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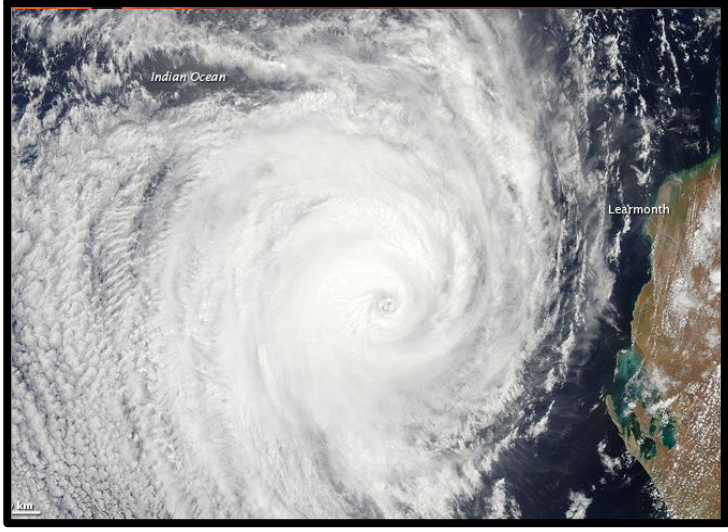
# ECONOMICS OF NATURAL HAZARDS

## Annual Project Report 2017-2018

**Veronique Florec, Abbie Rogers, Atakelty Hailu, David Pannell**
The University of Western Australia & Bushfire and Natural Hazards CRC

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# Table of Contents

# ACKNOWLEDGMENTS

We would like to acknowledge our end-users, who have actively participated in the case studies of the project and have brought invaluable input with their comments and feedback. We would also like to acknowledge the BNHCRC for continuous support to the researchers and the opportunity to participate in conferences and forums that are of great value for maintaining and developing relationships and improving the research conducted.

# EXECUTIVE SUMMARY

Our project aims to provide information on the economic, social and environmental impacts of natural hazards (tangible and intangible), in order to help hazard managers in their decision making. We investigate the impacts of hazard mitigation on intangible (non-market) values, to shed light on the real (total) costs and benefits of natural hazards.

Our main focus is on developing tools and materials that will provide natural hazards managers with information on the value of mitigation and how intangible (non-market) values affect the costs and benefits of mitigation activities.

Our project will have 4 key outcomes:

1. Provide an online platform for the intangible values database (called the Value Tool for Natural Hazards). The tool will be updated and maintained beyond the project so that managers can easily integrate intangible values in their analyses.
2. Fill major knowledge gaps identified in the literature on intangible values that are affected by the management of natural hazards and improve the value tool with this new knowledge.
3. Develop a Quick Economic Analysis Tool for the evaluation of the (tangible and intangible) costs and benefits of mitigation options that enables managers to conduct economic analyses in weeks rather than months.
4. Create a Free Online Course on the application of economics to the assessment of natural hazard management options.

This year, we have progressed in the 4 outcomes outlined above:

1. The value tool has been presented and promoted at several conferences and events and feedback has been positive. Ongoing discussions have been held between UWA and the BNHCRC regarding the format of the online platform for the Value Tool and the accessibility options for non-CRC partners.
2. A case study in the Shire of York, WA will be conducted in collaboration with GeoScience Australia to contribute to some of the known gaps in the Value Tool, potentially including values associated with cultural heritage and mental health.
3. A conceptual framework for the Quick Economic Analysis Tool has been developed and end-user feedback on the goals and principles of the tool has been collected. This had led to the decision of conducting 2 case studies to have high end-user participation in the development of the tool and be able to compare between different applications of the tool.
4. Key priority needs from end-users for topics and format preferences to be included in the free online course have been identified and will be taking into account when drafting video scripts.

For the most part, the utilisation outputs from our project this year involved the integration of intangible (non-market) values in benefit-cost analyses (BCAs) of mitigation options for different natural hazards. To do this, we either used the estimates available in the Value Tool or conducted benefit transfer on data available in the academic literature. We integrated non-market values into three economic analyses: (a) flood mitigation options for the Brown Hill and Keswick creeks catchment in Adelaide, South Australia; (b) prescribed burning options in public vs. private land in the Mount Lofty Ranges in South Australia; and (c) flood mitigation in Newstead, Tasmania with Geoscience Australia.

This year there were 5 publications from the project: 2 peer-reviewed, one non-peer reviewed, one Hazard Note and one submitted to an academic journal (see PROJECT PUBLICATIONS 2017-2018 section below).

# END-USER STATEMENT

**Ed Pikusa,**
*Manager Policy and Reporting*
*Fire and Flood Management Unit,*
*South Australian Department for Environment and Water*

"It is well understood that disasters cause damage and loss to more than items that can be bought and sold. The challenge is incorporating understanding of these losses into mitigation decision making. Recent studies indicate that for some of Australia'a largest natural disasters, intangible non-market losses equal or even exceed traditional estimates of monitary loss.

This project continues to improve our collective understanding of non-market losses from disasters, and make them accessible to practitioners by packaging this understanding into useful prodicts, such as the Value Tool, free online course and rapid benefit-cost analysis tool.

These products are strentehened by illustrating their application using case studies, also assisting in their accesibility

The outcomes of this process will aloow practitioners to more easily incorporate credible assessment of not-market costs into assessments of loss, potentially improving the case for increased mitigation."

# PRODUCT USER TESTIMONIALS

**Tim McNaught,** *Executive Manager, Office of Bushfire Risk Management, WA*

"Building a body of scientific and economic research is essential to guide government policy decisions and resource allocation. It is not just a matter of doing more with less, but better with less. For Western Australia, this research will be a component of the foundation of knowledge underpinning the bushfire reform underway."

**Tariq Maqsood,** *Senior Lecturer, School of Engineering, RMIT University (previously with Geoscience Australia)*

"Geoscience Australia (GA) was funded to undertake a project to conduct a Cost Benefit Analysis (CBA) of a proposed flood levee in Newstead (Tasmania) as a variation to its current project within the Bushfire and Natural Hazards CRC (BNHCRC). With the CBA the project assess the long term cost to Newstead from flood hazard before and after construction of the proposed mitigation works (levee). Within the project GA collaborated with the University of Western Australia (UWA) to quantify the intangible impacts of floods on the wellbeing of the community and environment in Newstead. The project used the Value Tool for Natural Hazards developed by the UWA to assess the intangible losses. The UWA provided the Willingness to Pay (WTP) estimates for a number of intangible impacts of flood on the affected community. The intangible losses quantified in this project included the impact of flooding on the physical health, mental health, social disruption, amenity and safety of the community. The outcome of the project was the evaluation of the efficiency of flood risk mitigation investment.

The Value Tool helped significantly to assess the intangible impacts of flooding and to conduct a comprehensive CBA by considering the investment costs and both the tangible and intangible benefits of mitigation."

# INTRODUCTION

Our project aims to provide information on the economic, social and environmental impacts of natural hazards (tangible and intangible), in order to help hazard managers in their decision making. The purpose of our research is to help emergency service and land management agencies better prioritise their investments in mitigation. Using economic tools and expertise, we assess the impacts of hazard mitigation on intangible (non-market) values, in order to shed light on the real (total) costs and benefits of natural hazards (tangible and intangible) and help agencies better allocate their resources for mitigation.

In previous work with the BNHCRC (2015-2017), we developed a tool for generating estimates of the intangible impacts of natural hazards and the intangible costs and benefits of hazard mitigation (called the value tool). We also produced two integrated economic analyses of management options including intangible costs and benefits: one for floods in Adelaide and one for prescribed burning in private land in the Mount Lofty Ranges of South Australia. In the new phase of the project (2017-2020), we are building on this work and developing tools that will help agencies conduct and utilise more rigorous economic analyses of management options and identify the options that generate the best value for money. These new tools, which consider both market and non-market (intangible) values, will help meet important end-user needs. The intangible values include social, environmental and health related values so that decisions are made to maximise the benefits to society in the management of natural hazards.

# BACKGROUND

The Productivity Commission's report released in 2015 (Productivity Commission 2014) on natural disaster funding arrangements in Australia found that governments overinvest in post disaster reconstruction and underinvest in mitigation activities that would limit the impact of natural disasters. Given the multitude of natural hazards that require mitigation and response from government agencies and the tighter budgets at both State and national levels, natural hazards managers are increasingly under pressure to justify the use and allocation of resources for mitigation efforts.

## STRATEGIC CONTEXT

Governments need to ensure that the benefits of mitigation justify the costs and that they are getting the best value for money out of mitigation activities. To ensure that government decisions are informed by analyses examining the value for money of different alternatives, more economic analyses are needed in the natural hazards field.

By bringing more economic knowledge into the natural hazards sector, our project is helping address four major issues in the sector:

1. To this date, economic analyses of natural hazard management options remain rare for some hazards (e.g. bushfires) or incomplete in their coverage of the different types of costs and benefits (i.e. intangible values are rarely taken into account).
2. Many (and in some cases the majority) of the benefits from natural hazard management are intangible (or non-market), but they are often excluded from economic analyses.
3. There is a general lack of information to carry out economic analyses and a shift in thinking is needed among land management agencies to ensure that more data is available (and useful) for economic analyses.
4. There is a lack of economics capacity in the sector, which results in government decisions rarely being informed by formal economics analyses.

# RESEARCH APPROACH

The focus of this project is on developing tools and materials that will provide natural hazards managers with information on the value of mitigation and how intangible (non-market) values affect the costs and benefits of mitigation activities. This information will help managers in their decision making and resource allocation. The aim is that our end users will be able to use the tools without the need for continuous assistance from researchers.

There will be 4 outcomes for our project:

## 1. ONLINE PLATFORM FOR THE VALUE TOOL FOR NATURAL HAZARDS

Aim: To provide an online platform for the Value Tool that will be updated and maintained beyond the project so that managers can easily integrate intangible values in their analyses.

In the first phase of the project (2015-2017), we developed an intangible values database (called the Value Tool for Natural Hazards), which consists of a searchable excel database of non-market valuation studies that provide dollar estimates of the intangible values that are affected by natural hazards. We integrated these values into benefit-costs analyses and case studies on flood management, prescribed burning, and earthquake impacts. The accompanying guidelines of the Value Tool explain how to use these values in benefit-cost analyses.

In the new phase of the project (2017-2020) this database will be updated, its usability will be improved based on end-user feedback, and we will develop an online platform for the database so that end users can easily access the material through a website.

## 2. IMPROVE THE VALUE TOOL WITH NEW KNOWLEDGE

Aim: To fill major knowledge gaps identified in the literature on intangible values that are affected by the management of natural hazards.

The development of the Value Tool required an extensive literature review of existing studies measuring the intangible values affected by natural hazards and their management. In undertaking this review, some important knowledge gaps were identified in key areas such as the environment (e.g. ecosystems, water quality) and mental health, as well as a lack of Australian non-market valuation studies specifically related to natural hazards.

To ensure the ongoing relevance of the value tool for natural hazard managers, we will fill the current knowledge gaps identified by conducting an original, nation-wide non-market valuation study.

## 3. DEVELOPMENT OF A QUICK ECONOMIC ANALYSIS TOOL

Aim: To provide an economic analysis tool for the evaluation of the (tangible and intangible) costs and benefits of mitigation options that enables managers to evaluate and prioritise the treatment options that are likely to provide the best value for money.

At the State and National levels, there is a need for simple and robust tools that help to prioritise treatment options for different natural hazards. Knowing the risk and the treatment options that are available to reduce that risk is only part of the picture. It is also very important to know how costly those treatment options are and, when they reduce the risk, what benefits they create.

We are developing a tool that can link risk, treatment options and their potential effectiveness with economic data in a simple and robust way. This Quick Economic Analysis Tool that will provide a quick overview of the tangible and intangible costs/benefits of mitigation options, permitting economic analyses to be done in weeks rather than months.

## 4. FREE ONLINE COURSE ON THE ECONOMICS OF NATURAL HAZARDS

Aim: To provide a Free Online Course with training materials relating to the application of economics to the assessment of natural hazard management options.

This Free Online Course will provide natural hazard managers with information on and explanations of the core economics concepts and models that are relevant to natural hazard management. In this course, managers will be exposed to the different economic analysis available and will be taught how to interpret the results.

The course will help natural hazard managers appreciate the importance and challenges associated with intangible values and recognise the data requirements for economic analyses.

# PROJECT PROGRESS (2017-2018)

In this section, we summarise the progress on each of the outcomes outlined above for the financial year 2017-2018.

## 1. ONLINE PLATFORM FOR THE VALUE TOOL FOR NATURAL HAZARDS

The value tool has been presented and promoted at several conferences and events, including:

- the BNHCRC Showcase in Adelaide,
- the AFAC/BNHCRC conference in Sydney,
- the Australasian Natural Hazard Management Conference (half-day workshop with hands-on exercises using the Value Tool),
- the State NRM and Coastal Conference in Perth, and
- the Research Advisory Forum in Sydney.

Feedback on the presentations and the hands-on workshop was very positive, and subsequent to this promotion of the Value Tool, there have been several inquiries from other agencies (i.e. other than the project end-users) about the suitability of the tool for their decision making needs.

Ongoing discussions have been held between Fiona Gibson, Abbie Rogers and John Bates regarding the format of the online platform for the Value Tool and the accessibility options for non-CRC partners. This is still under discussions and final decisions will be made in the new financial year (2018-2019). In the meantime, the Value Tool is being shared vie email with BNHCRC end-users that have requested a copy of the tool and the accompanying guidelines.

We distributed a survey in January 2018 to end-users that had used the Value Tool to seek their feedback about the tool and enquire about their preferences in terms of accessibility of the Value Tool. 90% of survey respondents had a preference for an online version of the Value Tool that includes both a downloadable spreadsheet of the tool and an interactive platform. Although the latter is beyond the scope of the current project, this feedback suggests that it might be worthwhile pursuing additional utilisation funds for the development of an interactive web platform.

## 2. IMPROVE THE VALUE TOOL WITH NEW KNOWLEDGE

The intangible values available in the value tool have been integrated into benefit-costs analyses and case studies, including one project for Geoscience Australia assessing flood risk mitigation in Launceston, and two case studies for the South Australian Department of Environment, Water and Natural Resources (DEWNR):

- one on flood management in the Brownhill and Keswick creeks catchment in Adelaide, and

- one on prescribed burning in the Mount Lofty Ranges in South Australia.

Through the use of the value tool in these case studies and numerous discussions with end-users regarding their needs in terms of intangible values, a number of gaps have been identified. After analysing (a) the state of available non-market value estimates in the literature for use in benefit transfer, (b) the importance of the values for natural hazard decision making, and (c) how easily an original study could be implemented to provide value estimates suitable for benefit transfer, we narrowed the intangible values that require better representation in the Value Tool to the following intangible values:

a. Ecosystem values, particularly in relation to threatened species values;

b. mental health values;

c. animal welfare values;

d. cultural heritage values; and

e. memorabilia values.

A couple of potential case studies were identified in Western Australia (WA) and in South Australia (SA) that would be suitable for implementation of the original non-market valuation study on one of these values. The case study selected is in WA and it will estimate values associated with earthquake mitigation. This work will be conducted alongside the GeoScience Australia project in the Shire of York, WA. The study will be able to contribute to some of the known gaps in the Value Tool, potentially including values associated with cultural heritage and mental health.

## 3. DEVELOPMENT OF A QUICK ECONOMIC ANALYSIS TOOL

A conceptual framework for the Quick Economic Analysis Tool has been developed, linking risk data, treatment options and potential costs and benefits. The conceptual model includes two versions of the tool:

- one that provides a quick and rough overview of the benefits and costs of mitigation options, and
- one that provides a more comprehensive benefit-cost analysis, that can still be completed with minimal data collection (see Figure 1).

The tool will be based on similar tools that have been developed by the Centre for Environmental Economics and Policy such as INFFER (Investment framework for environmental resources, see www.inffer.com.au) and INFFEWS (Investment framework for economics of water-sensitive cities, not publicly available yet). For this tool to be useful and informative to our end-users, more information is required regarding the most appropriate format and how the outputs of the tool will be used by different organisations. This will be discussed with end-users throughout the development of the tool.

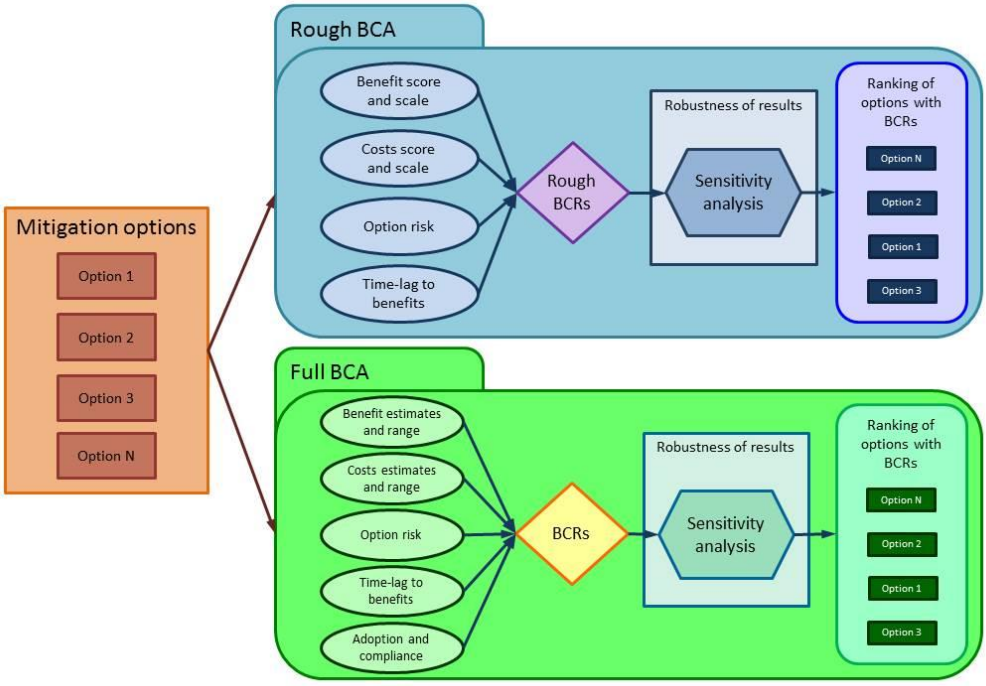


**Figure 1. Conceptual model of the quick economic analysis tool**

A snapshot of the tool's goals and principles was presented at the last RAF in Sydney (April 2018), where several end-users expressed their interest in becoming involved with the project, learn more about it, and be active participants in its development.

End-users have emphasised that the usefulness of the tool needs to be tested through case studies and that comparing different case studies would be of great value. We will therefore conduct two case studies and develop the tool with the organisations involved in them. The location and the partner organisations for the two case studies are in the process of being defined.

## 4. FREE ONLINE COURSE ON THE ECONOMICS OF NATURAL HAZARDS

For the free online course on the economics of natural hazards, we have a plan with priority needs from our end-users, these include:

- Be able to justify existing or potential investments in risk mitigation
- Prioritisation of investments (supported by strong evidence)
- Costs and benefits of natural hazards and mitigation options
- Understanding case studies and their transferability
- Uncertainty and validity of results
- Including non-market values (NMVs)

- The role of incentives

These priority needs will be included in the course. End-user preferences for how the economic concepts should be presented (e.g. provide evidence from case studies to explain a concept) have been collected and will be taken into account when drafting the scripts of the videos.

For the videos to have nation-wide relevance and include the most important information for BNHCRC end-users, we will need the participation and support from several BNHCRC partner organisations and researchers working on related topics. This in-kind contributions will be formalised in the second semester of 2018.

# KEY MILESTONES

The milestones completed for the project during the financial year 2017-2018 are outlined below.

## POSTER FOR THE 2017 AFAC/BNHCRC CONFERENCE

A poster showcasing the Value Tool Database and why it is important to include intangible values in decision making was presented at the 2017 AFAC/BNHCRC Conference (see Figure 2).

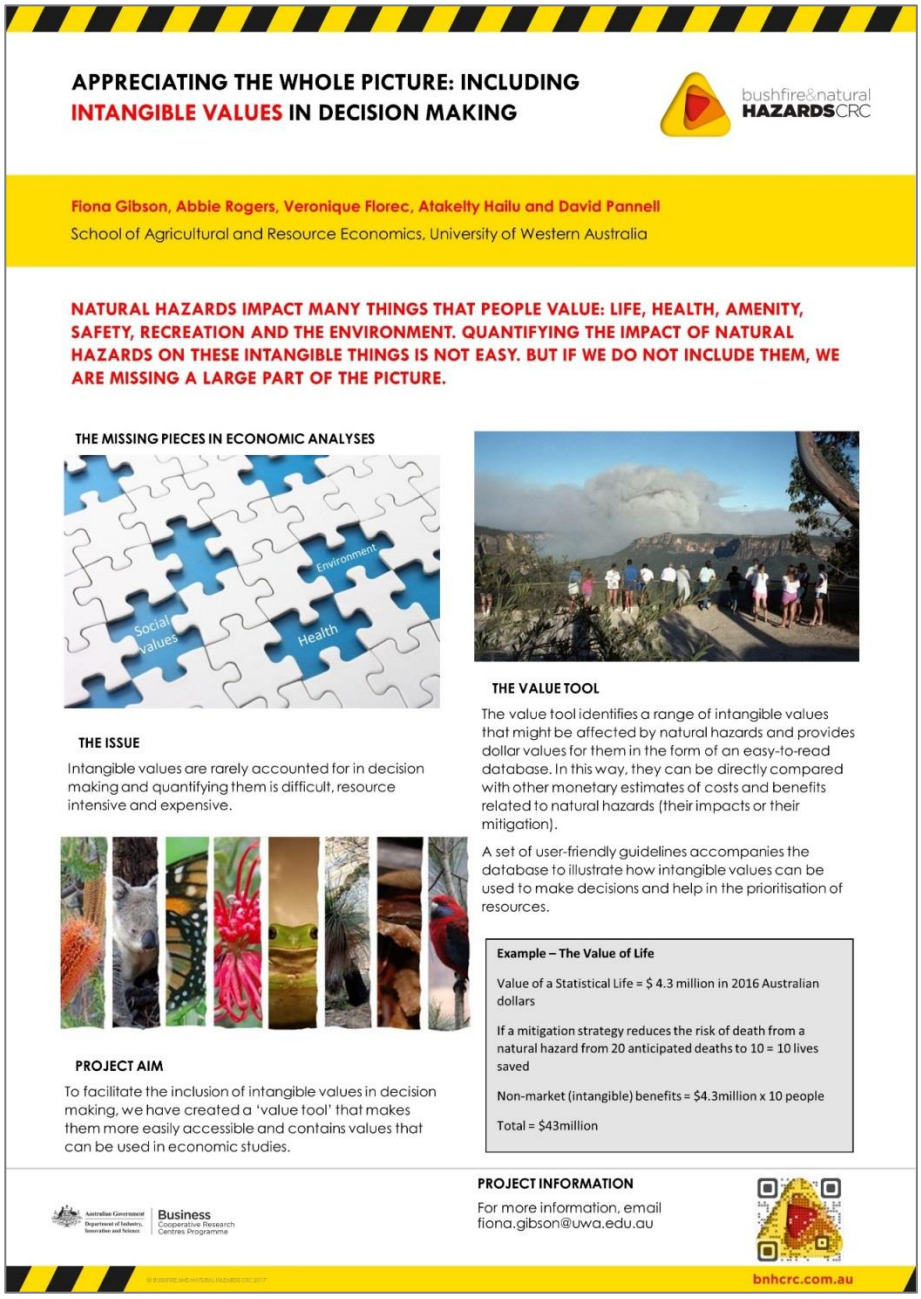


**Figure 2. Value Tool poster for AFAC 2017**

## REPORT OUTLINING DETAILED NEEDS FOR THE ORIGINAL NON-MARKET STUDY AS AGREED WITH END USERS AND COLLABORATORS

This report outlines the findings from the literature, the research gaps identified for non-market values in a natural hazards context, and the feedback from end-users on the on the potential original non-market valuation studies according to their most pressing needs for non-market values.

## WRITTEN PLAN FOR FREE ONLINE COURSE INFORMED BY CONSULTATION WITH END USERS

This report outlines the priority needs from our end-users for topics to be included in the course, their format preferences and a plan for how the videos will be developed.

## PAPER ON "ECONOMIC METHODS FOR VALUING NON-MARKET IMPACTS FROM NATURAL HAZARDS" SUBMITTED TO JOURNAL

A paper entitled "Economic methods for valuing non-market impacts from natural hazards" was submitted to the journal Natural Hazards.

## CONCEPTUAL MODEL FOR THE ECONOMIC TOOL TO EVALUATE TREATMENT OPTIONS DRAFTED

This report summarises the purpose of the tool, the type of information that organisations can expect to obtain from it and feedback from end-users on these two aspects of the tool.

## PROGRESS REPORT TO END USERS

This progress reports presents a short summary of the project, the research approach and the latest news and activities that we want to communicate to a wide audience of end-users. The report has been sent out to some end-users, but it needs to be more widely distributed to inform as many interested parties as possible. This report has been sent along with a Project Summary (which is not a milestone) to allow end-users to get more information on the research approach of the project if needed.

## REPORT OUTLINING RESULTS OF CONSULTATION WITH END USERS REGARDING CONTENT AND DESIGN OF ECONOMIC TOOL TO EVALUATE TREATMENT OPTIONS

This report summarises the comments from end-users on the key purposes of the tool, the principles it will adhere to, the outcomes sought and what it is meant to be used for.

## POSTER FOR THE 2018 AFAC/BNHCRC CONFERENCE

A poster showcasing the Quick Economic Analysis Tool and what it is intended to achieve will be presented at the 2018 AFAC/BNHCRC Conference (see Figure 3).

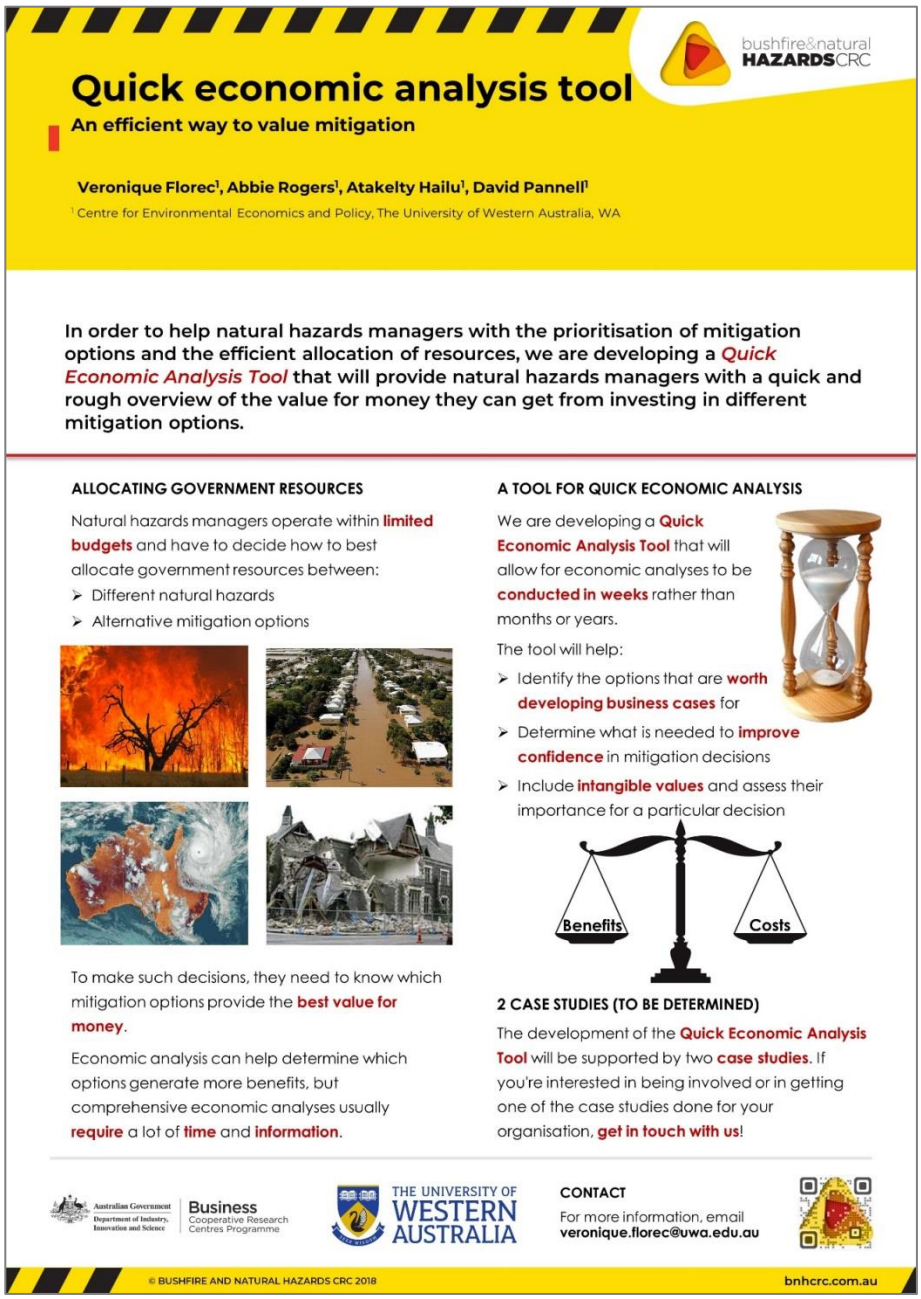


**Figure 3. Quick Economic Analysis Tool poster for AFAC 2018**

# UTILISATION OUTPUTS

For the most part, the utilisation outputs from our project this year involved the integration of intangible (non-market) values in benefit-cost analyses (BCAs) of mitigation options for different hazards. Where possible, we used the estimates available in the Value Tool to include dollar values of intangibles in the BCAs. If there was no information in the Value Tool for a particular intangible, we collected data from the existing academic literature and used the benefit transfer method to adapt the values from the literature to the context studied. We integrated non-market values into three economic analyses: (a) flood mitigation options for the Brown Hill and Keswick creeks catchment in Adelaide, South Australia; (b) prescribed burning options in public vs. private land in the Mount Lofty Ranges in South Australia; and (c) flood mitigation in Newstead, Tasmania with Geoscience Australia. A brief summary of each of these projects is provided below.

## FLOOD MITIGATION IN ADELAIDE

Economic assessments of flood mitigation benefits generally focus on estimating the tangible costs and benefits of mitigation strategies and rarely include intangible costs and benefits. However, it is important to take into account intangible values because these values can be substantial and in some cases they can even exceed tangible costs and benefits. Without intangible values, economic evaluations are incomplete. And in fact, the inclusion of intangible values has been identified as one of the key areas for improvement in BCAs of flood mitigation (Meyer et al. 2012).

We conducted an economic analysis of flood mitigation options for a high flood-risk catchment in Adelaide (South Australia): the Brown Hill and Keswick creeks catchment. We improved upon previous BCAs conducted for the catchment by incorporating intangible costs and benefits in the analysis. We used the Value Tool when estimates were available and the benefit transfer method (using existing estimates from the literature) when they were not available in the Value Tool. In this particular case, we found that the inclusion of intangible values did not change the attractiveness of the mitigation options evaluated and the benefit-cost ratios for all options remained below one.

## PRESCRIBED BURNING IN THE MOUNT LOFTY RANGES

A previous study (Gibson and Pannell, 2014) was conducted by UWA evaluating fire-prevention strategies in the Mount Lofty Ranges to assess which strategies provided the best value for money. This study was updated and a new analysis conducted to evaluate the costs and benefits of prescribed burning strategies in public land vs. private land.

The original analysis included two non-market values: the value of human life and the value of biodiversity. The end-user for this case study, the South Australian Department of Environment, Water and Natural Resources (DEWNR), asked for other non-market values to be included in the model. They suggested a range of non-market values that they were interested in seeing in the study, including: native vegetation (private land), riparian vegetation, threatened species,

amenity (visual), recreation, electricity outage, traffic disruption, cultural heritage, animal welfare, memorabilia, physical health, and mental health. Of these, the following non-market values were included in the analysis using the estimates available in the Value Tool: native vegetation (private land), riparian vegetation, threatened species, amenity (visual), electricity outage, and physical health. In addition, the values for human life and biodiversity were updated with the Value Tool. Out of the non-market values tested, physical health, threatened species and biodiversity were the ones that had the highest impact on the results.

## FLOOD RISK MITIGATION IN LAUNCESTON

The suburb of Newstead in Launceston, Tasmania, was not included in the Launceston Flood Authority strategy to design, construct and maintain existing and new flood levees (completed in 2016). As a result, a new levee was proposed to protect the properties in Newstead from future floods. Geoscience Australia (GA) conducted a BCA of the proposed flood levee in Newstead and worked with UWA to use the Value Tool estimates and include non-market values in the analysis.

The following non-market values were included in the BCA: fatalities, mental health, social disruption (electricity outage, road traffic delays and displacement of people), amenity, safety, ecosystems, water quality, recreation and memorabilia. In this case study for the suburb of Newstead, the size of non-market values as a proportion of total flood losses is relatively small and including non-market values in the analysis did not significantly affect the results.

# PROJECT PUBLICATIONS 2017-2018

Florec, V. (2017) Investing in prescribed burning: how much should we spend? *Hazard Note* 42, November 2017.

Florec, V., Chalak, M. and Hailu, A. (2017) Integrating intangible values in economic analyses of flood mitigation: A case study of the Brown Hill and Keswick creeks catchment in Adelaide, *Australian Journal of Emergency Management* 32(4): 30-36.

Florec, V. and Pannell, D. (2017) Where do we put our dollars? Economic analysis of different bushfire management options in Western Australia. In Rumsewicz, M. (2017) *Research proceedings from the 2017 Bushfire and Natural Hazards CRC and AFAC Conference*. Bushfire and Natural Hazards CRC & AFAC annual conference 2017, Sydney 4-7 September, non-peer reviewed paper, pp. 214-222.

Rogers, A. A., Gibson, F. L., Florec, V., Hailu, A. and Pannell D. J. (2017) Including the intangible benefits of bushfire mitigation in economic analyses: a 'Value tool' for informed decision making. In Rumsewicz, M. (2017) *Research proceedings from the 2017 Bushfire and Natural Hazards CRC and AFAC Conference*. Bushfire and Natural Hazards CRC & AFAC annual conference 2017, Sydney 4-7 September, peer reviewed paper, pp. 29-47.

Rogers, A.A., Gibson, F.L., Hawkins, J.I., Johnston, R., Boxall, P., A, Rolfe, J., Kragt, M., Burton, M. and Pannell, D.J. (2018) Valuing non-market economic impacts from natural hazards: A review. [submitted to *Natural Hazards*]

# COLLABORATIONS

The development of the value tool involved the participation of leading international experts in the field and a strong collaboration was developed with this group. The experts include Professor Robert J. Johnston from Clark University (Massachusetts, US), Professor Peter C. Boxall from the University of Alberta (Canada), and Professor John Rolfe from Central Queensland University.

We have been collaborating with Geoffrey Donovan (Research Economist, US Forest Service), Patricia Champ (Research Economist, US Forest Service), and Nicholas Flores (University of Colorado, Boulder) putting together a project investigating homeowners' attitudes towards bushfire events and bushfire risk. Geoff Donovan visited UWA for a week in May 2017.

We are currently collaborating with Matthew Thompson (Research Forrester and Economist, US Forest Service), and Francisco Rodriguez y Silva (Professor, University of Cordoba, Spain) working on an article on the costs of suppression.

We have an ongoing collaboration with Professor Kevin Ronan (Central Queensland University) working on the economics of disaster risk education. This collaboration now also includes Dr Ilan Kelman (Reader at the Institute for Risk & Disaster Reduction, University College of London).

# TEAM MEMBERS

### Veronique Florec (project leader)

BA(Econ) Grenoble, France; BA(Econ) Sussex, United Kingdom; MA(Econ) Paris, France; PhD Western Australia, Australia.

After living and studying in Colombia and France, Veronique came to Australia to travel and fell in love with the country. She completed a PhD on Environmental and Resource Economics at The University of Western Australia, investigating the economics of bushfire management in the south-west of Western Australia. Since completing her PhD, Veronique has worked at the Centre for Environmental Economics and Policy at UWA.

Her research focuses on evaluating value for money for investments in natural hazards management. It integrates socio-economic information and technical information about hazard risk, hazard severity and the effectiveness of management options in order to optimise the allocation of available resources for hazard mitigation.

### Atakelty Hailu

BSc Alemaya, Ethiopia; PhD Alberta, Canada.

Atakelty is an Associate Professor and the School's Graduate Research Coordinator (GRC). He had a strong and early desire to become a 'scientist' but no interest in economics. That is, until after the devastating (and partly man-made) Ethiopian famine of 1984/5 and until he realised that there was in fact a field of study that put both people and nature (including agriculture) at the centre of it -- Agricultural Economics. He obtained a BSc degree in Ag Econ from Alemaya University (1990). After two years working at Alemaya, he moved to Canada to study for a master's degree at the University of Alberta where he, with the encouragement of his supervisor, ended up pursuing a PhD instead (1998). He then worked as a postdoctoral researcher with the Canadian Sustainable Forest Management Network before joining the University of Western Australia as a lecturer in 2001. Atakelty has received several academic awards, including the Outstanding Doctoral Thesis Award for 1996-1998 from the Canadian Agricultural Economics Society (CAES), and a Chancellor's Gold Medal for his undergraduate academic achievements in Alemaya. His research interests include efficiency and productivity analysis, whole-farm bioeconomic modelling, environmental policy design, and agent-based computational economics.

### Abbie Rogers

BSc; PhD Western Australia, Australia.

Having always respected the environment, but recognising that there are limited resources available to manage the environment, lead me on a path to study a BSc in Natural Resource Management, followed by a PhD in Environmental Economics at The University of Western Australia. Since completing my PhD in 2011, I have worked in the School of Agricultural and Resource Economics and the Centre for Environmental Economics and Policy at UWA, currently as an Assistant Professor in Research.

My primary research interests are in the application of non-market valuation to estimate community values and preferences for environmental conservation and management. This includes applications in the context of marine, terrestrial and aquatic environments. Ultimately, I am interested in improving the application, understanding and accessibility of non-market valuation techniques such that they can be used to improve environmental decision making.

### David Pannell

BSc (Agric); BEc; PhD Western Australia, Australia.

David Pannell is Professor of Agricultural and Resource Economics at the University of Western Australia, and Director of the Centre for Environmental Economics and Policy. He was an ARC Federation Fellow, 2007-2012. He has been a prominent commentator on environmental policy within Australia, arguing for policies that better reflect scientific, economic and social realities. He was President of the Australian Agricultural and Resource Economics Society in 2000, a member of the WA Government's Salinity Taskforce in 2001, and a director on the Board of Land and Water Australia 2002-05.

His research includes the economics of environmental conservation; environmental policy; farmer adoption of land conservation practices; risk management; and economics of farming systems. His research has been published in seven books and 200 journal articles and book chapters, and has been recognised with awards from the USA, Australia, Canada and the UK, including the 2009 ARC Eureka Prize for Interdisciplinary Research.

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