

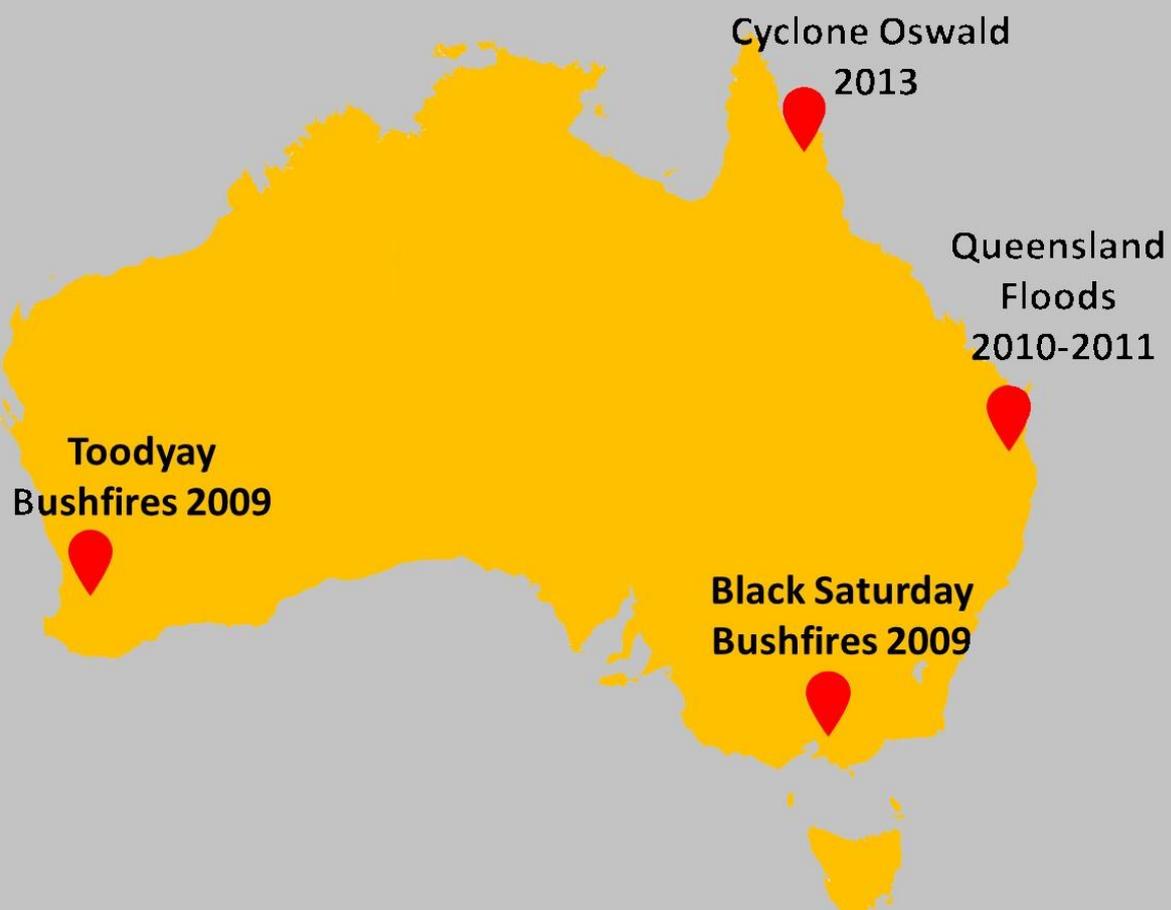
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OPTIMISING POST-DISASTER RECOVERY INTERVENTIONS IN AUSTRALIA

Annual report 2018-2019

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Deakin University & Bushfire and Natural Hazards CRC







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Cover: An illustration of several major natural disasters ranging around Australia.
 Credit: Mehmet Ulubasoglu.



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ACKNOWLEDGMENTS

As academic researchers, our primary focus is producing high quality research and rigorously examining the effects that natural disasters have on our local communities and economies.

But to deliver socially meaningful and impactful research, we need to work closely with our governmental and research counterparts, so that our research directly answers questions our policy makers are grappling with and makes our Australian communities safer and more resilient to natural disasters.

Our partnership with Bushfire and Natural Hazards CRC (BNHCRC) has been a fantastic avenue for doing that. We are very grateful to its dedicated and passionate staff who have facilitated these conversations and pushed for greater utilisation of our research among our end-users and beyond.

We thank our lead end-user, Ed Pikusa from the Department for Environment and Water (SA), who has steadfastly promoted the value of our research. We also warmly thank all our end-users, whose expertise has greatly informed our research approach and guided our efforts towards realising our research's potential and utilisation outside of academia: Emergency Management Australia, IGEM Victoria, Emergency Management Victoria, Department of Environment, Land and Water Planning (VIC), Queensland Reconstruction Authority, and Office of Bushfire and Risk Management (OBRM) – Department of Fire and Emergency Services (WA).



EXECUTIVE SUMMARY

Natural disasters in Australia are very costly, and often have devastating socio-economic effects on impacted communities.

In Victoria, we have sadly seen this first-hand. This year marked the 10th anniversary of the Victorian Black Saturday Bushfires (VIC BSB), which remains the most devastating modern-day bushfire our state has witnessed. From our fellow BNHCRC *Beyond Bushfires* researchers, we know that these fires have had profound measurable effects on the mental health of people living in the bushfire-hit areas, with disruptions to income – the focus of our own research – demonstrated to be a key contributing stressor.

Our pioneering research program explores the impact of a number of Australian natural disasters, including the VIC BSB, on disaster-hit individuals' economic resilience. By analysing Australian 2006, 2011 and 2016 Census data, we determine whether their income levels were able to recover post disaster in the short and medium term, considering demographic factors and employment sectors. Through real-life case studies, our research helps illustrate how these events—of different types and scales—impact and ripple through communities and the broader economy over time.

This year, we have achieved important milestones. Short-term findings for our Queensland Floods 2010-11, VIC BSB and Toodyay Bushfires 2009 studies are now complete. Our VIC BSB results have been widely published (e.g. Australian Journal of Emergency Management, 2019; ABC Radio, 2019). Our demographic profiling of areas hit by these disasters dug deeper into their socioeconomic histories, allowing us to investigate the “why” behind some of our more puzzling results, and proving how valuable this type of analysis can be to overcome limitations in statistical computations like we experienced in the case of the regional Toodyay bushfires 2009.

We published our *Floods, bushfires and sectoral economic output in Australia, 1978-2014* paper in the Economic Record, which found that Australia's sectoral output is more sensitive to floods – Australia lost more than two years' worth of agricultural output during the period 1978 to 2014 due to floods. Bushfires on the other hand do not affect *overall* sectoral output in an *economically* meaningful way, though it does exhibit sectoral effects. There are clear policy implications for this work, which we delve into more deeply in the key milestones section.

Looking ahead, we expect to complete our medium-term modelling for all studies in the second half of 2019, and work with our end-users on developing policy briefs that contribute our knowledge on how Australia can enhance the economic resilience of its communities, and better direct recovery efforts to core income generating activities of disaster-hit areas.



END-USER PROJECT IMPACT STATEMENT

Tim McNaught, *Office of Bushfire Risk Management (OBRM), Department of Fire and Emergency Services, Western Australia*

The Toodyay Case study has provided an insight into the impacts of a bushfire on a community in Western Australia and how national data from the Census could tell a story about the event's impacts over time.

Importantly, it engages people to understand the ways in which data can be utilised to better understand the longer-term impacts of events on communities. By drawing on national datasets, it fosters further questioning and thus a deeper understanding of the inter-connectedness of elements reflected in these datasets and their correlation to a single event and/or other influencing factors.

With a warming and drying climate, and greater potential for these disasters, understanding the impacts of disaster events, and measures that may affect a change in impacts, could be useful to inform future investment strategies.



INTRODUCTION

With the financial assistance and overall guidance of the BNHCRC, Deakin University has conducted this economic research project titled "Optimising post-disaster recovery interventions in Australia".

The research program is a pioneering effort that combines confidential ABS Longitudinal Census data on disaster affected areas, advanced disaster mapping, and empirical economic modelling to provide policy makers with a unique evidence-based estimation of the economic impacts of some of the worst recent natural disasters in Australia's history. It also provides a more granular level of analysis than otherwise available, thus complementing other major Australian research disaster resilience endeavours (e.g. the BNHCRC Australian Disaster Resilience Index project).

The project aims to assist the Australian federal and state policymakers in building a more sustainable natural disaster recovery model by investigating both the sector-disaggregated and demographic-specific economic effects of natural disasters of different types and scales. Through real-life case studies, the project helps illustrate how these events impact and ripple through communities and the broader economy over time.

By focusing on individuals, our research can help design post-disaster recovery government interventions that direct funding to individuals and communities most vulnerable to disasters and in need of assistance, thus enhancing their economic resilience. Investigation of the vulnerability dimension is expected to also help policymakers better understand the socioeconomics of natural disasters and formulate public policies in a way that will tangibly minimise the disaster risks.

2018-19 marks the halfway point of our four-year research program. In this report, we explain the research rationale behind our work, highlight our achievements to date, and plans for the year ahead.



BACKGROUND

Natural disasters in Australia are very costly, and often have devastating socio-economic effects on impacted communities.

With the severity and frequency from natural disasters set to increase (Intergovernmental Panel on Climate Change, 2018), there is a need—now more than ever—for Australia to have a sustainable disaster recovery model that:

- incorporates an evidence-based and disaster-specific assessment of potential damages and impacts of natural disasters on Australian communities, and
- helps build resilience within Australian communities to such disasters.

An important dimension of resilience to natural disasters is economic resilience (Rose, 2007). As income stream represents the economic resilience of individuals to external shocks, economic resilience at an individual level can be defined as the ability to return to the pre-disaster income trajectory. This can happen if the individual has the necessary labour market skills, education and/or experience; the economy is sufficiently diverse to withstand firm/industry-specific losses; or if the government assists the individuals during the recovery and assistance period.

A major research gap is a lack of estimates of the full economic impact of natural disasters covering all the affected sectors and households of the economy. Without understanding both the primary and secondary effects of the natural disasters, we cannot determine the economic resilience of individuals and communities to such disasters. Consequently, persistent losses throughout the economy emanating from various sectors are not adequately accounted for in the disaster recovery model.

Secondly, 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 can 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.



RESEARCH APPROACH

Overview

To address these known research gaps, our research aims to determine the disruptive effects that natural disasters have at the individual income level, investigated with respect to the social status of individuals (i.e., gender, age, income-level, employment status and type, and education level) and considering the economic diversity of the area they live in.

The research program utilises a difference-in-difference model and four real life case studies of varying types and scales to illustrate the effects of natural disasters on economic resilience:

- The Victorian Black Saturday Bushfires 2009 (fire, regional, large scale)
- The Queensland Floods 2010-11 (flood, city, large scale)
- The Western Australian Bushfires 2011 (fire, regional, small scale)
- Cyclone Oswald 2013 (cyclone, small scale).

Research program objectives

1. **Research objective** – estimate the economic impact of natural disasters on individuals' income levels in Australia:
 - 1.1 estimate the sector-disaggregated economic impact of natural disasters on individuals' income levels in Australia
 - 1.2 estimate the demographic-specific economic impact of natural disasters on individuals' income levels in Australia.
2. **Policy objective** – use research outcomes as evidence to optimise and inform a sustainable Australian disaster recovery model: Identify pathways for research outcomes to optimise disaster recovery expenditure for individuals affected by natural disasters in Australia
 - 2.2 Identify pathways for research outcomes to inform an evidence-based sustainable disaster recovery model in Australia.



Primary data

The research exploits individual level economic information as retrieved from the 2006, 2011 and 2016 Australian Census Longitudinal Dataset. This dataset brings together a nationally representative 5% sample of all three Census records.

The availability of such data provides a unique opportunity to explore how Australian citizens are affected over time due to natural disasters, i.e. changes to the individual incomes of the disaster affected individuals as compared with the unaffected cohort, by economic sector.

The richness of this data enables investigation of both social and economic dimensions as shown below:

Table 1 Individual data collected, by dimension

Economic Dimension	Attributes	Social dimension	Attributes
Income	Income levels	Gender	Male, Female
Employment Status	Employed, Unemployed, Not in Labour force	Age	Age groups
Employment Type	Full time, Part time	Marital Status	Married, Never Married, Separated, Divorced, Widowed
Employment Sector	ANZSIC classification	Parental Status	Number of children
		Educational level	Year 8 or lower, Year 9-12, Bachelor degree, Higher than Bachelor degree
		Property ownership	Owner (outright), Owner (mortgage), Renting
		Migration	Stayed in bushfire affected SA2, Migrated out of bushfire affected SA2

We also capture the magnitude or severity of each disaster through a disaster severity measure.

Apart from Bureau of Meteorology data, the project capitalises on the BNHCRC end-user framework to obtain state level information on disaster impact and affected regions from the project's participating end-user state representatives.

Modelling

The project adopts a difference-in-difference model to analyse each natural disaster case study's medium-term effects on affected individuals' income:

$$Y_{ict} = \text{cons} + \alpha_i + \beta_1 \text{Treat}_{it} + \beta_2 \text{PostDisaster}_{ct} + \beta_3 \text{Treat}_{it} \times \text{PostDisaster}_{ct} + \varepsilon_{ict}$$

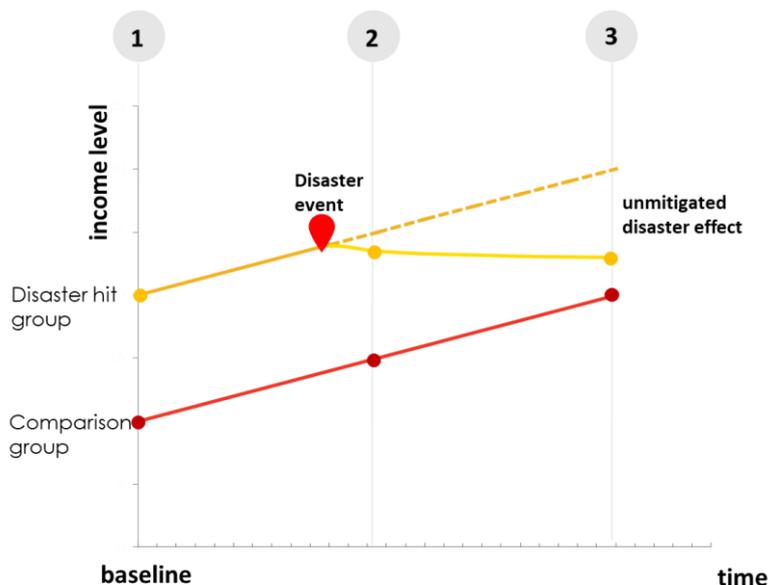
where:

Y_{ict}	= Income
α	= Individual fixed effect
β_3	= Coefficient of interest
i	= Individuals
c	= Cluster/SA2
t	= 2006, 2011, 2016
ε	= Disturbance Term

Using advanced mapping and end-user expertise, for each case study, we construct two distinct areas: the disaster-hit areas (affected group) at either the SA2 or LGA level, and comparator (control) groups that typically have similar characteristics to the disaster-hit areas, including topography and economy, but have not been affected by these disasters. This allows us to pinpoint the specific income effect of the natural disaster (the shock) on the affected (treatment) group.

The difference-in-differences modelling allows us to determine the difference between the incomes of disaster-hit groups before and after the natural disaster, do the same for comparator groups, and see if there is any difference between the two differences (hence, "difference-in-differences").

Figure 1 Difference-in-difference model





By incorporating a:

- disaster severity measure, the model considers the effect of the magnitude of this shock on these affected groups. The construction of the disaster measure is case-study specific and may include other information (e.g. topography data)
- vulnerability dimension, we consider the possible differences in the effect of the disasters on different subsets within the affected groups.

This enables observation of the net effect on individual income, post the disaster and any subsequent injections (from government). Ideally, the research model would provide a breakdown of estimates of both these effects on the observed final income levels of affected groups. However, the lack of complete and readily available information of such government assistance at different demographic layers and economic agents renders this analysis difficult.

The project performs the necessary robustness checks, sensitivity analysis and additional analysis recommended by end-users, so that the reported results are statistically significant and robust and provide policymakers with the necessary level of confidence in any subsequent project policy proposals.

Outcomes

The immediate outcomes as relevant to the objectives are:

1. A robust economic model capable of estimating the economic impact of natural disasters, of varying types and severities, on the income levels of individuals, from various socio-economic demographical backgrounds.
2. Estimates of sector-disaggregated and demographic-specific economic impacts of real-life natural disasters on individuals' income levels in Australia
3. Identification of individuals, and their sectors of employment, most in need of disaster recovery assistance
4. Publications, including journal articles, conference papers, media articles, and guidance notes to disseminate and expand economic research on natural disasters in Australia
5. Policy briefs and other documentation for end-users that inform the budget allocation decisions in both pre-disaster mitigation as well as post-disaster recovery phases.



KEY MILESTONES

This year has seen a flurry of activities across all our major case studies. We have wrapped up the short-term findings for both large scale disasters (VIC BSB and Queensland Flood case studies), and our regional, small scale impact Toodyay case study. We have also dissected the underlying demographic profiles of the areas hit by each of these disasters, which provided a rich, deep layer of contextual information that enhanced our understanding of the effects these disasters had on the impacted communities.

We have also been very active in disseminating our results in conferences, workshops and the media channels. Importantly, we have deepened our relationships with our end-users, and created new connections with other BNHCRC projects and community organisations that play an active role in building community disaster resilience.

For brevity, we highlight one case study per milestone.

MAJOR MILESTONES

1. Short term results finalised for three case studies

Table 2 Summary of short-term results

Case study	State	Summary of findings
Queensland Floods 2010-11	QLD	No statistically significant overall effects within the first six months post the floods. The full analysis (incorporating 2016 results) will be more informative of true effects.
Black Saturday Bushfires 2009	VIC	Overall income losses across all individuals, with particular demographic groups and individuals working in particular sectors more acutely impacted than others. Those who made the decision to migrate out of the disaster-hit zones suffered notable income losses.
Toodyay Bushfires 2009	WA	Small sample size limited us to demographic analysis only and hampered statistical significance of results. However, the signs of the point estimates reveal similar patterns to those seen in the VIC BSB and Queensland 2010-11 floods case studies. For instance: Low-income: Low-income individuals also experienced some income decrease, consistent with their vulnerability to major shocks and results obtained in the Victorian BSB case study.
Cyclone Oswald 2013	QLD	Not commenced. To be completed next year

Still counting the costs: the Victorian Black Saturday Bushfires case study

This year, we finalised our short-term results (2006 to 2011) for the VIC BSB case study, in which we found significant negative effects at an overall individual income level, as well as at the demographic and sectoral levels.

Figure 2 VIC BSB individual income changes (2009-11), by demographic grouping

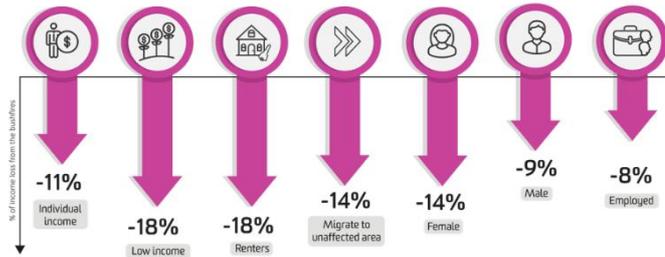
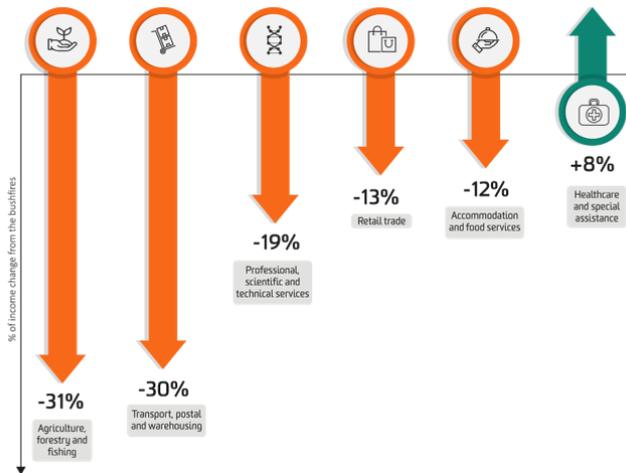


Figure 3 VIC BSB individual income losses (2009-11), by individual's sector of employment



We presented our findings at the inaugural Centre for Energy, the Environment and Natural Disasters “Expanding the Nexus” workshop in November 2018, which attracted a broad audience, including our end-user IGEM Victoria and representatives from the Victorian Council of Social Services (VCOSS), a primary beneficiary group of our work on the vulnerability dimension of disasters.

We presented our non-peer reviewed paper *Disasters and economic resilience: income effects of the Black Saturday bushfires on disaster-hit individuals* at the AFAC 2018 Conference in Perth and showcased how this research could help in natural disaster risk reduction at the RAF & Northern Australia Fire Managers Forum in Darwin in April 2019.



Figure 4 Conference and workshop presentations



Prof Mehmet Ulubasoglu, CEEND "Expanding the Nexus" Workshop 2018



Research Fellow Farah Beaini, RAF Northern Australia, 2019

The project team also held a meeting on 19 March 2019 with Dr Lisa Gibbs to discuss how to incorporate our project's research learnings into the "financial capital" aspect of the BNHCRC "Factors affecting long term community recovery" project.



2. Demographic profiling for three case studies completed

Table 2 Summary of demographic profiling analysis

Case study	State	Highlights
Queensland Floods 2010-11	QLD	The demographic profiling revealed the heterogeneity of the Brisbane river catchment area, which encapsulates regional areas with ageing populations and strong agricultural histories, transitioning economy with a younger population base, and a capital city
Black Saturday Bushfires 2009	VIC	The demographic profiling revealed economically significant infrastructure located in disaster-hit areas that explained some of the sectoral income losses
Toodyay Bushfires 2009	WA	The demographic profiling revealed work patterns of Toodyay residents and the rapidity of recovery efforts. Shifts away from disaster-sensitive industries such as agriculture and manufacturing, and large percentage of workforce employed outside of Toodyay helped mitigate the potential for income losses.
Cyclone Oswald	QLD	Not commenced. To be completed in the next reporting year

Demographic profiling series – insights hidden in plain sight

Natural disaster economic and emergency management literature suggest that certain underlying socioeconomic characteristics can affect a community's vulnerability to natural hazards, and thus its ability to prepare, respond and ultimately recover from disasters (Finch et al., 2010). From the literature we also know that limiting the longevity of income disruptions post-disasters is incredibly important for the mental health of individuals within disaster-affected communities (Gibbs et al, 2016).

For each case study, we provided some high-level demographic profiling and descriptive analysis of the disaster affected areas to present a baseline of their overall socioeconomic characteristics, drilling in on particular attributes (e.g. home ownership) to provide further context to some of our more puzzling research findings. The profiling is area-based (either SA2 or LGA, depending on available information) and utilises the ABS Census as the primary data source, in line with project methodology.

For regional communities in particular, where there are challenges in obtaining sufficient sample size for statistical computations, our study reveals that detailed demographic profiling, using publicly available data, could be undertaken as part of disaster risk reduction exercises to help policy makers build disaster resilience and better direct post-recovery interventions to minimise disruptions to important income streams.

For example, in our Toodyay 2009 bushfire case study, a small isolated fire in a regional town, we did not find an overall statically significant effect on income levels. This did not surprise us as, from our demographic profiling, we knew that Toodyay's employed residents – at an SA2 level – mostly worked outside of Toodyay, which naturally limits the fire's effect on income. From a policy perspective, ensuring that these areas remain/are quickly made accessible to community members if such disasters were to strike is critical for their longer-term prosperity.

3. Paper published in *Economics record*

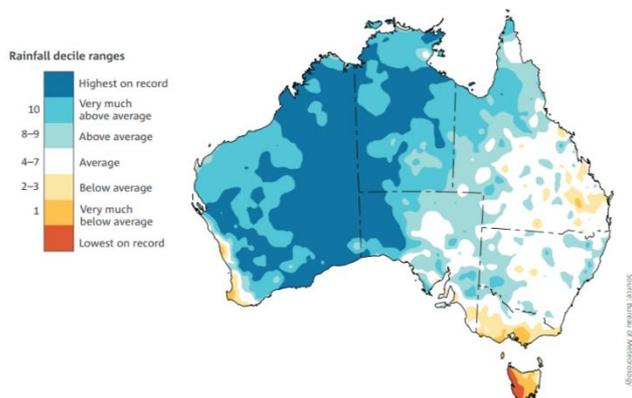
We published our *Floods, bushfires and sectoral economic output in Australia, 1978-2014* paper in the *Economic Record*, the highest ranked economic journal in Australia.

In this paper, we found that Australia's sectoral output is more sensitive to floods – Australia lost more than two years' worth of agricultural output during the period 1978 to 2014 due to floods. Bushfires on the other hand do not affect overall sectoral output in an economically meaningful way, though they do exhibit sectoral effects. The lack of overall effect is likely due to bushfires generally occurring outside of areas of nationally significant economic activity (e.g. cities). The timing of the bushfires in our sample was also generally after harvesting, limiting the potential for more persistent effects on agricultural produce that would result in income losses.

With climate change projected to increase extreme rainfall in Northern Australia and extend the fire seasons in Southeast Australia (Bureau of Meteorology and CSIRO, 2018), there are clear policy implications for this work, as evidenced by interest in this paper from government agencies investigating the impacts of weather events on various economic sectors.

For instance, increased flooding is likely to magnify the effects we observed in our study and exacerbate current well-known weaknesses in our disaster funding arrangements. Historically, insurance payouts have been insufficient to meet natural disaster claims, exerting pressure on fiscal disaster relief expenditure (Commonwealth of Australia Treasury, 2018). Flood insurance premiums in particular are beyond the reach of average households, especially those in high-risk flood areas. In New South Wales, only 2% of these areas have full flood cover, while in Queensland, the figure is 5%. For an average house in these areas, the premium for flood insurance alone can be between \$10,000 and \$20,000, while other perils in Queensland combined attract an average premium of \$1000 (Munich Re, 2015).

Figure 5 Rainfall during the northern wet season has been very much above average for the last twenty years

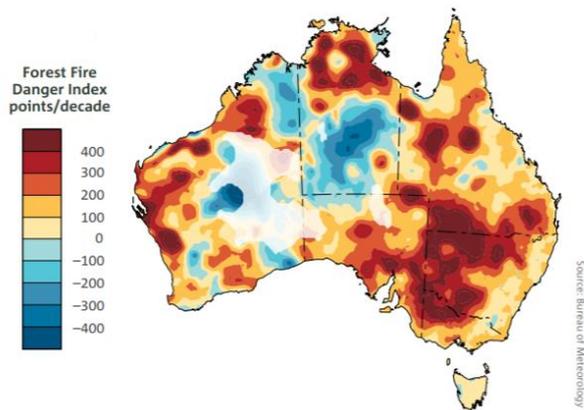




Source: Bureau of Meteorology and CSIRO (2018)

Additionally, longer fire seasons and more frequent fires in southern Australia may increase the sensitivity of the agriculture sector to bushfires. Policies promoting population and economic expansion in regional areas may also increase the likelihood that a greater share of sectors will be affected by bushfires.

Figure 6 Fire weather conditions are mostly worsening, particularly in the south and east of Australia



Source: Bureau of Meteorology and CSIRO (2018)



UTILISATION AND IMPACT

SUMMARY

While our project is still primarily in the research phase, with medium-term modelling for our case studies to be completed in the first half of 2019-20, we have been working closely this year with end-users and potential beneficiaries towards building a clear utilisation pathway for our research. A key avenue for this has been through our quarterly stakeholder engagement reports, which outline our research progression and offer broader trends and insights into natural disaster research that our end-users have found beneficial.

More broadly, we have heavily promoted our short-term research outputs, particularly our VIC BSB case study, by holding workshops, publishing journal articles and holding media interviews. We have actively expanded our utilisation network to incorporate other researchers (e.g. BNHCRC project lead Professor Lisa Gibbs) and community-based organisations with strong utilisation potential, setting us on a solid research utilisation path in the coming year.

Our research findings are already being used to inform natural disaster-related reforms. Most notably, informed by our short-term VIC BSB results, we provided a public submission to the VIC IGEM review of ten years of emergency management reform, picking 3 out of IGEM's 7 themes we think are important to explore as part of this review.

OUTPUT 1 – VIC BSB 2009 SHORT-TERM FINDINGS

Output Description

The VIC BSB short-term findings models changes in the income of individuals residing in the disaster-hit areas, by demographic and sectoral attributes, in the immediate years following the fires (up until 2011).

By comparing these changes to a control group (neighbours of neighbouring SA2s), we can understand:

- What the income trajectory would have been had the disaster not struck?
- What was the disaster's effect on the income trajectory of individuals in the disaster-hit areas?
- If there was an effect, did it differ according to individual attributes, e.g. their sector of employment, their age, gender, employment, income grouping, etc.?



Extent of Use

We have heavily promoted our VIC BSB short-term research outputs by holding workshops, presenting at conferences, publishing journal articles, holding media interviews, and direct outreach and engagement activities:

- publication of non-peer reviewed paper *Disasters and economic resilience: income effects of the Black Saturday bushfires on disaster-hit individuals*, accepted and presented as part of the AFAC 2018 Conference (September 2018)
- public submission to IGEM Victoria's review of 10 years of emergency management reform, using the short-term findings to advise on which themes the review should focus on (October 2018)
- presenting the findings at Deakin University's Centre for Energy, the Environment and Natural Disasters workshop: "Expanding the nexus" in November 2018 which attracted a multidisciplinary audience including representatives from Victorian IGEM and the Victorian Council of Social Services (November 2018)
- public dissemination of our findings via the Black Saturday Bushfire ABC "The Money" program media interview which examined the economic and mental health costs of the fires, ten years on (February 2019)
- publication of findings within the Deakin Business Newsroom (February 2019)
- publication of short-term findings in the Australian Journal of Emergency Management, widely read by the emergency management sector (April 2019)
- inputting our findings and analysis of short-term results into the complementary BNHCRC research project "Factors affecting the long-term community recovery", led by Professor Lisa Gibbs. Our learnings will be incorporated into the "financial capital" aspect of the community framework (ongoing)

Utilisation Potential

- The model assists decision-makers in discerning the short-term impacts of disasters on individuals, to enable better direction of income-generating activities in the immediate aftermath of disasters
- The model's use of public data (ABS Census) makes it accessible, robust and replicable by decision-makers outside of academic settings



- The short-term results enable policymakers and organisations involved in disaster resilience and relief activities (e.g. VCOSS and the Red Cross) to better direct relief expenditure and resilience activities towards those who need it the most. Combined with other case studies, these results provide evidence-based, robust information of how disasters of different types, sizes and locational settings impact communities, uncovering which groups and sectors are consistently vulnerable/sensitive to disruptions.

Utilisation Impact

Our complete findings, capturing income changes until 2016, are expected to be finalised in the first half of 2019-20, after which we expect research impact.

Utilisation and Impact Evidence

- *Disasters and economic resilience: income effects of the Black Saturday bushfires on disaster-hit individuals* [non-peer reviewed paper](#) presented as part of the AFAC 2018 Conference in September 2018
- News and views: Black Saturday bushfires: counting the cost ([Australian Journal of Emergency Management](#))
- Black Saturday Bushfire's Economic Legacy ([Deakin Business Newsroom](#))
- Black Saturday: the economic costs ([ABC The Money program](#))
- Public submission into IGEM Victoria's review of 10 years of emergency management reform (snapshot below):



Monday, 1 October 2018

To whom it may concern,

RE: THEMATIC EXPLORATION OF TEN YEARS OF EMERGENCY MANAGEMENT REFORM

Thank you for the opportunity to provide input into IGM Victoria's review of emergency management reforms.

Since 2014, Deakin University has conducted natural disasters research funded by the Bushfire and Natural Hazards CRC (BNHCRC). Entitled "Optimising post-disaster recovery interventions in Australia", this pioneering research investigates the economic resilience of individuals within disaster hit areas to determine whether their income levels were able to recover post-disaster, considering demographic factors and sectors of employment. Project case studies include the worst recent natural disasters in Australia's history, including the Victorian Black Saturday Bushfires 2009 and the Queensland Floods 2010/11.

Based on our experience to date in researching the Victorian bushfires and other project case studies, we strongly recommend that the review thoroughly explore the following issues within the identified themes:

Identified theme	Issue to explore
Essential services and meeting basic needs	<i>Tailoring relief support to the specific needs of vulnerable population</i>
<p>We strongly support exploration of this theme. Our research has found significant evidence of different effects on different socioeconomic groups: gender, age, employment status and sector, income grouping, and decision to remain/leave bushfire affected areas. For example, we have found that individuals who migrated out of Victorian bushfire affected areas had significantly higher income losses compared to overall losses incurred by individuals within these areas.</p> <p>The timing and extent of monetary assistance also appear to influence outcomes for different vulnerable groups. For example, renters, who are already identified in natural hazard risk analysis research as being a vulnerable cohort, had more severe income losses than home owners with a mortgage. We note VBAF housing-related monetary assistance in the first eighteen months was predominantly directed towards home owners. There also appears to have been a difficulty in identifying affected tenants quickly (due to real estate property closures and privacy laws) which appears to have delayed direct fund distribution (including release of bonds on destroyed properties) to renters, and urgent repairs being undertaken on bushfire affected rental properties.</p>	
Capacity, capability, responsibility and service delivery	<i>Coordination and collaboration between agencies who respond to emergencies and assist communities recover and rebuild</i>
<p>We strongly support exploration of this theme. Every second counts to save lives, property, critical infrastructure, economically significant assets/industries, and our environment. We believe that up-to-date information and information sharing processes are crucial to effective coordination and collaboration between agencies. Based on our experience in researching natural disasters, despite the extensive damage and costs of the Black Saturday Bushfires, data remains fragmented across agencies. No single agency has been able to provide us with a</p>	

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OUTPUT 2 – QLD FLOODS 2010-11 SHORT-TERM FINDINGS

Output Description

The QLD Floods 2010-11 short-term findings models changes in the income of individuals residing in the flooded Brisbane River catchment area, by demographic and sectoral attributes, in the immediate months following the floods (up until 2011).

Extent of Use

- The results have been shared with our end-user, Queensland Reconstruction Authority

Utilisation Potential

- The model assists decision-makers in discerning the short-term impacts of disasters on individuals, to enable better direction of income-generating activities in the immediate aftermath of disasters within a regional setting
- The model's use of public data (ABS Census) makes it accessible, robust and replicable by decision-makers outside of academic settings



Utilisation Impact

As the timing of the floods is quite close to the Census date (August 2011), the impact will be realised once we complete findings, capturing income changes until 2016, which are expected to be finalised in the first half of 2019-20.

Utilisation and Impact Evidence

Our complete findings, capturing income changes until 2016, are expected to be finalised in the first half of 2019-20, after which we expect research utilisation and impact.



OUTPUT 3 – WA TOODYAY BUSHFIRE 2009 SHORT-TERM FINDINGS

Output Description

The WA Toodyay short-term findings models changes in the income of individuals residing in the disaster-hit areas, by demographic and sectoral attributes, in the immediate years following the fires (up until 2011).

Extent of Use

- Our end-user for this case study, OBRM, has shared these results within their wider team to consider in ongoing risk management projects (April 2019)
- Our non-peer reviewed paper, *Disaster and economic resilience in small regional communities: the case of Toodyay*, has been accepted and will be presented as part of the 12th Australasian Natural Hazards Management Conference in June 2019 (May 2019)

Utilisation Potential

- The model assists decision-makers in discerning the short-term impacts of disasters on individuals, to enable better direction of income-generating activities in the immediate aftermath of disasters within a regional setting
- The model's use of public data (ABS Census) makes it accessible, robust and replicable by decision-makers outside of academic settings
- Our end-user, OBRM, considers that, with a warming and drying climate, and greater potential for these disasters, our findings could be useful to inform future investment strategies

Utilisation Impact

Our complete findings, capturing income changes until 2016, are expected to be finalised in the first half of 2019-20, after which we expect research utilisation and impact.

Utilisation and Impact Evidence

Our complete findings, capturing income changes until 2016, are expected to be finalised in the first half of 2019-20, after which we expect research utilisation and impact.



OUTPUT 4 – DEMOGRAPHIC PROFILING

Output Description

For each case study, we provide some high-level demographic profiling and descriptive analysis of the disaster-affected areas.

The profiling utilises the ABS Census as the primary data source (in line with project methodology), at either a SA2 or local government area (LGA) level, depending on available information. It also relies on official government reports for disaster-related statistics.

The reports explore certain underlying socioeconomic characteristics, which natural disaster economic and emergency management literature suggest can affect a community's vulnerability to natural hazards, and thus its ability to prepare, respond and ultimately recover from disasters.

Extent of Use

- The demographic profiling has been forwarded to each of our end-users, complementing our short-term results findings, and providing a clearer understanding of the underlying reasons for some of our more curious findings.

Utilisation Potential

- For regional communities in particular, where there are challenges in obtaining sufficient sample size for statistical computations, our study reveals that detailed demographic profiling, using publicly available data, could be undertaken as part of disaster risk reduction exercises to help policy makers build disaster resilience and better direct post-recovery interventions to minimise disruptions to important income streams.

Utilisation Impact

Our complete findings, capturing income changes until 2016, are expected to be finalised in the first half of 2019-20, after which we expect research utilisation and impact.

Utilisation and Impact Evidence

Our complete findings, capturing income changes until 2016, are expected to be finalised in the first half of 2019-20, after which we expect research utilisation and impact.



NEXT STEPS

Looking ahead, we expect to complete our medium term modelling for all studies in the second half of 2019, and work with our end-users on developing policy briefs that contribute our knowledge on how Australia can enhance the economic resilience of its communities, and better direct recovery efforts to core income generating activities of disaster-hit areas.

In the coming year, we will also be progressing a number of working papers. These papers, while strictly outside the scope of our project, nevertheless have greatly benefited from and been informed by our BNHCRC research program methodology and learnings, underscoring the positive externalities that CRCs such as the BNHCRC effect on the quality and relevance of Australian research:

- Onder, Rahman, Ulubasoglu: *The Spillover Effects of Black Saturday Bushfires: A Network Approach*
- Onder, Rahman, Ulubasoglu: *Droughts and Crop Yield in Australia*
- Rahman, Anbarci, Ulubasoglu: *"Storm Autocracies": Islands as Natural Experiments*
- Rahman, Guven, Ulubasoglu: *Floods and Agricultural Productivity: Natural Field Experimental Evidence from Micro Plot-Level Data on Sri Lanka.*



PUBLICATIONS LIST

PEER REVIEWED JOURNAL ARTICLES

- 1 Ulubasoglu M, Rahman MH, Önder Y, Chen Y, Rajabifard A, *Floods, bushfires and sectoral economic output in Australia, 1978-2014*, 2019: 1-23, Economic record, Chichester, Eng., C1.
- 2 Rahman MH. *Earthquakes don't kill, built environment does: Evidence from cross-country data*, Economic Modelling 2018; 70: 458–468.
- 3 Rahman MH, Anbarci N, Bhattacharya P, Ulubasoglu M, *Can Extreme Rainfall Trigger Democratic Change? The Role of Flood-Induced Corruption*, Public Choice, March 2017;171:331–358.
- 4 Rahman MH, Anbarci N, Bhattacharya P, Ulubasoglu M, *The Shocking Origins of Political Transitions? Evidence from Earthquakes*, Southern Economic Journal, January 2017;83: 796–823.

CONFERENCE PAPERS

Refereed conference papers

- 1 Rahman, M.H., M. Ulubasoglu, P. Bhattacharya, K. Potts, Y. Chen, M. Kalantari and A. Rajabifard (2015). "Natural Disasters and Economic Development: Evidence from Australia", Australian Conference of Economists, 7-10 July 2015, Brisbane.

Non-Refereed Conference Papers

- 2 Ulubasoglu, M. *Disasters and economic resilience: income effects of the Black Saturday bushfires on disaster-hit individuals*. AFAC18 (Bushfire and Natural Hazards CRC, 2018).Google Scholar BibTeX XML
- 3 Ulubasoglu M, Onder YK, Rahman MH, *Evaporative Heating: The Negative Income Effects of the Black Saturday Bushfires in Disaster-Hit Areas*, The 2018 Annual Conference of the Australasian Fire and Emergency Service Authorities Council, 5-8 September 2018, Perth.
- 4 Ulubasoglu M, Rahman MH, *Unpacking the Sectoral Income Effects of Natural Disasters: Evidence from the 2010-11 Queensland Floods*, The 2017 Annual Conference of the Australasian Fire and Emergency Service Authorities Council, , 3-5 September 2017, Sydney.
- 5 Rahman MH, Chen Y, Potts K, Bhattachary P, Rajabifard A, Ulubasoglu M, Kalantari M, *Bringing hazard and economic modellers together: A spatial platform for damage and losses visualisation*, 2015, Research proceedings from the Bushfire and Natural Hazards CRC and AFAC conference, Report No. 2015.084, Adelaide.
- 6 Rajabifard A, Ulubasoglu M, Potts K, Rahman MH, Kalantari M, Bhattacharya P. "A pre-disaster multi-hazard damage and economic loss estimation model for Australia", The 2014 Annual Conference of the Australasian Fire and Emergency Service Authorities Council, 2-5 Sep 2014 Wellington.

OTHER

- 1 Ulubasoglu M, Beaini F, *Black Saturday bushfires: counting the cost*, Australian Journal of Emergency Management, 2019:5–6.
- 2 Beaini F, Ulubasoglu M, *Demographic profiling: Toodyay Bushfire 2009 case study*, Bushfire and Natural Hazards CRC, 2019.
- 3 Beaini F, Ulubasoglu M, *Demographic profiling: Victorian bushfires 2009 case study*, Bushfire and Natural Hazards CRC, 2018, <https://www.bnhcrc.com.au/node/5214>.
- 4 Beaini F, Ulubasoglu M, *Demographic profiling: Queensland Floods 2010-11 case study*, Bushfire and Natural Hazards CRC, 2018.



TEAM MEMBERS

The project team consists of many stakeholders from a range of organisations. As a BNHCRC project, these stakeholders are categorised into the two groups: researchers, and end user state government agencies responsible or involved in natural disaster policymaking.

RESEARCH TEAM

Professor Mehmet Ulubasoglu – Project lead

Professor Mehmet Ulubasoglu is the Head of the Department of Economics and the Director of the Centre for Energy, the Environment and Natural Disasters at Deakin University. Professor Ulubasoglu is one of Australia's foremost experts on the economic impacts of natural disasters, with many years' experience working on these questions with governments in Australia, through his work with the Bushfire and Natural Hazards Cooperative Research Centre, and in South-East Asia with the Asia Disaster Preparedness Centre.

His current BNHCRC research project "Optimising post- disaster recovery interventions in Australia" project fills a major gap by estimating economic impacts of several Australian natural disasters on economic sectors and vulnerable groups.

He has published extensively in leading international journals, including the Review of Economics and Statistics, Journal of Development Economics, American Journal of Agricultural Economics, European Economic Review, and American Journal of Political Science.

Ms Farah Beaini – Research fellow

Farah Beaini is a Research Fellow in the Department of Economics at Deakin University, and the Industry Program and Research Coordinator at the Deakin Business School's Centre for Energy, the Environment and Natural Disasters.

Farah brings a wealth of stakeholder engagement and project management experience from her previous state and Commonwealth government roles in digital transformation, service delivery, administrative law and economic research. As part of the BNHCRC project, Farah oversees the stakeholder management and end-user engagement as the project matures and develops policy briefs. Farah has led research into the demographic profiles of disaster-hit communities, to provide a richer context to the project's research findings.

Other

In addition to the core research team, there are a number of casual members who contribute valuably to the project by working on the ArcGIS, statistical programming, and performing regressions as part of the ABS visits.



END-USERS

This project currently has a total of 6 end users across government:

- Emergency Management Australia, Department of Home Affairs
- Department for Environment and Water, South Australia
- Queensland Reconstruction Authority
- Western Australian Office of Bushfire Risk Management (Department of Fire and Emergency Services)
- Department of Environment, Land, Water & Planning, Victoria
- Inspector General of Emergency Management, Victoria
- Emergency Management Victoria

The end users extend their support to the research team in delivering the assigned outcomes of the project.



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- 3 Commonwealth of Australia, Treasury, 2018, Natural Disaster Insurance Background Paper, Treasury, <https://financialservices.royalcommission.gov.au/publications/Documents/enright-paper-15.pdf>, accessed 2 May 2019
- 4 Finch C, Emrich C, Cutter S (2010), Disaster disparities and differential recovery in New Orleans, *Population and Environment*, vol 31(4), pp.179-202
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- 6 Munich Re, 2015, *Expect the unexpected: Scientific facts and economic impacts of natural disasters (Australia and New Zealand)*, https://www.munichre.com/site/corporate/get/documents_E284843648/mr/Australia-Hazards/documents/Downloads/302-08732_en.pdf, accessed 27 May 2019
- 7 Rose A (2007), Economic resilience to natural and man-made disasters: Multidisciplinary origins and contextual dimensions, *Environmental Hazards*, vol 7(4), pp. 383–398