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COST-EFFECTIVE MITIGATION STRATEGY DEVELOPMENT FOR FLOOD PRONE BUILDINGS

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Cost-effective mitigation strategy development for flood prone buildings

Annual Report 2014

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GEOSCIENCE AUSTRALIA

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COST-EFFECTIVE MITIGATION STRATEGY DEVELOPMENT FOR FLOOD PRONE BUILDINGS

CONTEXT

What is the Problem?

Australia has experienced floods on a regular basis and some communities have been impacted repeatedly over a period of few years due to inappropriate urban development in floodplain areas. The flood events have resulted in significant logistics for emergency management and disruption to communities. They have also resulted in considerable costs to all levels of government to repair damage and enable community recovery. As evidenced in 2011, many of the structures damaged in the Queensland floods were recently rebuilt using inappropriate construction such as slab-on-grade and flood susceptible building materials.

Why is it Important?

Retrospective analysis show large benefits from disaster risk reduction (DRR) in contexts of many developed and developing countries. A study conducted by the U.S. Federal Emergency Management Agency (FEMA) found an overall benefit-cost ratio of 4 suggesting that DRR can be highly effective in future loss reduction (MMC, 2005). However, in spite of potentially high returns, there is limited research in Australia on assessing benefits of different mitigation strategies with consequential reduced investment made in loss reduction measures by individuals and governments. This is true not only at an individual level but also at national and international levels. According to an estimate, international donor agencies allocate 98% of their disaster management funds for relief and reconstruction activities and just 2% is allocated to reduce future losses (Mechler, 2005).

To address this issue the United Nations took an initiative in 2005 in the form of developing Hyogo Framework for Action (HFA) to emphasise the need of pro-active disaster investment and planning. The first phase of HFA is going to be concluded in 2015 and several activities are ongoing to define its successor (HFA2).

In 2011, the Australian Government took an initiative to develop the National Strategy for Disaster Resilience that aims to build disaster resilient communities across Australia by applying a resilience-based approach and its responsibilities shared by governments, communities, businesses and individuals (NSDR, 2011).

How are we going to solve it?

The first step towards DRR is the assessment of risk. The need to understand current risk is generally accepted but the evidence base is lacking to inform this process. Also to mitigate the risk, there is a need for supporting information on the cost-effectiveness of different mitigation strategies. Therefore research is underway at Geoscience Australia (GA) to improve the understanding of flood risk by assessing vulnerability of elements at risk. In this regard, during the last few years GA has taken a number of initiatives such as developing tools required to capture building stock information; conducting post-disaster surveys to capture empirical data; and developing vulnerability models for key Australian building types.

Building on research to date, within this BNHCRC project GA will broaden the knowledge of vulnerability of Australian building stock to flood hazard and will identify retrofitting strategies. The knowledge will serve as an evidence-base to inform decision making on the mitigation of the flood risk posed by Australian residential buildings located in flood plain environments.

BACKGROUND KNOWLEDGE

As a first step towards assessing flood impacts and risk to community a research methodology has been developed by GA to define the primary inputs. Flood impact assessment requires knowledge of the hazard, the number and nature of properties exposed and their vulnerability to flood damage as outlined by Edwards (2012). For DRR, mitigation strategies need to be developed and a cost-benefit analysis is conducted to identify the optimum retrofit option. Figure 1 presents the overall research framework.

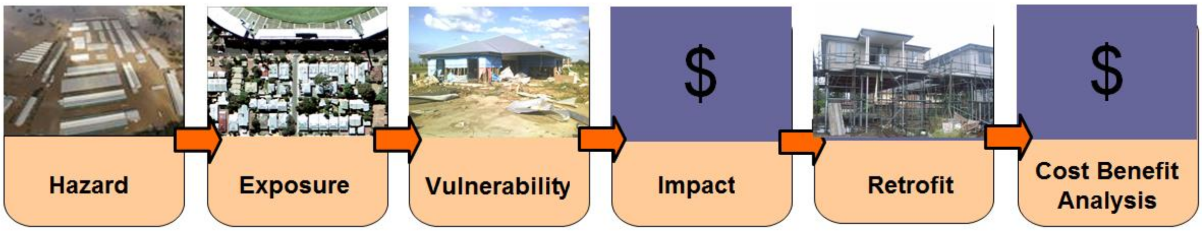
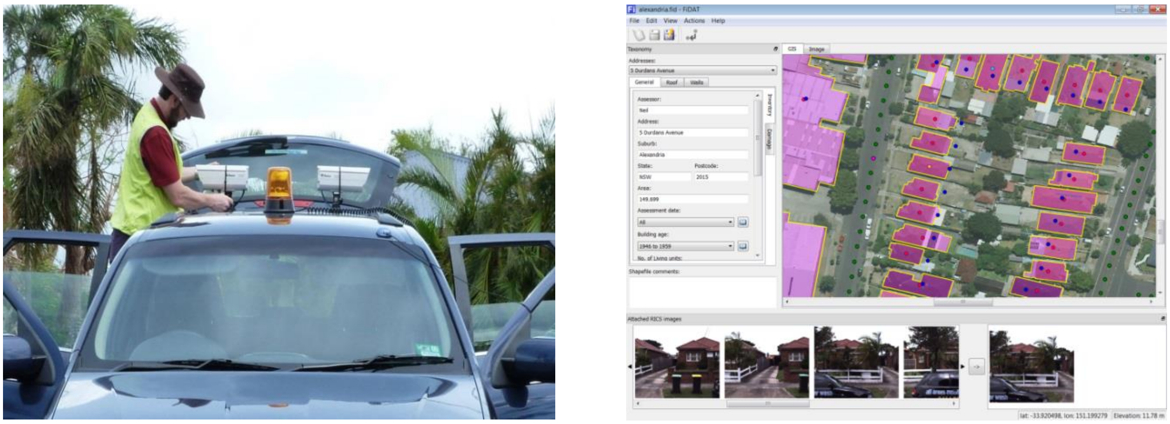


Figure 1: Research framework

The next step taken by GA is the collection of building attributes to classify the Australian residential building stock into a limited number of typical building types. GA has developed an exposure database, the National Exposure Information System (NEXIS), which provides information on building attributes at a range of resolutions (Nadimpalli, 2009). Furthermore, GA has developed the Rapid Inventory Capture System (RICS), a tool which captures street view imagery (Habili et al. 2011). The images captured by RICS can then be interrogated by the Field Data Analysis Tool (FiDAT). This tool was developed by GA to enable the interpretation of data to develop a building inventory and to assess damage. Figure 2 presents tools to capture exposure and damage information.



(A) The Rapid Inventory Collection System (RICS) (B) Interface of the Field Data Analysis Tool (FiDAT)

Figure 2: Tools developed by Geoscience Australia

After the devastating 2011 Queensland floods GA led a collaborative post-disaster survey to assess damage to residential buildings due to flood inundation. The surveys consisted of a RICS survey capturing an overview of the damage within the flood extents; foot surveys capturing detailed building attributes and damage incurred; and postal surveys to assess building repair costs and social consequences due to floods. The building information captured was utilised to develop a database which was then used to develop vulnerability models for 11 generic house types (Wehner et al. 2012). An example vulnerability model is shown in Figure 3. To augment the vulnerability models for other building types further 8 vulnerability models were developed within the Alexandra Canal flood study project (Maqsood et al. 2013).

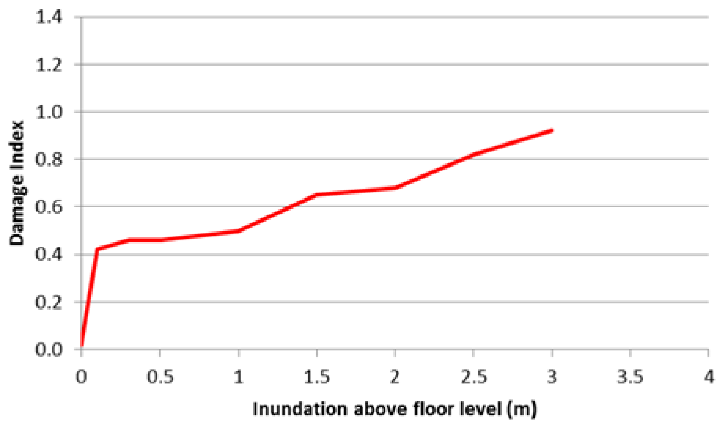


Figure 3: An example of a flood vulnerability model

PROJECT ACTIVITIES

This research project will draw upon and extend existing research and capability within both academia and government to develop information that will inform policy, business and private individuals on their decisions concerning vulnerability reduction. The detailed scope and strategy to be followed for this project is outlined under key activities below:

• **Classification of flood prone Australian buildings into vulnerability classes**.

While an almost infinite variety of individual building forms are found in Australian communities, these needs to be categorised into a limited number of types based on the building features that influence flood vulnerability. During the first financial year of the project, a literature review has been conducted to study 7 published schemas developed in the United States of America (HAZUS), New Zealand (RiskScape), Germany (Bauhaus-University Weimar), Philippines (Greater Metro Manila Risk Assessment Project), Australia (NSW Office of Environment& Heritage and Geoscience Australia) and for the United Nation's Global Assessment of Risk 2015 Report (GAR15).

From the review, key building attributes required to define a schema for Australian building stock are identified. The selected key attributes adopted for this research are *Construction Period*, *Fit-out Quality*, *Storey Height*, *Bottom Floor System*, *Internal Wall Material* and *External Wall Material*. These attributes help to define the building types that represent the variety of housing within the nation's building stock and, more specifically, the variation in vulnerability across the nation's building stock.

Based on these 6 attributes a new building schema has been proposed for this project. The proposed schema divides each building into the sub-elements of foundations, bottom floor, upper floors (if any) and roof to describe its vulnerability. Through this arrangement it is possible to assess vulnerability of structures with different construction material used in different floors and also to assess vulnerability of tall structures where only bottom floors are expected to be inundated. From this schema, a limited number of building types will be selected for the balance of this research (summarised below) representing those contributing most to community flood risk through their vulnerability and predominance.

• **Literature survey of existing flood mitigation options for buildings**.

Strategies have been developed by researchers, government agencies and practitioners in a number of countries to address the vulnerability of buildings to flood. However, the appropriateness of strategies and associated material choices as to cost effectiveness for Australian buildings is unclear and gaps in approaches exist. In this research existing publically available research on retrofitting of flood prone buildings, their components and the strength implications of immersion of key structural elements will be examined to ascertain where deterioration due to wetting and subsequent drying needs to be addressed as part of repair strategies and pre-emptive mitigation options.

• **Development of Australian specific retrofit options and costing**.

New strategies will be developed as required and all appropriate strategies will be costed for key building types through the engagement of quantity surveying specialists. The research may also entail experimental testing of preferred material types to ascertain their resilience to flood water exposure.

• **Vulnerability assessment for current and retrofitted building types**.

Vulnerability of selected building types to a wide range of inundation depths will be assessed and supplemented by both a significant body of flood vulnerability research by GA and a body of damage and socio-economic survey activity in Australia. The outputs of this research will be suitable for use in other CRC research concerning risk assessment and impact forecasting in the immediate aftermath of an actual event.

• **Benefit-cost analysis for key retrofit strategies and new construction options**

Retrofit options entail an investment that will realise a benefit over future years through reduced average annualised loss due to severe flood exposure. Decisions to invest in reducing building vulnerability, either through asset owner initiatives or the provision by government or the insurance industry incentives, will depend upon the benefit versus cost of the retrofit. In this exercise all retrofit options will be assessed through a consideration of a range of severity and likelihood of flood hazard covering a selection of catchment types.

PROJECT OUTCOME

The work will provide information on the retrofit types suitable for Australian building types and associated cost-benefit analysis. The output will be an evidence-base to inform decision making on the mitigation of the community risk posed by Australian residential buildings located in flood plain environments. The outcomes will be communicated to stakeholders through workshops, reports and conference/journal publications.

PROJECT STAUS AT THE END OF 2013/2014

List of current integrated project team members

Lead Researcher:	Dr Tariq Maqsood (Geoscience Australia)
Researchers:	Mr Martin Wehner (Geoscience Australia)
	Dr Ken Dale (Geoscience Australia)
Lead End users:	Dr Leesa Carson (Geoscience Australia)
	Mr Ralph Smith (WA DFES)
End users:	Mr Duncan McLuckie (NSW OEH)
	Mr Greg Howard (SA SAMFS)
	Mr Shane Turner (SA DPTI)
	Mr Elloitt Simmons (NSW SES)
	Mr Corey Shackleton (NSW RFS)
	Mr Greg Buckley (NSW F&R)

Project meetings held in 2013/2014:

- Hardening Buildings and Infrastructure Cluster meeting. Melbourne. 18 December 2013.
- BNHCRC Research Advisory Forum. Adelaide. 18-20 March 2014.

Reports issued in 2013/2014:

- Project Management Plan
- 1st Quarterly Report (January 2014 - March 2014)
- 2nd Quarterly Report (April 2014 - June 2014)
- Report on Australian Building Stock Classification
- Annual Report 2014

Agreements:

- BNHCRC research Contract for Cost-Effective Mitigation Strategy Development for Flood prone Buildings

REFERENCES

- Edwards, M. 2012. Impact assessment framework. A report submitted by Geoscience Australia to Department of Climate Change and Energy Efficiency. June 2012.
- Habili, N. 2011. Open-source tools for field data collection and analysis at Geoscience Australia, Open Source Developers Conference Canberra, available at: http://2011.osdc.com.au/schedule/#opensourcetoolsfo (accessed December 2012).
- Nadimpalli, K. 2009. National exposure Information System (NEXIS) – A Capability for Evidence Based disaster Management. Proc. 7th FIG Regional Conference Spatial Data Serving People: Land Governance and the Environment – Building the Capacity Hanoi, Vietnam.
- Maqsood, S.T., Senthilvasan, M., Corby, N., Wehner, M. and Edwards, M. 2013. Improved assessment of flood impact: an urban storm water case study of a City of Sydney catchment. Proc. Floodplain Management Association National Conference, Tweed Heads, Australia.
- Mechler, R. 2011. Cost-benefit analysis of natural disaster risk management in developing countries. Eschborn. Deustche Gesellschaft fur Technishche Zusammenarbeit (GTZ).
- MMC. 2005. Natural hazard mitigation saves: an independent study to assess the future savings from mitigation activities. Vol. 2-study documentation. Washington DC: Multi-hazard Mitigation Council.
- NSDR, 2011. National Strategy for Disaster Resilience. Council of Australian Governments. Attorney-General’s Department. February 2011. 25pp. ISBN: 978-1-921725-42-5
- Wehner, M., Maqsood, S.T., Corby, N., Edwards, M. and Middelmann-Fernandes, M. 2012. Augmented vulnerability models for inundation. Technical report submitted to DCCEE. Geoscience Australia, Canberra, Australia.