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PRE-DISASTER MULTI-HAZARD DAMAGE AND ECONOMIC LOSS ESTIMATION MODEL

Annual project report 2015-2016

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Cover: Natural hazards can impact Australia's economy, including food availability.
Photo: Bushfire and Natural Hazards CRC

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EXECUTIVE SUMMARY

In Australia, a country that suffers from numerous natural disaster events, understanding the economic impacts of these events is key to implementing effective disaster risk reduction strategies and improving overall community resilience to minimise the social, economic and environmental impacts. One aspect of achieving this goal includes understanding not only the primary economic effects of the natural disasters, but also the secondary effects that can impact more broadly in many different economic sectors.

Understanding not only the local, but also the larger scale impacts of disaster events is important to enable the full extent of the disaster event to be known. With this information, all sectors impacted can be recognised enabling more comprehensive disaster risk reduction approaches for the future.

In order to address this problem, the multi-hazard damage and economic loss estimation model team are conducting a case study on the 2010-2011 Queensland Floods which involves comparisons between the economic sectors of flooded areas and unaffected areas. The income of individuals residing in those areas will be compared with finer detail revealing the sectoral decomposition of employment to reflect any differences in income by employment type as a result of the flood.

Preliminary results indicate that some sectors experienced no income difference as a result of the floods. Three sectors were impacted negatively, and two were impacted positively as a result of the flood event. Future work will continue to investigate these results, and will aim to understand the different economic impacts to each sector.

END USER STATEMENT

Ed Pikusa,
Lead User Representative, Economics and Strategic Decision-Making Cluster

Department of Environment, Water and Natural Resources, Government of South Australia

I have been involved as an end user of this project since the inception of the CRC, this has included participation ion three Research Advisory Forums in Adelaide (2014), Sydney (2015) and Hobart (2016).

This project has developed a method for analysing the broader economic impacts of natural disasters as they flow through sectors of the economy.

It is seeking to address the questions of the broader economic impacts of natural disasters. Insights from this analysis could be used to tailor investments in recovery to meet the needs of the most disadvantaged sectors of the economy.

The Brisbane River floods were selected as a case study to test the method, based on the size and scale of the event, ensuring the best chance of observing an economic signal from the event.

The initial results of the project so far, presented in Hobart are encouraging, and it is hoped future development and application of the method can be used to improve our understanding of the true national costs and benefits of natural disasters.

INTRODUCTION

The economic impacts resulting from natural disaster events are often overlooked in management planning as the effects are not immediately felt. Instead focus has been on emergency response and recovery systems and the protection of lives and property. However, in terms of the economic impacts of the natural disasters, less attention and resources have been allocated.

One of the problems identified is the inability to estimate the full economic impact of natural hazards, considering all the affected sections of the economy. This estimation should reflect both the primary and secondary effects of the natural disasters so that persistent losses throughout the economy emanating from various sectors within the economy can be taken into account.

In Australia, natural disasters are estimated to cost an average of AU$1.14 billion annually. Recent natural disaster events such as the 2010-2011 Queensland Flood was estimated to have caused $6.7 billion in damage, and overall cost $14.1 billion. The impacts of this event include inundation of more than 28,000 homes, and 100,000 residences being left without power. It is considered one of the most devastating floods in Australian history.

In the last 12 months the 'pre-disaster multi-hazard damage and economic loss estimation model' research team has focused on the Queensland Flood case study to investigate the impact of the event on the different sectors of the economy. The goal is to estimate the effect of floods on individuals' income by sector to identify the sectors that are vulnerable to natural disasters, the sectors that are beneficiaries of natural disasters, and the sectors that are unlikely to be affected by natural disasters. The outcome of this research will be a ranked list of the economic sectors that seek more attention for policy intervention to minimise potential negative effects of natural disasters. This outcome can be utilised by end users of this project, and particularly government, to guide budget allocation across economic sectors in pre-disaster mitigation.

PROJECT BACKGROUND

With the financial assistance and overall guidance of the Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC), the University of Melbourne and the Deakin Business School (DBS) at Deakin University are conducting a research project titled "Pre-disaster Multi-Hazard Damage and Economic Loss Estimation Model."

WHY THIS PROJECT IS IMPORTANT

History portrays numerous natural disasters that not only reshaped topographical settings but also have bearings on the economic structures of many countries, including Australia. The economic impacts are often overlooked in management planning as they are not immediately felt and focus is put onto emergency response systems. Instead focus has been on emergency response and recovery systems and the protection of lives and property. However, in terms of the economic impacts of the natural disasters, less attention and resources have been allocated.

In Australia, the economic costs of natural disasters are hiking up over time. Natural disasters are estimated to cost an average of AU$1.14 billion annually (BTE, 2001). This statistic, which includes the costs carried by individuals, governments, businesses etc., along with the rapid economic growth in Australia, makes natural disasters a significant issue for policy makers. One of the substantial issues identified in this connection is the inability to estimate the full economic impact of natural hazards, considering all the affected sections of the economy. For example, a single disaster event, the Queensland floods 2010-11 has incurred a total cost of AUD 14.1 billion, in which tangible cost is around AUD 6.7 billion and intangible AUD 7.4 billion (Deloitte Access Economics, 2016).

In this initiative, the effort should be given to take into account not only the primary effects of the natural disasters, but also its lingering, all-important secondary effects due to the pervasive losses throughout the economy emanating from various sectors within the economy.

At least two major research gaps have been identified that seeks immediate attention to bridge the related gap. First, a disaster risk assessment system needs to be developed which provides adequately quantifiable potential damages as a result of different types of disasters for regions of Australia. Second, a framework needs to be established to estimate the indirect economic losses. With the identification of the disaster-specific potential damage and losses, policymakers at different levels will be able to formulate disaster risk reduction-inclusive development policies to mainstream disaster resilience practices. Hence, estimating the impacts of previous natural disasters remains highly critical towards designing more informed national economic policies.

To move from reactive response to a proactive risk reduction culture, this research program will be a pioneering effort in mainstreaming disaster risk reduction (DRR) measures into the economic development process. The overall objective of the research project titled- 'A pre-disaster multi-hazard damage and economic loss estimation model for Australia' is to estimate the economic

sector-specific losses of natural disasters so as to support decision makers in reducing disaster risks.

Australia is the primal beneficiary of this research on a number of levels. First, at the national level, the research project investigates the economic impact of natural disasters on the growth of sectors in the Australian economy such as agriculture, forestry and fishing, mining, manufacturing, utilities, construction, retail trade, transport, health care etc. At the state level, in addition to the national benefits, the research will conduct some case studies to understand detailed economic effects of natural disasters at individual level. This will enable the identification of optimum economic policy options to recover or minimise such adverse effects on Australian communities.

REVISED OBJECTIVES OF THE PROJECT

This project aims to increase the effectiveness of end users' interventions in disaster risk reduction (DRR).

Based on the suggestions made by the end users and other stakeholders in the Research Advisory Forum held in 2015 in Sydney and with the consent of the project research team, this project has undergone a review process to ensure its relevance and utility to the end users. This process realigned the objectives of the project to better suit the current needs of the End Users and to take into account recommendations of independent subject experts. The project more closely with the needs of End Users and consequently should provide a smoother path to utilisation of the research findings. The revised objectives of this research in Figure 1.

"The Research Team has made good progress in modelling the sectoral productivity effects of natural disasters and I believe that the approach taken by the Team is correct and that it is a valuable exercise that gives insight into the productivity effects of natural disasters."

- *An independent reviewer appointed by BNHCRC*

"End users support the general outcome of determining losses from natural disasters through analysis of sectors of the economy. This support is 'in principle', meaning end users believe it has the potential to produce outcomes that add to our understanding of the broader impact from natural disasters.

The economic analysis proposed in this project has the potential to affect a redesign of investment in response, relief and recovery based on the type of event and its location. "

- *BNHCRC management*

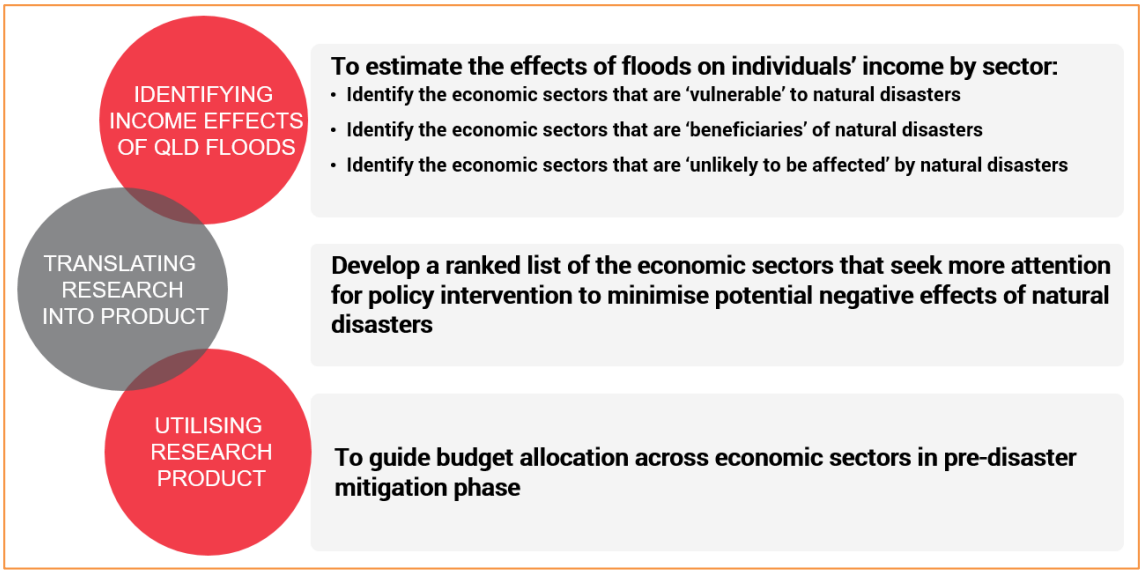


Figure 1: Objectives of the Research

The revised scope of the project is qualitatively similar to the original objectives of this project but more closely aligned with the needs of the project end users. This revised scope focusses on estimating the ubiquitous effects of natural disasters more appropriately, which will directly support in fulfilling the end users' requirements.

As the guiding principles, the revised project scope is:

- Select notable emergency events (e.g. Black Saturday fires, Newcastle earthquake, cyclone Tracy), and
- Present the sectoral impacts of these events over time through those sectors, illustrating how events ripple through the broader economy in space and time.
- Analyse the impacts in terms of how different events of different types, in different places, affect the broader economy.
- Assess the potential limitations and uncertainties of the process.

WHAT THE PROJECT HAS BEEN UP TO

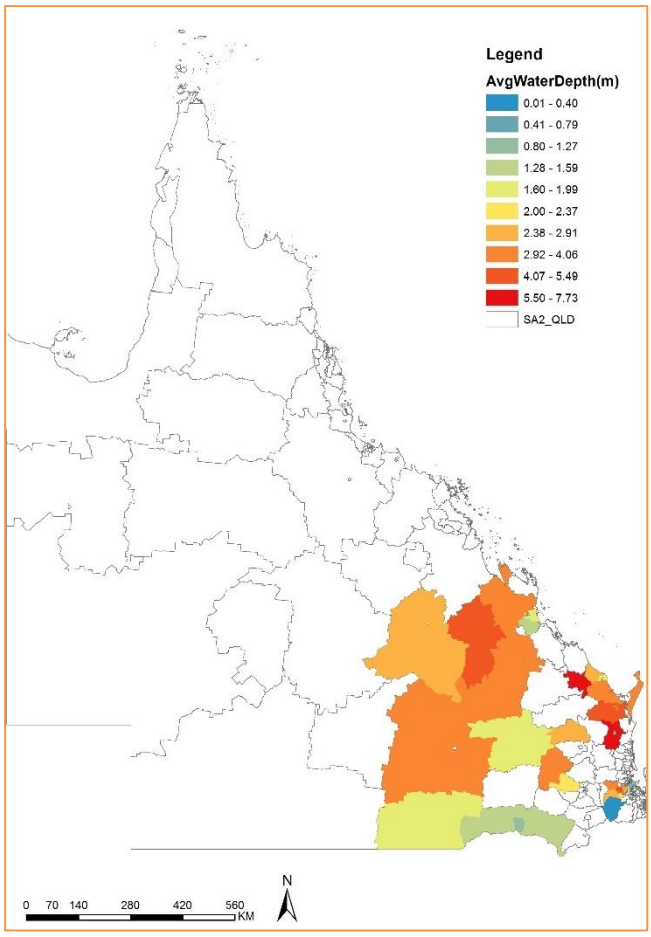
The project research team has organised two meetings with the end users to revise the scope of the project based on the guidelines given above. In particular, the team agreed to conduct a case study on the Queensland Floods 2010-2011—one of the most devastating floods in Australian history that claimed 35 human lives and affected more than 200,000 individuals (see Map 1 that shows average flood water height at statistical area 2 level)—for estimating its overall impacts on the 19 economic sectors of Australian National Accounting System. These sectors are represented in Snapshot 2.

Snapshot 2: Economic Sectors of Australia

- Agriculture, Forestry & Fishing
- Mining
- Manufacturing
- Electricity, Gas, Water & Waste Services
- Construction
- Wholesale Trade
- Retail Trade
- Accommodation & Food Services
- Transport, Postal & Warehousing
- Information Media & Telecommunications
- Financial & Insurance Services
- Rental, Hiring & Real Estate Services
- Professional, Scientific & Technical Services
- Administrative & Support Services
- Public Administration & Safety
- Education & Training
- Health Care & Social Assistance
- Arts & Recreation Services
- Other Services

In particular, under this new scope, the project team is delivering the following outcomes:

- To provide evidence for the mitigation of the negative economic effects of disasters
- To guide the investment decisions across sectors in pre-disaster mitigation phase:
    - Estimate the effect of Black Saturday bushfire and Queensland Flood on each sector of the State economy
        - Identify the economic sectors that are vulnerable to natural disasters
        - Identify the economic sectors that are 'beneficiaries' of natural disasters
        - Identify the economic sectors that are unlikely to be affected by natural disasters
- Develop a ranked list of the economic sectors that need more attention for policy intervention to minimise potential negative effects of natural disasters
- Present the sectoral impacts of the Black Saturday bushfire and Queensland Flood over *time* and in *space*.



Map 1: Queensland Floods, 2010-11

DISASTER IMPACT ESTIMATION: DEVELOPING A METHOD

Every economy has two distinct parts: a) market for goods and services, where households purchase goods and services from firms in exchange for money; and b) market for factors of production (such as labour or capital), where firms purchase factors of production from households in exchange for money. This has been graphically presented in Figure 2. Using this simple economic concept, one can estimate the total income generated within the economy by adding up all households' incomes and firms' profits. In our context, the research team exploits individual level economic information as retrieved from the Australian Census Longitudinal Dataset, 2006 and 2011 to estimate the changes in individuals'

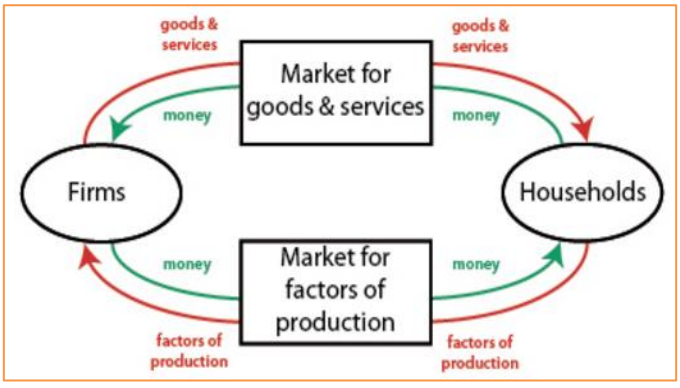
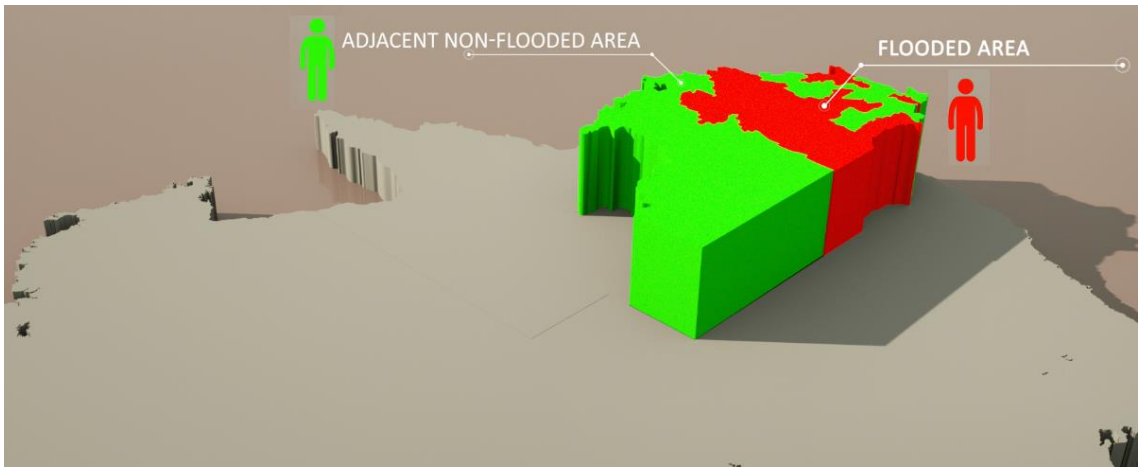


Figure 2: Circular Flow Diagram of the Economy

incomes of the flood affected victims as compared with the affected cohort by economic sector. For example, as shown in Map 2, we are basically comparing income variation from 2006 to 2011 of the flood affected individuals with the unaffected.

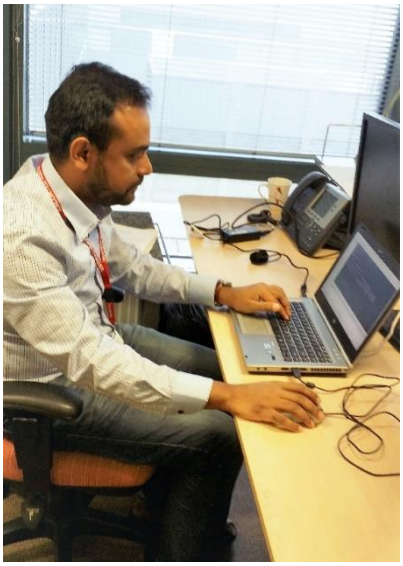


Map 2: Income Comparison between flooded and non-flooded groups

The team has developed a unique natural experimental method of estimating the effects of natural disasters by using the Australian Census Data. This is the most advanced method frequently used in Applied Microeconomic studies. We believe that using such a method in disaster-related research opens a new window of opportunity to understand about the causal effects of natural disasters on various economic, social, and cross-cutting factors.

ACCESSING THE AUSTRALIAN CENSUS LONGITUDINAL DATASET (ACDL), 2006 AND 2011

Based on the revised scope, the project has used the Australian Longitudinal Census Data (ACLD), 2006-2011 as the work horse. It brings together a 5% sample from the 2006 Census with records from the 2011 Census to create a research tool for exploring how Australian society is changing over time. As this data is at person level, the Australian Bureau of Statistics (ABS) does not disseminate it publicly. As a matter of fact, accessing the data is a very tedious process that is in place to ensure the confidentiality of the people's personal information.


A representative of the research team Works in ABS Melbourne Office;

After a long chase, our project team has developed a solid rapport with ABS and they agreed to share the dataset, provided that one of our team members had to work in their office. We accepted this offer, and hence, an office space

has been allocated in ABS data lab (ABSDL), Melbourne office for us to work there sporadically by using a statistical software package 'STATA'.

PRESENTING AT THE RESEARCH ADVISORY FORUM, HOBART 2016

In the last RAF meeting in Hobart, the project has generated extensive interest on how the Queensland Floods (2010-11) affected individuals' income stream. In the second phase of the project, the research team is willing to investigate how business firms have been affected by the Queensland Floods.

Moreover, the team is keen to work on a new case study on the Black Saturday Bushfires 2009 by highlighting on the profitability, productivity, and employment effects at both person and business firm levels.

Finally, the participants of this RAF expressed their interests to understand whether both the Queensland Floods and Black Saturday Bushfire have had differing effects on vulnerable groups, such as female workers, low and high income earners, and small business employees. Moreover, a few end users advocated the research team to understand whether the two natural disasters above have made any effect on family violence and crime, which can be investigated by using the Household, Income and Labour Dynamics in Australia (HILDA) data.

FINALISING UTILISATION MATRIX

The BNHCRC regards research utilisation as to a) provide tangible and operationally focused outputs, or b) influence knowledge and policy positions. This project is aimed at accomplishing the latter in that it targets to ensure the following outcomes:

- The end users can access the estimates of the specific effects of disasters on each sector of the Australian economy at both state and local levels
- The end users can identify the economic sectors that experience negative, positive and net effects of natural disasters
- The decision makers can obtain a ranked list of the economic sectors that seek more attention for policy intervention to minimise potential negative effects of natural disasters
- This ranked list can act as a guiding principle for effective budget allocation across economic sectors in pre-disaster mitigation phase

Broadly, this project will be influencing knowledge and policy positions through:

- informing public policy
- contributing to public debate
- influencing budget allocation decisions on both mitigation and assistance
- projecting sectoral economic losses
- improving household welfare
- assisting economically vulnerable groups

In the last RAF held in Hobart 2016, the following utilisation activities have been identified for this project:

- Organise a series of workshops with the end-users to:

- identify possible utilisation opportunities
- Identify relevant stakeholders that are in need of our research outputs

- Organise a national level seminar to sensitise relevant stakeholders by information dissemination on how floods may affect income flow of individuals
- Video for public dissemination

KEYNOTE SPEECHES AT HIGHLY REGARDED CONFERENCES

- We have been invited to speak on the topic- "*Natural Disasters and Economic Growth: Evidence from Australia*" at the 6th Annual Conference of the International Society for Integrated Disaster Risk Management, October 2015 in India. This is the key conference organised by Technology Information, Forecasting and Assessment Council, Department of Science and Technology, Government of India.

- A keynote speech has been delivered on "*Advanced Techniques of Conducting Household Survey for Disaster Impact Assessment*" in the Regional Workshop on Disaster Risk Assessment Methodology, 08 September, 2015, Kathmandu, Nepal. This event was organised by the Nepal Academy of Science and Technology (NAST), an autonomous apex body to promote science and technology in Nepal.

- Received an invitation to speak at *the 6th International Building Resilience Conference*, which would be held in September 2016 in Auckland.

- Been invited for a keynote speech on "*Econometric Model for estimating loss and damage in agriculture sector due to climate change induced floods*" in the Consultative Forum of Econometric Modelling in Disaster Studies, 13-14 September, 2016, Colombo, Sri Lanka. This event is organised by the Department of Meteorology, Government of Sri Lanka.

ENGAGEMENT ACTIVITIES

In the past year the research team has been involved in a number of activities to engage with end users and to promote the work. The engagement has been aimed at presenting recent research developments and gaining feedback from end users, colleagues and researchers from other clusters.

To engage with end users, two end user workshops have been held – the first on 16 December 2015, and the second on 5 February 2016. These workshops took place in Canberra. In the first workshop, the revised method of estimating economic effects of Queensland flood 2010-11 was explained and the end users that attended gave valuable feedback. In the second workshop a research utilisation plan for ensuring the maximum utility of this project was developed with the end users. In addition to the workshops that have taken place, the research team engages regularly with the end users through email updates.

Another engagement activity that the research team has participated in was the recent RAF event held in Hobart in May. Two members of our research team attended and presented the latest developments in our work. The RAF also offered the opportunity to meeting with end users, engage further potential end users to the project, and hold discussions with researchers from other research projects.

Finally, the Project Leader has given a three-minute video interview through the BNHCRC Media to inform the wider audience about the objectives of the project.

PUBLICATIONS LIST

As mentioned below, the project has produced 8 papers including 2 journal papers, 2 conference papers, 2 working papers, with the remaining 2 being work-in-progress.

PEER REVIEWED PUBLICATIONS

1. Rahman, M. H., Chen, Y., Potts, K., Bhattacharya, P., Rajabifard, A., Ulubasoglu, M. & Kalantari, M. (2015). "*Bringing hazard and economic modellers together: A spatial platform for damage and losses visualisation*", Research proceedings from the Bushfire and Natural Hazards CRC and AFAC conference, Report No. 2015.084, Adelaide.
2. Rahman, M. H. and Ulubasoglu, M. (2015). "*Economic Growth: Measurement*", In Wright, James D. (Ed.), International Encyclopaedia of the Social and Behavioral Sciences, Second Edition, pp. 45–50. Oxford: Elsevier.

PEER REVIEWED CONFERENCE PAPERS

3. Presented a paper on "*Natural Disasters and Economic Development: Evidence from Australia*" in Australian Conference of Economists (ACE) 2015 [This is a key annual event organised by the Economic Society of Australia]
4. Had a paper accepted on "*Climate Variability, Natural Disasters and Sectoral Economic Growth: Evidence from Australia*" for AFAC 2016

WORKING PAPERS (DRAFT IS AVAILABLE UPON REQUEST)

5. Human Casualties in Natural Disasters and Economic Development: A Trichotomous Approach (under submission)
6. The Data on Natural Disasters in Australia: Evidence from Victoria

WORK-IN-PROGRESS

The following two papers are in progress in the revised scope of the project, and we are planning to submit them to *The Economic Record* journal in June 2016 and December 2016, respectively. The *Economic Record* is a premier Australian journal in Economics:

7. Natural Disasters on Sectoral Economic Activity: Evidence from Australia
8. Natural Disasters and The Income Stream of Households: The Queensland Floods 2010-11 as Natural Experiment

In addition, a report on the Methodology for Exposure and Vulnerability Assessment has been prepared and submitted to BNHCRC. Moreover, the outcomes of the project have been accepted for oral presentation in all three AFAC conferences since 2014.

CURRENT TEAM MEMBERS

The pre-disaster multi-hazard damage and economic loss estimation model team consists of many stakeholders from a range of organisations. These stakeholders are categorised into the three groups of researchers, students and end users.

RESEARCHERS

The researchers in this project hail from three different organisations – the University of Melbourne, Deakin University, and Asian Disaster Preparedness Centre (ADPC).

- Prof. Mehmet Ulubasoglu
- Prof. Abbas Rajabifard
- Assoc. Prof. Nelson Lam
- Dr. Mohsen Kalantari
- Dr. Prasad Bhattacharya
- Dr. Habibur Rahman
- Dr. Benny Chen
- Dr. Katie Potts
- Dr. Peeranan Towashiraporn
- Ms. Anggraini Dewi

STUDENTS

Currently there is one PhD candidate aligned with this project – Roozbeh Hasanzadeh Nafari, from the University of Melbourne. Roozbeh's work is focused on flood damage assessment in urban areas.

END USERS

This project currently has a total of 7 end users from across industries. The end users extend their support to the research team in delivering the assigned outcomes of the project.

Name	Organisation
Ed Pikusa	South Australia Fire and Emergency Services Commission
Samantha Ward	Attorney-General's Department
Martine Woolf	Geoscience Australia

Stuart Midgley	New South Wales Rural Fire Service
David Launder	South Australian Metropolitan Fire Service
Joe Buffone	Emergency Management Victoria
David Nichols	Country Fire Authority Victoria

In the recent RAF in Hobart 2016, the following End Users expressed their interests explicitly:

- Department of Environment, Land, Water and Planning, Victoria
- Queensland Reconstruction Authority
- Department of Treasury and Finance, Victoria

REFERENCES

1 Bureau of Transport Economics (2001) Economic costs of natural disasters in Australia, Report 103, Bureau of Transport Economics, Commonwealth of Australia, Canberra

2 Deloitte Access Economics (2016) The economic cost of the social Impact of natural disasters, Australian Business Roundtable for Disaster Resilience and Safer Communities, Canberra.