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COST-EFFECTIVE MITIGATION STRATEGY DEVELOPMENT FOR FLOOD PRONE BUILDINGS

Annual Report 2018-2019

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Cover: Flood mitigation strategy: elevating floor level (Geoscience Australia)

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ACKNOWLEDGMENTS

The project team would like to thank the significant contributions to date towards project outcomes from a wide variety of stakeholders. The following contributors are gratefully acknowledged:

- City of Launceston
- Launceston Flood Authority
- Tasmanian Department of Premier and Cabinet
- Northern Midlands Council
- Tasmanian State Emergency Service
- National Flood Risk Advisory Group (NFRAG)
- Floodplain Management Australia (FMA)
- Australian Institute for Disaster Resilience (AIDR)
- Insurance Australia Group
- Insurance Council of Australia
- Wagga Wagga City Council
- Tweed Shire Council
- Brisbane City Council
- Bundaberg Regional Council
- BMT WBM
- University of Western Australia
- City of Sydney
- NSW State Emergency Service
- Suncorp Insurance

EXECUTIVE SUMMARY

The motivation for this project arises from the experience and observations made during the 2011 and 2013 floods in Australia, which caused widespread devastation in Queensland. Considerable costs were sustained by all levels of government and property owners to effect damage repair and enable community recovery.

A fundamental reason for this damage was inappropriate development in floodplains and a legacy of high risk building stock in flood prone areas. The vulnerability and associated flood risk is being reduced for newer construction by adopting new standards (ABCB, 2012), building controls and land use planning, however, the vulnerability associated with existing building stock remains. This vulnerability contributes disproportionally to overall flood risk in many Australian catchments.

The Bushfire and Natural Hazards Collaborative Research Centre (BNHCRC) project entitled "Cost-effective mitigation strategy development for flood prone buildings" aims to address this issue and is targeted at assessing mitigation strategies to reduce the vulnerability of existing residential building stock in Australian floodplains. The project addresses the need for an evidence base to inform decision making on the mitigation of the flood risk posed by the most vulnerable Australian houses and complements parallel BNHCRC projects for earthquake and severe wind.

To date, the project within the BNHCRC has developed a building classification schema to categorise Australian residential buildings into a range of typical storey types. Mitigation strategies developed nationally and internationally have been reviewed. A floodproofing matrix has been developed to assess appropriate strategies for the selected storey types. All appropriate strategies have been costed for the selected storey types through the engagement of quantity surveying specialists. Vulnerability for a range of inundation depths has been assessed after implementing appropriate mitigation strategies for the five selected storey types.

Furthermore, selected building materials/systems have been tested to ascertain their resilience to floodwater exposure. These tests were aimed at addressing knowledge gaps in the areas of strength and durability of building materials during immersion.

A research utilisation project with NFRAG, AIDR and FMA as key stakeholders commenced in 2018. The project will develop new vulnerability functions and make these available alongside a broader body of other flood vulnerability research to the floodplain management community.

In future years (2019-2020) of this project, cost benefit analyses will be conducted to determine optimum retrofit strategies for selected residential buildings for a range of catchment behaviours. The result will be an evidence base to inform decision making by government and property owners on the mitigation of flood risk by providing information on the cost effectiveness of different mitigation strategies.

END-USER PROJECT IMPACT STATEMENT

Leesa Carson, *Geoscience Australia, ACT*

Floods historically have, and continue to, cause widespread damage and disruption to Australian communities. This project is developing an important evidence base to assist governments and householders make informed decisions on reducing flood risk through retrofit of existing houses to reducing flood vulnerability.

During the past year the project has progressed its scheduled tasks building on the achievements of the previous years. A key deliverable was the finalisation of reporting on Milestone 1.4.1 on retrofitted vulnerability. The report described work in which mitigation strategies were applied to five common storey types found in Australian residential buildings and the resultant reduction in their susceptibility to flood was quantified.

The next major task in the core research program is the cost versus benefit analysis of the mitigation options and work is moving forward in the collection of data necessary to undertake this task. The team has worked collaboratively with IAG in evaluating methods for characterising Australian floodplains and has assembled flood hazard information at a variety of recurrence intervals for selected communities of interest: Murwillumbah, Tweed heads, Wagga Wagga and Launceston. Work towards developing building exposure information has also progressed well for the communities of interest. Information provided by local governments has been further augmented by the project team, typically determining the building area and age. Next steps will be the cost benefit analysis itself.

Similarly, the utilisation project that commenced in the previous year has continued to progress. The project aims to develop a suite of new vulnerability functions for use by floodplain managers or others with an interest in flood impact and risk who may not have detailed exposure information. Key stakeholders including the BNHCRC, the National Flood Risk Advisory Group (NFRAG), the Australian Institute for Disaster Resilience (AIDR) and Floodplain Management Australia (FMA) were updated on progress at a workshop in Melbourne in April. At that workshop draft vulnerability curves were presented and discussed, along with a typology for describing Australian communities exposed to flood and the selection of a number of case –study communities. Work continues on this project which has the potential for broad utilisation.

Aside from the workshop and standard reporting to the BNHCRC, oral presentations at the FMA conference in Canberra in May and the International Conference on Natural Hazards and Infrastructure in Greece in June have been important mechanisms for disseminating research outcomes.

As lead end user I am pleased with the progress being made by this project, and look forward to the utilisation of project outcomes aiding in the reduction of flood risk to our communities.

INTRODUCTION

Globally, floods cause widespread damage with loss of life and property. An analysis of global statistics conducted by Jonkman (2005) showed that floods (including coastal flooding) caused 175,000 fatalities and affected more than 2.2 billion people between 1975 and 2002. In Australia floods cause more damage on an average annual cost basis than any other natural hazard (HNFMSC, 2006). The fundamental cause of this level of damage and the key factor contributing to flood risk, in general, is the presence of vulnerable buildings constructed within floodplains due to ineffective land use planning.

Retrospective analysis show large benefits from disaster risk reduction (DRR) in the 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 four 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, 2011).

The Bushfire and Natural Hazards Collaborative Research Centre project entitled 'Cost-effective mitigation strategy development for flood prone buildings' is examining the opportunities for reducing the vulnerability of Australian residential buildings to riverine floods. It addresses the need for an evidence base to inform decision making on the mitigation of the flood risk posed by the most vulnerable Australian building types and complements parallel BNHCRC projects for earthquake and severe wind.

This project investigates methods for the upgrading of the existing residential building stock in floodplains to increase their resilience in future flood events. It aims to identify economically optimum upgrading solutions so the finite resources available can be best used to minimise losses, decrease human suffering, improve safety and ensure amenity for communities.

This 2018-19 Annual Report describes the activities undertaken to date and their potential for utilisation in accordance with the BNHCRC focus on research utilisation.

BACKGROUND

In Australia, floods cause more damage on an average annual cost basis than any other natural hazard. Figure 1 shows the Average Annual Losses (AAL) by disaster type in Australia from 2007 to 2016 (DAE, 2017). The fundamental cause of this level of damage and the key factor contributing to flood risk, in general, is the presence of vulnerable buildings constructed within floodplains due to ineffective land use planning.

The Australian Government has developed a national strategy which defines the roles of government and individuals in improving disaster resilience (NSDR, 2011). The Australian Government also emphases the responsibility of governments, businesses and households on assessing risk and taking action to reduce the risk by implementing mitigation plans (Productivity Commission, 2014).

Community level mitigation options such as levees, dams and retention basins have been implemented by governments in many catchments in Australia but there always remains a residual risk. Recently there has been a growing body of research both nationally and internationally that measures the potential of reducing flood risk by implementing property level flood mitigation options (Kreibich et al. 2011; Thieken et al. 2016).

The Bushfire and Natural Hazards Collaborative Research Centre project entitled 'Cost-effective mitigation strategy development for flood prone buildings' (BNHCRC, 2019) is examining the opportunities for reducing the vulnerability of Australian residential buildings to riverine floods. It addresses the need for an evidence base to inform decision making on the mitigation of the flood risk posed by the most vulnerable Australian building types and complements parallel BNHCRC projects for earthquake and severe wind.

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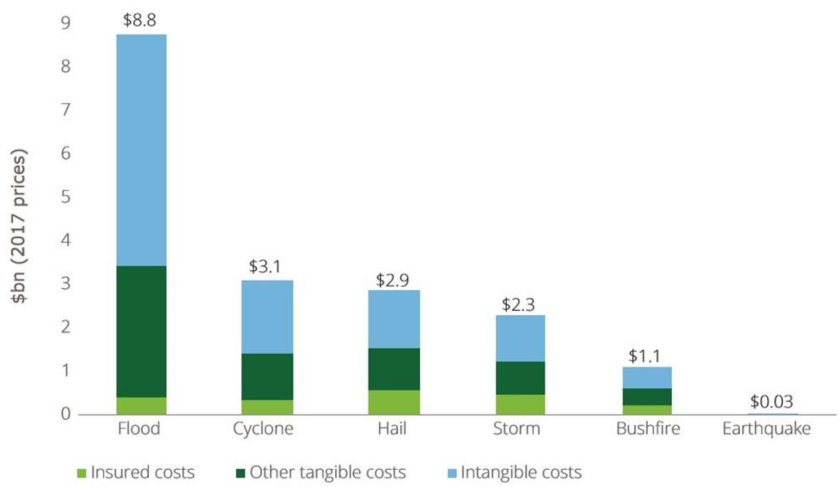


FIGURE 1: AVERAGE AANUAL LOSSES BY DISASTER TYPE IN AUSTRALIA FROM 2007 TO 2016 (DAE, 2017)

The objective of this project is to provide an evidence base for two target groups to inform their decision making process around mitigation against flood risk: government and property owners. Federal, State/Territory and local governments have an interest in the losses arising from past or future flood events and require vulnerability information to support several objectives including decision making concerning the allocation of funding and risk management. Property owners are also interested in vulnerability and mitigation assessment to better understand the potential risk to their properties due to floods and to make decisions on undertaking mitigation measures to reduce risk and (possibly) their insurance premiums (Meyer et al. 2012).

RESEARCH APPROACH

Information on the vulnerability of buildings and factors affecting vulnerability is fundamental to evaluating mitigation strategies to reduce future losses. Therefore, this BNHCRC project is systematically developing information about residential building types in Australia, their vulnerability and possible mitigation measures to reduce their vulnerability.

The research approach and associated milestones broadly align with the activities mentioned in the above paragraph:

- a building classification schema has been developed to categorise Australian residential buildings into a finite set of typical building types.
- a literature review of flood mitigation strategies applied internationally has been conducted.
- an experimental program has been undertaken to examine the impact of immersion in water (simulating slow flood water rise and fall) on structural and other building components.
- each mitigation strategy has being evaluated and costed through the engagement of professional quantity surveyors.
- cost benefit analyses will be conducted to determine optimum retrofit strategies for selected building types applicable to a range of catchment behaviours.

Each of these research activities is described further in the following sections of this report.

KEY MILESTONES

The first four milestones were completed by the end of June 2017 in line with the project schedule and the fifth is progressing as scheduled. A summary of the project activities is provided below:

BUILDING CLASSIFICATION SCHEMA

Following a literature review a new schema was proposed in this project to categorise Australian residential building stock into a limited number of typical storey types. It was a fundamental shift from describing the complete building as an entity to one that focuses on sub-components. The proposed schema divided each building into the sub-elements of foundations, bottom floor, upper floors (if any) and roof to describe its vulnerability (see Figure 2).

Through this approach it was made possible to assess the vulnerability of structures with different usage and/or construction materials used in different floors, and also to assess the vulnerability of tall structures with basements where only basements and/or bottom floors are expected to be inundated (Maqsood et al. 2015a). The schema classified each storey type based on six attributes: construction period, fit-out quality, storey height, bottom floor, internal wall material and external wall material.

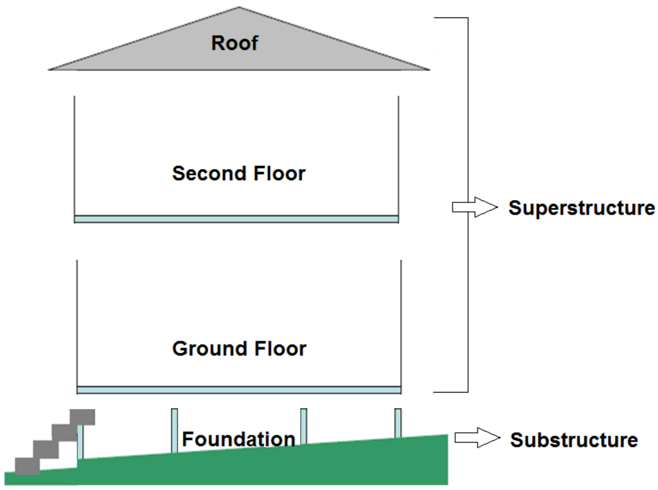


FIGURE 2: SCHEMATIC DIAGRAMS OF EACH TEST TYPE (MAQSOOD ET AL., 2015A)

LITERATURE REVIEW OF FLOOD MITIGATION STRATEGIES

The succeeding task completed in this project was the literature review of mitigation strategies developed nationally and internationally. The review helped to evaluate the strategies that suit Australian building types and typical catchment behaviours for adoption in Australia. The review categorised mitigation strategies into five categories: elevation, relocation, dry floodproofing, wet floodproofing and flood barriers (Maqsood et al. 2015b).

DEVELOPMENT OF COSTING MODULES FOR SELECTED MITIGATION OPTIONS

A list of building materials typically used in Australian residential construction was developed. This list helped to identity predominant construction materials and storey types in Australia and also informed the development of costing modules. Five typical residential storey types were selected for the balance of the research which was a subset of the schema described earlier in this report. Key characteristics of these storey types are presented in Table 1.

TABLE 1: CHARACTERISTICS OF SELECTED STOREY TYPES

Storey Type	Constructio n period	Bottom floor system	Fit-out quality	Storey height	Internal wall material	External wall material	Photo
1	Pre-1960	Raised Timber	Low	2.7m	Timber	Weather-board	
2	Pre-1960	Raised Timber	Low	3.0m	Masonry	Cavity masonry	
3	Pre-1960	Raised Timber	Low	2.4m	Masonry	Cavity masonry	
4	Post-1960	Raised Timber	Standard	2.4m	Plasterboard	Brick veneer	
5	Post-1960	Slab-on-grade	Standard	2.4m	Plasterboard	Brick veneer	

Further, based on the characteristics of the selected storey types a floodproofing matrix was developed which excluded the mitigation options that were invalid in the Australian context. Costing modules (see Table 2) were developed by quantity surveying specialists to estimate the cost of implementing all appropriate mitigation strategies for the five storey types (Maqsood et al., 2016a).

TABLE 2: COST OF IMPLEMENTING FLOOD MITIGATION STRATEGISES TO EXISTING BUILDINGS FOR SELECTED STOREY TYPES (MAQSOOD ET AL., 2016A)

Storey Type	Elevation-Extending the walls ($)	Elevation-Building a second storey ($)	Elevation-Raising the whole house ($)	Relocation ($)	Flood Barriers (Permanent) ($)		Flood Barriers (Temporary) ($)			Dry Flood-proofing ($)	Wet Flood-proofing ($)	
					1.0m high	1.8m high	0.9m high	1.2m high	1.8m high		Existing structure	Substantial Renovation
1	N/A	N/A	78,200		N/A	N/A	N/A	N/A	N/A	N/A	11,700	68,000
2	N/A	213,500	N/A	N/A	133,500	177,600	62,500	111,800	136,300	N/A	15,400	56,600
3	397,700	429,700	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17,400	104,300
4	N/A	405,200	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15,500	140,000
5	N/A	431,000	N/A	N/A	154,300	208,300	164,600	144,100	176,200	$154,320	17,400	149,800

EXPERIMENTAL TESTING OF SELECTED BUILDING MATERIALS

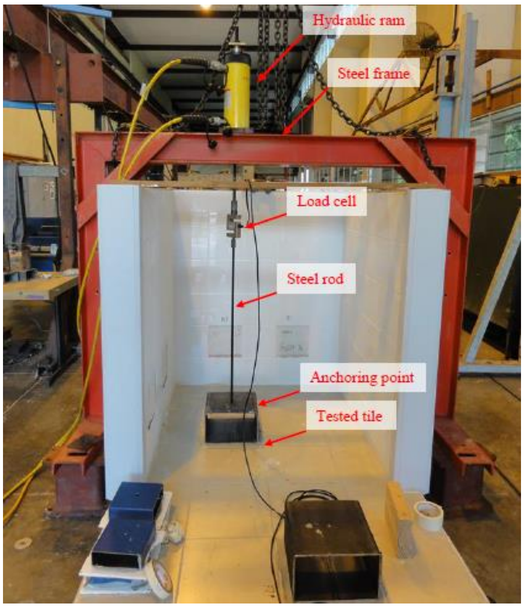
In this project the strength and durability implications of immersion of key structural elements and building components in conditions of slow water rise were examined to ascertain where deterioration due to wetting and subsequent drying needed to be addressed as part of repair strategies (Maqsood et al., 2017a; Maqsood et al., 2018a; Maqsood et al., 2018b).

The experimental program examined the bond strength of floor and wall ceramic tiles to their substrate with the objective of determining the necessity or otherwise of replacing all tiles following inundation (see Figure 3). The experiments also explored the racking strength of Oriented Strand Board (OSB) and High Density Fibreboard (HDF) sheet wall bracing, and the bending and shear strength of engineered timber joists.

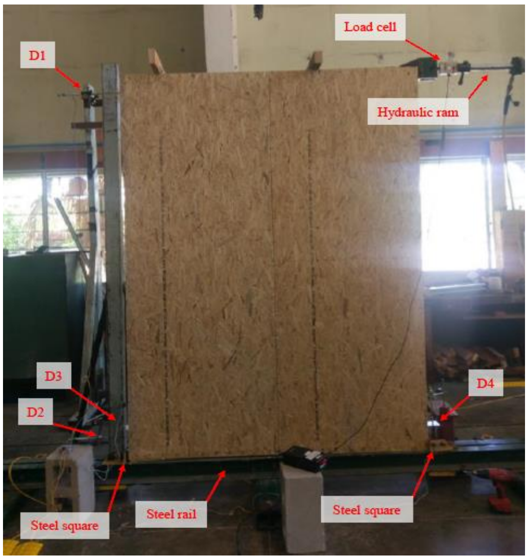
The results showed that flooding did not cause any significant effect on most of these materials. The bond strength of the ceramic tiles to their substrate, and the racking strength of the OSB wall sheet bracing after drying were unaffected. Results demonstrated that there was no significant variation in stiffness of the OSB and HDF wall sheet bracing that were exposed to floodwater to those that were not exposed to the flooding.

However, there was a significant reduction (46%) in load carrying capacity of the timber joists when tested in the wet condition. Moreover, the stiffness of floor joist samples was significantly reduced when in the wet state. These results suggest that the floor joist samples whilst saturated may be compromised due to reduced strength and stiffness.

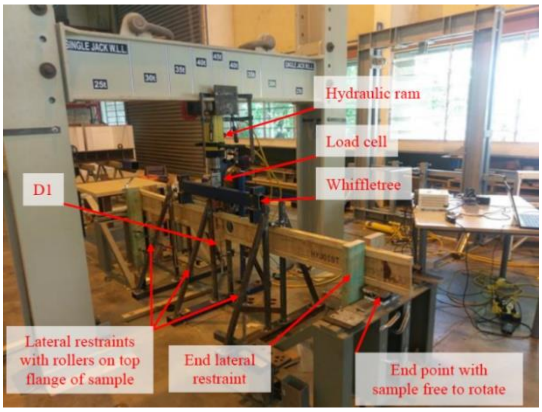
It was also observed that the moisture content level in all the tested components returned close to pre-inundation level within a week after the test.



(A) TILED SURFACES WITHIN A TYPICAL BRICK VENEER, SLAB-ON-GROUND HOUSE



(B) MANUFACTURED SHEET WALL BRACING



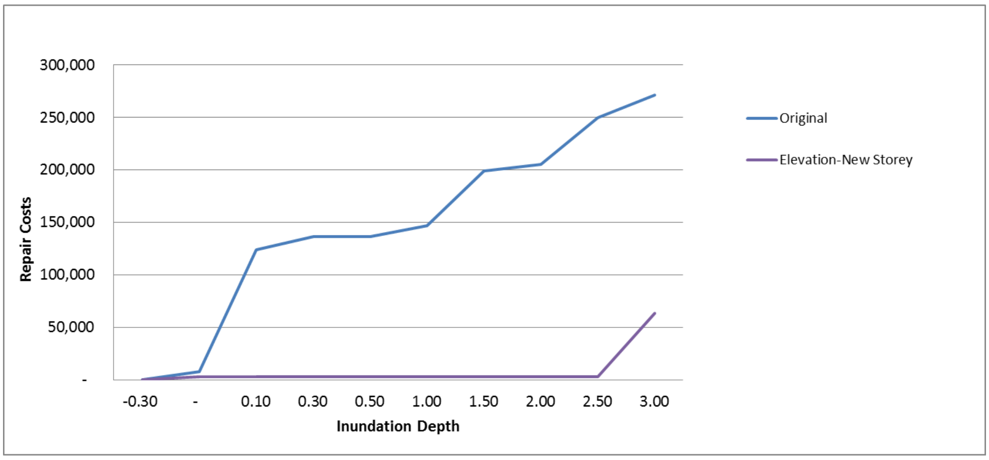
(C) ENGINEERED TIMBER JOISTS

FIGURE 3: TESTING ARRANGEMENTS

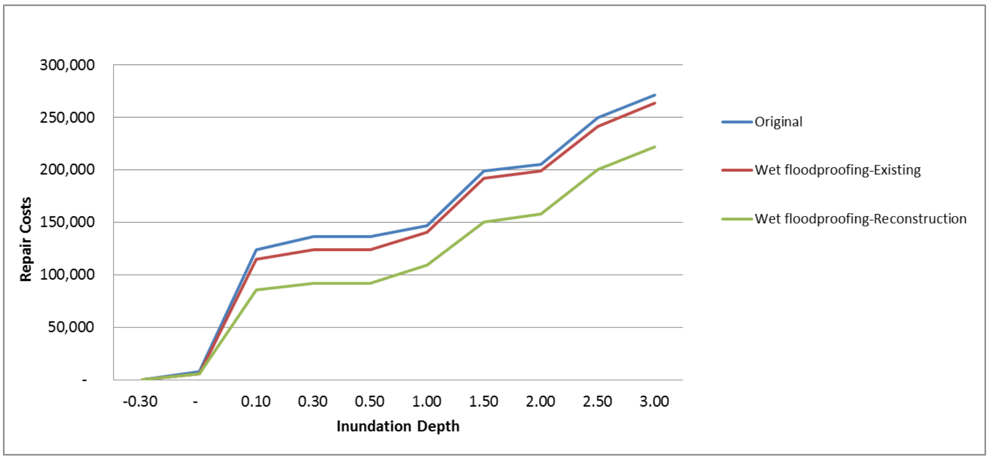
VULNERABILITY ASSESSMENT FOR CURRENT AND RETROFITTED BUILDING TYPES

The vulnerability of selected building types to a wide range of inundation depths was assessed and supplemented by a significant body of flood vulnerability research by Geoscience Australia. An example of implementing appropriate mitigation measures considered for the slab-on-grade brick veneer (Storey type 5) and resulting vulnerability models is shown in Figure 4.

(A) Original vs Elevation



(B) Original vs Wet Floodproofing



(C) Original vs Flood Barriers

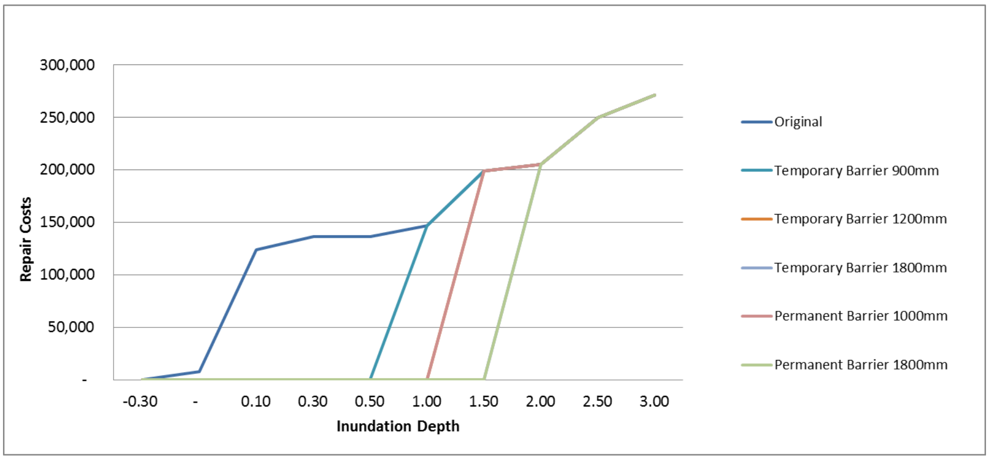


FIGURE 4: VULNERABILITY MODELS FOR STOREY TYPE 5: BRICK VENEER (SLAB-ON-GRADE)

This activity considered appropriate strategies for five selected storey types during two construction regimes: existing state (pre-event) and during substantial renovation or post-event reconstruction. Detailed outcomes were reported by Maqsood et al (2018).

It was observed that elevating a structure through a variety of techniques can significantly reduce flood risk. The use of flood barriers if sourced and placed on time can also result in a significant reduction in modelled flood damage. Barriers are only effective while floodwaters remain below their design height however. There is less scope for implementing wet floodproofing strategies to existing buildings as compared to new construction or where substantial renovation is being conducted. However, in the former case the mitigation investment is also quite low and therefore a comprehensive cost-benefit analysis is required to assess the optimal mitigation option for a particular storey type. Moreover, the characteristics of catchments in terms of expected flood depths for a range of flood severities will be critical in evaluating the best mitigation option.

BENEFIT VERSUS COST ANALYSIS AND OPTIMAL COST EFFECTIVE MITIGATION STRATEGIES

Retrofit options entail an investment that will realise a benefit over future years through reduced average annualised loss caused by 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. The work will provide information on the optimal retrofit types and design levels in the context of Australian construction costs and catchment behaviours.

Four locations have been identified for study at this time: Murwillumbah (NSW), Tweed Heads (NSW), Wagga Wagga (NSW), and Launceston (Tasmania). The following sections detail progress to date in accessing and preparing the data required to undertake the benefit versus cost analyses.

Catchment Type Definition

The project team investigated ways of defining catchment behavior in an attempt to cover as many situations as possible (ie catchment behavior and building stock variation) in the benefit versus cost analyses. Through a collaboration agreement between IAG and Geoscience Australia the team has been able to access flood studies held in IAG's database.

The method the team has used is to take flood depths for a range of Average Recurrence Intervals (ARIs) for all residential buildings within the 100 year ARI flood extent map and fit a curve through the points. The slope of the curves from a number of flood studies can be used to characterise catchments into three typical types (low, medium, high) based on selected definition/criteria.

As an example Figure 5 shows results from a number of different catchments with average flood depth plotted against ARI. The 'steepness' of the regressed line will be used in defining catchments into three types as discussed in the previous point. In turn, this relativity in flood depth versus ARI will feed into the economic evaluation for each retrofit measure if implemented for each catchment type.

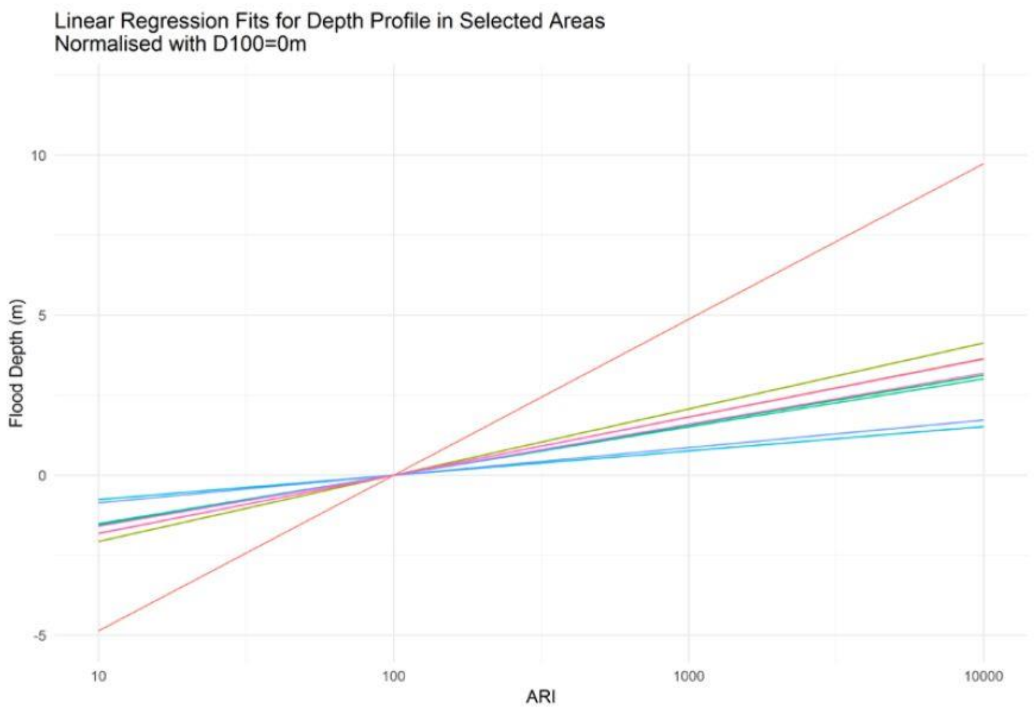


FIGURE 5: EXAMPLES OF CATCHMENT 'STEEPNESS' USING IAG FLOOD DATABASE

Flood Hazard Information

Flood hazard information at a range of recurrence intervals is necessary for the assessment of cost versus benefit for the mitigation options.

The Tweed Shire Council provided flood mapping for Murwillumbah and Tweed Heads in Geographic Information System (GIS) format for ARIs of 5, 20, 100, and 500 years in addition to the probable maximum flood (PMF).

Similarly the Wagga Wagga City Council provided flood maps in GIS format for ARIs of 10, 20, 50, 100, 200 and 500 years, in addition to the PMF.

Launceston data had been previously acquired for use in the Launceston Flood Risk Mitigation Assessment Project (Maqsood et al., 2017) with the Launceston City Council (LCC, 2011) providing information for the 20, 50, 100, 200 and 500 year ARIs, subsequently a consultant was engaged to develop the hazard maps for the 1,000 year ARI and the PMF (BMT WBM, 2016).

Building Exposure Information

Detailed building exposure information is required to undertake the cost benefit analysis at a building-by-building level of resolution. The project team has assembled detailed building exposure information for four locations to date, as described below.

Murwillumbah, NSW

Building data for Murwillumbah was shared under licence by the Tweed Shire Council. The Council was able to provide data in a GIS format with building information including location, floor level height, property type (residential, commercial, industrial), and primary building material (brick, weatherboard etc). The data was enhanced by the project team to include information that would enable the assignment of detailed flood vulnerability models to each building. Key additional features included the building area and the broad building age.

Building area was evaluated by digitising roofprints of buildings using available imagery in the GIS. As this was a time consuming manual process only the buildings within the PMF extent were digitised. Building age definition was determined as 1961 and earlier or 1962 and later. Age attributions were undertaken using aerial imagery sourced within Geoscience Australia's imagery repository. Comparing images pre-and post-1961 allowed ages to be assigned to buildings. A total of 1,859 buildings within the PMF extent were compiled in the Murwillumbah database.

Tweed Heads, NSW

Tweed Heads exposure information was compiled in the same way as for Murwillumbah. Data provided by Tweed Shire Council and then enhanced by the project team. Buildings within the PMF zone had their roofprints digitised and ages were attributed through comparing aerial imagery pre- and post 1961. In this case the imagery was freely accessed through the Queensland Government's QImagery website (https://qimagery.information.qld.gov.au/). A total of 4,821 buildings were compiled in the Tweed Heads exposure database.

Wagga Wagga, NSW

Wagga Wagga City Council provided building exposure information in a GIS format. Building attributes included location, whether they were commercial or residential, the number of storeys and the floor height. Additional data was available following a comprehensive survey of light industrial buildings in Wagga Wagga by Geoscience Australia in 2013. The building information provided by Wagga Wagga City Council is currently being enhanced by the project team, with footprinting underway.

Launceston, TAS

Launceston building exposure information was pre-existing within the flood research project, having been assembled and used in the Launceston Flood Risk Mitigation Assessment Project (Maqsood et al., 2017). From that report:

> The exposure database was compiled for all buildings (2,656 in total) within the mapped PMF extent by sourcing building attributes from GA's National Exposure Information System - NEXIS (GA, 2017). This database was supplemented by a desktop study utilising Google street view imagery to record additional building attributes. Floor height information was provided by the LCC for all buildings within the 500 ARI extent map. For all the remaining buildings exposed to rarer events a desktop study was conducted to assess floor height for each building.

UTILISATION AND IMPACT

SUMMARY

In addition to the core work program of this project, two utilisation projects through the BNHCRC have also been undertaken. The costs and benefits of flood risk mitigation in Launceston was a study commissioned to examine the effectiveness of a flood levee system upgrade that commenced in 2010 and was completed in 2014 prior to floods in 2016. The study was completed in 2017.

A further utilisation project commenced in 2018 with an aim of translating vulnerability information (existing and mitigated) developed by Geoscience Australia (GA) into practical guidance for flood risk managers undertaking studies under the floodplain-specific management process as outlined in AEM Handbook 7 (AIDR 2017). This work is still currently underway. The utilisation projects are described further in the following sections.

COSTS AND BENEFITS OF FLOOD RISK MITIGATION IN LAUNCESTON

Output Description

This utilisation project reviewed the costs and benefits of flood mitigation work (upgraded levees) in Launceston, Tasmania. The upgrade of the levee system began in 2010 and was completed in 2014. Severe flooding in Launceston in 2016 provided an opportunity to assess the cost and benefit of the levee system.

The flood mitigation through the levee system in did not extend to the suburb of Newstead in the east of Launceston and a new levee was proposed to protect these properties from future floods. As part of the utilisation activity the project team also conducted a cost benefit analysis of the proposed flood levee in Newstead. This piece of work also afforded the opportunity to include intangible losses due to mental health, social disruption, amenity, safety and a number of other intangible mechanisms.

Extent of Use

- This work was undertaken with a number of end-user stakeholders who have been able to utilise the outputs from this activity:
    - City of Launceston
    - Launceston Flood Authority
    - Tasmanian Department of Premier and Cabinet
    - Northern Midlands Council
    - Tasmanian State Emergency Service
- The outcomes of the utilisation project were also included in a submission to the Independent Review into the Tasmanian Floods of June and July 2016 (Blake, H. 2017).

Utilisation Potential

- There is potential for further utilisation related to this work. The flood hazard for Launceston has been reassessed following the 2016 floods with the hazard reported to have increased (Leister, J. 2019). Climate change has also been considered and found to siginificantly exacerbate future flood hazard. A logical extension to this work would be to reassess the cost versus benefit analysis using the updated hazard and the project team plans to pursue this.
- This activity also featured the project team incorporating intangible costs in the estimation of losses for the first time. The inclusion of these types of costs helps in creating a more holistic picture of impact due to an event. There is ongoing potential for the inclusion of these types of costs in project activities, particularly in assessing the effectiveness of mitigation measures.

Utilisation Impact

- The outcomes of the cost benefit analysis into the Launceston levee system were quoted and referenced in the report on the independent review into the floods (Blake, H. 2017).

Utilisation and Impact Evidence

Blake, H.M. 2017. Report of the independent review into the Tasmanian floods of June and July 2016. Department of Premier and Cabinet. Hobart, Australia.

Maqsood, T., Wehner, M., Mohanty, I., Corby, N., Edwards, M. 2017. Costs and benefits of flood mitigation in Launceston. Hazard Note, Issue 40. October 2017. Bushfire and Natural Hazards CRC, Melbourne, Australia.

Maqsood, T., Wehner, M., Mohanty, I., Corby, N., Edwards, M., Gibson, F., Rogers, A. 2017. Launceston flood risk mitigation assessment project – Suburb of Newstead. Bushfire and Natural Hazards CRC, Melbourne, Australia.

Maqsood, T., Wehner, M., Dale, K., Edwards, M., Mohanty, I., Corby, N., Gibson, F., Rogers, A. 2019. Assessing tangible and intangible flood impacts in Newstead, Launceston. Proc. Floodplain Management Association National Conference, Canberra, Australia.

FLOOD DAMAGE MODELS FOR FLOODPLAIN MANAGEMENT

Output Description

This utilisation project aims to provide advice on assessing flood impact and risk to floodplain managers and other who may not have access to detailed building exposure information. It involves developing and testing a number of resolution options (from asset specific vulnerability assessments to more generalised methods) in a series of case studies.

Work is still underway on this project with key activities being the development of a typology for grouping community exposure. Four case study communities have been selected for study: Tweed Heads, Murwillumbah, Wagga Wagga and Launceston. Flood and building exposure data has been obtained and those communities (and enhanced by the project team in the case of of exposure). Draft generalised curves have been presented to the project steering committee and are currently being refined.

Extent of Use

- The project is still active with final deliverables to come, but he stakeholder group includes:
    - National Flood Risk Advisory Group (NFRAG)
    - Floodplain Management Australia (FMA)
    - Australian Institute for Disaster Resilience (AIDR)
    - Local Government
    - Insurance Industry (Insurance Australia Group and the Insurance Council of Australia)
    - Consulting Industry

Utilisation Potential

- There is broad potential for the use of generalised curves by those who do not have access to detailed building exposure information. Users could include floodplain managers, flood consultants, state emergency services, impact modellers.
- The curves would allow consistent comparisons to be made across jurisdictions where exposure information may otherwise be inconsistent, benefitting decision makers in comparing flood impact and risk.
- The publication of the finalised curves and use instructions through AIDR will allow for widespread dissemination and access.

Utilisation Impact

- The broad stakeholder group interested in the proposed project outputs suggests that, if fit for purpose, the impact should be widespread, particularly with dissemination through AIDR.

Utilisation and Impact Evidence

Dale, K.; Maqsood, T., Edwards, M., Nadimpalli, K. 2018. Cost-effective mitigation strategy development for flood prone buildings: Reporting on Workshop: Flood Damage Models for Floodplain Management, 14th June 2018. Bushfire and Natural Hazards CRC, Melbourne, Australia.

Dale, K., Maqsood, T., Edwards, M., Dunford, M. 2019. Flood Damage Models for Floodplain Management: Reporting on Steering Committee Meeting 9 April 2019. Bushfire and Natural Hazards CRC, Melbourne, Australia.

NEXT STEPS

The tasks for the balance of the project are summarised below:

COST BENEFIT ANALYSIS

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.

The application of the cost versus benefit analysis (CBA) in this project is to evaluate the efficiency of a variety of flood risk mitigation investments. The CBA will comprise of four steps as presented in Figure 6 and described below.

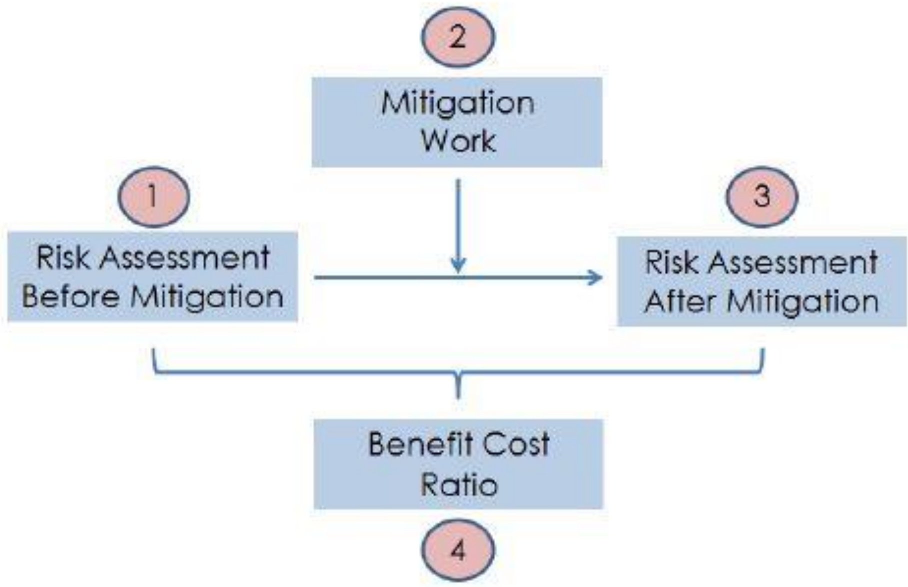


FIGURE 6: COST BENEFIT ANALYSIS FRAMEWORK (ADAPTED FROM MECHLER, 2005)

1. Risk Assessment before mitigation: at this step risk will be calculated in terms of loss to building stock in its present state.
2. Mitigation work: this will be the investment ($) to reduce potential impacts assessed in the first step. It will be the costs of conducting selected building mitigation activities.
3. Risk Assessment after mitigation: risk will be recalculated by incorporating the effects of the mitigation investment (reduced vulnerability of the building stock). There should be a reduction of loss ($) as compared to the pre-mitigation state. This reduction in loss ($) will be the benefit arising from the investment.
4. Benefit Cost Ratio: finally, economic effectiveness of the mitigation investment will be evaluated by comparing benefits and costs. Costs and benefits accumulating over time needed to be discounted to make current

and future effects comparable as any money spent or saved today has more value than that realised from expenditure and benefits in the future. This concept is termed Time Value of Money. Thus future values also need to be discounted by a discount rate representing the loss in value over time. A Benefit Cost Ratio of 1.0 or more suggests the mitigation investment was an economically viable decision.

The above steps will be repeated for the different mitigation options available to determine which yield the largest Benefit Cost Ratio.

DISSEMINATION

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. Using the outcomes of the stakeholder workshop and the research, tailored retrofit information will be developed to inform decision making by governments and property owners to reduce flood risk.

PUBLICATIONS LIST

PEER REVIEWED JOURNAL ARTICLES

Maqsood, T., Wehner, M., Dale, K., Edwards, M. 2016. Cost-Effective Mitigation Strategies for Residential Buildings in Australian Floodplains. International Journal of Safety and Security Engineering, Volume 6, No. 3, 550-559.

CONFERENCE PAPERS

Maqsood, T., Wehner, M., Dale, K. 2015. A schema to categorise residential buildings in Australian floodplains. Floodplain Management Association National Conference; 12pp.

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TEAM MEMBERS

DR KEN DALE

Dr Dale is a structural engineer at Geoscience Australia who obtained his Bachelor Degree (1994) and PhD (2001) at Monash University. Undertook Post-Doctoral research in Japan related to the earthquake behaviour of steel beam-to-column connections (2001-2003) before joining Geoscience Australia in 2003. Research interests include the behaviour of structures and other infrastructure under extreme loads (blast, flood, tsunami, and earthquake). Research in the flood area has included modifying damage curves that incorporate flood height and velocity to suit Australian construction, and the development of stage-damage curves for a small suite of residential structures. Flood experience also includes leading teams on post-event damage surveys in Melbourne (2004) and Brisbane (2011). He is a Member of Engineers Australia and IABSE.

DR TARIQ MAQSOOD

Dr Maqsood is a Senior Lecturer at RMIT University. Before joining the university in 2018 Dr Maqsood was a structural engineer at Geoscience Australia. He is a member of Civil College of Engineers Australia and also a member of the Australian Earthquake Engineering Society (AEES). During the last 15 years Dr Maqsood has focused his research on vulnerability and risk assessment of built environment from natural hazards (earthquakes, floods, tsunami and volcanic ash). He has also been a part of several international initiatives, such as the Global Earthquake Model, the Greater Metro Manila Risk Assessment, the UNISDR Global Assessment Report and the Earthquake Risk Assessment in Pakistan. He has conducted numerous post-disaster surveys after damaging events (earthquakes, floods, cyclones, storm surges) in several countries. He has published several papers in international refereed conferences and reputed journals.

MR MARTIN WEHNER

Mr Wehner is a structural engineer at Geoscience Australia. He has 22 years of experience as a practising structural engineer designing buildings of all sizes and types both in Australia and internationally. Since joining Geoscience Australia in 2009 his research work has centred on the vulnerability of structures to flood, wind and earthquake. He has participated in post-disaster damage surveys to Padang (Earthquake), Brisbane (Flood), Kalgoorlie (Earthquake) and Christchurch (Earthquake). In each case he has led the post-survey data analysis to develop vulnerability relationships and calibrate existing relationships. He has led the development of Geoscience Australia's suite of flood and storm surge vulnerability curves. He is a Member of Engineers Australia and IABSE.

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