, (invited paper – submitted).

REPORTS

Van Delden H, Riddell GA, Vanhout R, Newman JP, Maier HR, Zecchin AC, Dandy GC, Daniell J, Schaeffer A. 2017. **UNHaRMED – Unified Natural Hazard Risk Mitigation Exploratory Decision Support System, Technical Specification Version 1.0.** Bushfire and Natural Hazard CRC.

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Van Delden H, Riddell GA, Vanhout R, Newman JP, Maier HR, Zecchin AC, Dandy GC, Daniell J, Schaeffer A. 2017. **UNHaRMED – Unified Natural Hazard Risk Mitigation Exploratory Decision Support System, User Training, Version 1.0.** Bushfire and Natural Hazard CRC.

Riddell GA, Van Delden H, 2017. **UNHaRMED Greater Adelaide: Utilisation workshop report, July 2017**. Bushfire and Natural Hazard CRC.

Riddell GA, Van Delden H, Maier HR, 2018. **Urbanisation pressures & flood risk: Gawler River catchment and regional development.** Bushfire and Natural Hazard CRC.

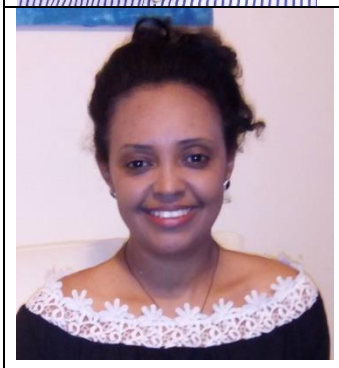
Riddell GA, Van Delden H, Bennett B, Maier HR, 2018. **Western Australia – Developing a risk reduction planning DSS: Stakeholder engagement stage 1 report, 2017**. Bushfire and Natural Hazard CRC.

Van Delden H, Riddell GA, Maier HR, Newman JP, Zecchin AC, Dandy GC, 2018. **UNHaRMED – Framework for the development and use of decision support systems for disaster risk management through co-creation.** Bushfire and Natural Hazard CRC.

Newman JP, Dandy GC, Zecchin AC, Maier HR, van Delden H, Newland CN, Riddell GA, 2018. **Simulation optimisation for natural hazard risk management.** Bushfire and Natural Hazard CRC.

TEAM MEMBERS

	Prof. Holger Maier (University of Adelaide) Project Lead Researcher, responsible for ensuring that the project delivers to contractually agreed scope and budget, and also responsible for the project communication between end-users and the project team, and communication with the cluster Lead User Representative and Lead Researcher. Also responsible for supervision of post-doctoral fellow and PhD students.
	Dr Aaron Zecchin (University of Adelaide) Deputy project leader, co-supervision of post-doctoral fellow and PhD students, oversight of optimisation and development of overall process and decision support system.
	A/Prof Hedwig van Delden (Research Institute for Knowledge Systems (RIKS) / University of Adelaide) Key researcher, responsible for running participatory workshops with end-users, data/information/model integration, application and calibration of the Metronamica land use modelling framework for those cases it will be applied to, and development of DSS software. Also responsible for supervision of post-doctoral fellow and PhD students. Accountable to the Project Lead Researcher for delivery of the prototype DSSs.
	Emeritus Prof Graeme Dandy (University of Adelaide) High level oversight on optimization and development of overall process. Workshop facilitator and co-supervision of the post-doctoral fellow.

	Graeme Riddell (University of Adelaide) Responsible for day-to-day running of the project, data and model collection and conceptualization, and stakeholder engagement processes. PhD project looks to support the integration of foresight principles and methodologies into risk assessment and management enabling more strategic responses.
	Sofanit Araya (University of Adelaide) Responsible for data analysis and processing especially for spatial information.
	Jeffrey Newman (University of Adelaide) Responsible for development and implementation of optimisation component of the project.
	Charles Newland (University of Adelaide) Spatially distributed models are an effective means for the assessment of policy and planning investment options for optimal natural hazard mitigation. To broaden the applicability of spatially distributed models and allow more effective and efficient usage by decision makers, Charles' research aims to improve their calibration procedure. Charles successfully submitted his PhD thesis in early 2018.

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1. Fraser, S., Jongman, B., Balog, S., Simpson, A., Saito, K., Himmelfarb, A., *The making of a riskier future: How our decisions are shaping future disaster risk.* Global Facility for Disaster Reduction and Recovery, The World Bank, Washington DC, USA, 2016.

2. Rose, A., et al., *Benefit-cost analysis of FEMA hazard mitigation grants.* Natural Hazards Review, 2007. 8(4): p. 97-111.