NATURAL HAZARD DECISION SUPPORT SYSTEM
Holger R. Maier, Hedwig van Delden, Aaron Zecchin, Jeff P. Newman, Graeme C. Dandy, Ariella Helfgott, Graeme Riddell, Charles P. Newland, Michael O’Flaherty
School of Civil, Environmental and Mining Engineering, The University of Adelaide, SA
RISK ASSESSMENT
“Natural disaster risk management is complex, and decision makers need to deal with uncertainty, long time frames, unquantifiable costs and benefits, and stakeholder values and expectations”

(Source: Productivity Commission Draft Report)
A Decision Support System for assessing Policy & Planning Investment Options for Optimal Natural Hazard Mitigation
A Decision Support System for the Assessment of Policy & Planning Investment Options for Optimal Natural Hazard Mitigation

How the system assesses risk

How you can use the system, what it can do for you

Work ahead and end-user engagement
How the system assesses risk

How you can use the system, what it can do for you

Work ahead and end-user engagement
Hazard

Landuse model

Flood inundation model

Terrain

Climate

Flood / Coastal Risk

Indicators:
• Building value at risk maps

Vulnerability

Building flood vulnerability curves

Building stock model

Exposure

Flood inundation model

Indicators:
• Inundation maps

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Bushfire Risk

Indicators:
- Building value at risk maps
- Building damage state maps
- Expected fatality maps

Bushfire Likelihood Model

Ignition Potential
- Historical Fire data, lightning potential data

Fire Behaviour
- 90% Weather, Fuel Group, Slope Factors

Exposure

Vulnerability

Landuse model

Building bushfire vulnerability curves

Building stock model

Bushfire fatality curves
Earthquake Risk

Indicators:
- Building value at risk maps
- Building damage state maps
- Expected fatality maps

Hazard

Earthquake ground acceleration model

Indicators:
- Acceleration maps for big, medium and small events

Soil and geological data, Vs30 data

Exposure

Landuse model

Vulnerability

Building earthquake vulnerability curves

Building stock model

Earthquake fatality curves
HAZARD RISK IS INCREASING

- Increased population and assets
- Increased value of assets
- Climate change
- Increased population in high risk areas
- Ageing population
Disaster risk can be mitigated by reducing exposure, vulnerability (and sometimes hazard).

Information

Mitigation

Land use planning

Exposure

Vulnerability

Building regulations

Risk

Hazard

(Source: Productivity Commission Draft Report)
LAND USE PLANNING IS VITALLY IMPORTANT

“Land use planning is perhaps the most potent policy lever for influencing the level of future natural disaster risk”

(Source: Productivity Commission Draft Report)
The objective of natural disaster risk management is not to reduce the level of risk to zero. 

...the resources that are allocated to risk management have to be traded off against other priorities.
A Decision Support System for the Assessment of Policy & Planning Investment Options for Optimal Natural Hazard Mitigation

How the system assesses risk

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Work ahead and end-user engagement
USING THE SYSTEM

1) Where should the system be?
2) How do I use the system?
3) What can I do with the system?
4) What does the software look like?
WHERE SHOULD THE SYSTEM BE?
HOW DO I USE THE SYSTEM?

Social learning occurs when stakeholders, modellers and facilitators explore and evaluate policy options through group interaction with the DSS — adding value over the common approach where reports are delivered using software.
WHAT CAN THE SYSTEM DO?

1) Identify areas of risk, now and into the future
2) Understand the implications of this risk, through indicators
3) Test different mitigation options
4) Identify/suggest mitigation portfolios, through sifting through a large number of mitigation options with optimisation.
Multi-hazard Mitigation Options

Structural  Management  Landuse

Sift through large number of mitigation options with optimisation

Spatially explicit, temporal, integrated model

Optimal mitigation portfolios

Portfolio 1  Portfolio 2  ...  Portfolio n

Obj. 1  Obj. 2  Obj. 3  Obj. 4  Obj. 1  Obj. 2  Obj. 3  Obj. 4

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Mitigation Investment Ratio

1:4 ratio

- Predisaster Mitigation spend
- Reduces present value of postdisaster recovery spend by factor of about 4
Mitigation Investment Ratio

- 2008-09: $390m
- 2009-10: $371m
- 2010-11: $983m
- 2011-12: $3004m
- 2012-13: $366m
- 2013-14: $2055m
- 2014-15: $171m

Response and Relief vs Mitigation
“On balance, total mitigation expenditure across all levels of government is more likely to be below the optimal level than above it, given the biased incentives towards recovery under current budget treatments and funding arrangements.”

The Australian Government “...should increase annual mitigation expenditure gradually to $200 million, distributed to the states and territories on a per capita basis.”
WHAT DOES THE SYSTEM LOOK LIKE?
Land use classes match information required for risk indicators.
<table>
<thead>
<tr>
<th>Direct costs</th>
<th>Cost</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure investment</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Upgrades</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Opportunity costs</td>
<td></td>
<td></td>
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<tr>
<td>Inefficiencies in land allocation</td>
<td>40</td>
<td></td>
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<tr>
<td>Risk reduction benefits</td>
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<tr>
<td>'Flood risk reduction</td>
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<tr>
<td>Bushfire risk reduction</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Economic benefits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic stimulus</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>470</strong></td>
<td><strong>245</strong></td>
</tr>
</tbody>
</table>

**Analysis**

**Cost/benefit**

**Policy objective scoring**

**Contingency table**
A Decision Support System for the Assessment of Policy & Planning Investment Options for Optimal Natural Hazard Mitigation

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Work ahead and end-user engagement
NEXT STEPS

• Workshops for DSS development to Victoria and Tasmania case studies (Oct/Nov 2015)

• Developing Scenarios and mitigation portfolios for Adelaide through Workshops (Oct/Nov 2015)
MAJOR OUTCOMES (1)

1) Utilisation of a **systematic** and **transparent** approach to evaluating disaster and natural hazard mitigation options (e.g. infrastructure, land use, policy).

2) The ability to make **more strategic** and **less responsive** decisions in relation to mitigating the impact of disasters and natural hazards as a result of the availability of better information.
3) The availability of prototype decision support software tools for three end-user defined case studies to enable recommended options to be identified by sifting through and evaluating and ranking a large number of options.

4) A better understanding of the trade-offs between economic and risk objectives for different mitigation options for three end-user defined case studies.
1) Prof Holger Maier (U of A – Project Leader)
2) A/Prof Hedwig van Delden (U of A / RIKS)
3) Dr Aaron Zecchin (U of A)
4) Prof Graeme Dandy (U of A)
5) Dr Ariella Helfgott (U of A)
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Information

Mitigation

Risk

Hazard

Exposure

Vulnerability

Land use planning

Building regulations

(Source: Productivity Commission Draft Report)
TODAY’S PRESENTATION

Mitigation options considered

A framework for disaster mitigation DSSs

Proposed graphical user interface to the DSS

The development and use process

Milestones and next steps
Mitigation Investment Ratio

1:4 ratio

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Response and Relief
Mitigation

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Milestones and next steps
DEVELOPMENT PROCESS

IT Specialist
System architecture
Software technology and implementation

Integrate and code models

Scientist
Model main processes
Define scale, resolution and levels of detail

Build usable and user-friendly system

End user
Deliver policy context
Define problems, functions and usage of DSS

Select policy-relevant research

Architect
Integration
Communication
Management
USE PROCESS

Facilitator
- Catalyse social learning
- Elicit knowledge through participatory techniques

Architect
Integration Communication Management

Modeller
- Apply DSS to use case
- Determine mitigation portfolios

Stakeholder
- Aim and focus of use case
- Define mitigation options and indicators

Develop scenarios
Rank mitigation portfolios

Align modelling and participation

Quantify qualitative information

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The development and use process

Milestones and next steps
1. Literature review (Delivered)
2. Framework report (Delivered)
3. Workshop report for Adelaide (Delivered)
4. Strategy report for Adelaide (in progress)
NEXT STEPS

• Scoping of other two case studies
  • Victoria
  • Tasmania

• Workshops 2 and 3 for Adelaide case study (Oct/Nov 2015)

• Workshop 1 for other two case studies (Oct/Nov 2015)
MAJOR OUTCOMES (1)

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2) The ability to make **more strategic** and **less responsive** decisions in relation to mitigating the impact of disasters and natural hazards as a result of the availability of better information.
MAJOR OUTCOMES (2)

3) The availability of **prototype decision support software tools** for **three** end-user defined **case studies** to enable recommended options to be identified by sifting through and evaluating and ranking a large number of options.

4) A better understanding of the **trade-offs between economic and risk objectives** for different mitigation options for **three** end-user defined **case studies**.
PROJECT TEAM - RESEARCHERS

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3) Dr Aaron Zecchin (U of A)
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9) Michael O’Flaherty (U of A – PhD Student)
- Robust and transparent evaluation process
- Consideration of all alternative mitigation options
- Consideration of multiple hazards

Identification of mitigation portfolios that provide the best trade-offs between risk and cost
Local Land Use

RISK MODELS
- Bushfire
- Flood
- Heatwave
- Earthquake
- Coastal Inundation
“The objective of natural disaster risk management is not to reduce the level of risk to zero.”

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Milestones and next steps
Mitigation options considered

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Milestones and next steps
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Milestones and next steps
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RISK MODELS
- Bushfire
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EXTERNAL DRIVERS
- Climate
- Demographics
- Economics

MITIGATION OPTIONS
- Spatial Planning
- Structural Measures
- Land Management
- Community Resilience / Education

LOCAL LAND USE

RISK MODELS
- Bushfire
- Flood
- Heatwave
- Earthquake
- Coastal Inundation

INDICATORS
- Integrated Risk (per Hazard)
- Benefit Cost
- Social
- Environmental
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