NATURAL HAZARDS EXPOSURE INFORMATION FRAMEWORK REPORT

Annual Report 2016-2017

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EXECUTIVE SUMMARY

Bushfires and Natural Hazards are features of the Australian climate and landscape and will continue to pose a threat (Council of Australian Governments (COAG), 2011). These hazards can have profound personal, social, economic and environmental impacts. The impacts of these disasters demand efforts in planning, preparation, response and recovery to improve community resilience. Exposure in Disaster Risk Reduction (DRR) describes as "what is at risk" that includes people, buildings, infrastructure (transport, energy, communications and water), businesses, hazardous substances, primary and major industries.

Australian Natural Hazards Exposure Information Framework (ANHEF) is aimed at supporting the development of nationally consistent exposure information systems to enable decision-making in disaster management to be evidence-based. This research has reviewed the current literature, engaged end-users and researchers to determine the requirements for both disaster response and disaster mitigation. The project conducted an on-line survey of existing exposure information capabilities in Australia to assess existing data and information capabilities. The survey identified significant gaps in the existing data availability and models to translate the raw data into meaningful information for evidenced-based disaster risk response, recovery and reduction decision-making. Overall, a lack of national consistency in existing data and information capabilities is a limiting factor in evidence-based decision-making. The collective views of data managers, researchers and end-users have formed the basis for exposure information requirements to develop a consistent, standardised exposure information framework that will support vulnerability assessments for disaster risk reduction and socio-economic impact analysis.

The ANHEF presents the exposure elements required to develop information systems to support various phases of disaster risk reduction from a variety of natural hazards at different levels of governance. The document outlines a generic framework to underpin the above mentioned diverse utilisation and is focused on end-user requirements. To reduce complexity in the user levels, the framework categorises the information provision into three levels depending on user requirements such as policy and planning; response and recovery; and research and analysis.

The ANHEF report is completed and being reviewed. Spatial enablement, land-use categorisation, insurance status and metadata are covered in the framework as fundamental information. Buildings are vulnerable from the impact of natural hazards and malevolent acts. The exposure elements of buildings considered are usage, type, structural system, number of storeys, number of basements, wall type, roof type, size, age, attachments, replacement value and contents value. Infrastructure is the lifeline support for communities, the economy and disaster response. The infrastructure sectors considered are transportation, energy, communication, urban water supply, waste management and hazardous substances. Infrastructure assets are vulnerable to the impact of not only natural hazards and malevolent acts but also their own failure. Information on heavy industries exposed to natural

hazards is critical to the economy and safety of workers. Major industries, particularly the manufacturing sector, are considered within the scope of this exposure component. An industrial site has many unique elements that are at risk and contribute to the value chain of the economy. Primary industries sector includes agriculture, fishing, forestry and mining. Population exposure with a particular emphasis on the demographic indicators such as remoteness, population density, mobility, socio-economic status, age profile and communication skills are included.

Business exposure information framework, part of ANHEF consists of business definition and activities information that is deemed necessary for disaster management. The framework identifies information requirements on business exposure that address issues of business continuity, disruption, resilience and recovery in disaster management. The framework has identified different elements of business and economics exposure for different economic activity levels such as micro and macro-economic levels, through an extensive literature review and subject area expert and stakeholders consultations. The report is completed and submitted.

Reliability assessment framework, part of ANHEF provides knowledge on the data available for end-user decision-making. The exposure information systems source the data from sources with varied resolutions, quality, standards, aggregations, disaggregations, statistical approximations and estimations. The reliability assessment framework primarily adopts the ISO standards data quality evaluation procedure as well as data provenance framework. The report is completed and under review.

The ANHEF will increase quality, and drive consistency and continuous improvement in Australian DRR. In achieving these outcomes, the framework provides shared strategic directions and priorities for governments, communities and industry sectors to implement the entire framework to build a national exposure information system. The framework also enables and provides guidance for the end-users to identify certain exposure components as a priority for implementation.

END USER STATEMENT

Martine Woolf, *Geoscience Australia*

This project has developed a nationally consistent built environment information framework for Australia. The framework presents details of key components, elements and attributes of the built environment. Importantly, the project has engaged with end users and researchers through a roadshow to determine their requirements for disaster response, disaster mitigation and research.

The project has now fully delivered on its milestones, including the business exposure framework, which was deferred until September 2016. This outcome is significant as the Business Exposure Information Framework developed is a significant component which will underpin consequence assessment for disasters impacting the business sector. The project has also completed the reliability assessment framework which provides an ISO derived evaluation framework to convey the data provenance to end users. This will prove useful in addressing the variability in resolution of data quality and standards found in available exposure data.

Through the range of its outputs, this project has contributed significantly to a better and more consistent assessment of the consequences of natural disasters. This project therefore directly supports one of the fundamental elements of disaster resilience, aligning with the Bushfire and Natural Hazards CRC research program objectives as well as the UN Sendai Agreement for Disaster Risk Reduction. The project has also been advancing by developing a tool for the exposure information dissemination for end users as an utilisation project.

INTRODUCTION

What is the Problem?

Disaster Risk Reduction (DRR) is a systematic approach to identify, assess and reduce the risks from natural hazards. Exposure information is a fundamental requirement for situational awareness in disaster management. A nationally consistent, standardized terminology and comprehensive exposure information system to assist decision makers and researchers is not available in Australia. Geoscience Australia (GA) has developed a nationally consistent exposure information capability: 'National Exposure Information System (NEXIS)', to assist the development of risk assessment capabilities for GA's Community Safety program. There are many other organisations that maintain their own datasets to support specific programs. There is no nationally consistent, comprehensive, authoritative, robust and reliable information accessible for all natural hazards and all levels of governance.

Why is it Important?

Natural hazards have a profound impact on the Australian communities. The Hyogo Framework for Action (HFA, United Nations 2005) and subsequent national strategies such as the Australian National Strategy for Disaster Resilience (COAG 2011), highlight the importance of assessing risks and preparing for them. Communities are subject to the damaging impacts of disasters caused by destructive bushfires, floods, and severe storms. The impacts of these disasters on people, economy, infrastructure and environment remind us of the need to continue improving our resilience to disasters (COAG, 2011).

Current disaster preparedness strategies often focus on building resilience for known disaster risks. However, disasters are characterized by interdependent and systemic risks that can trigger cascading effects which are hard to predict. The 'unexpected' is already part of life for many communities. For this reason, there is an urgent need to investigate ways to prepare for what we are not able to predict or to communicate to the communities.

There is a need to develop a framework to prepare guidelines for national consistency to provide situational awareness and support disaster management initiatives, provision of comprehensive exposure information is fundamental for risk assessments and to underpin decision making.

How are we going to solve it?

An exposure information framework that supports all hazards is a significant step towards developing national exposure information capabilities for Australia.

A literature review, stakeholder engagement workshops and consulting experts will enable the project to prpare a framework that consists of comprehensive exposure information needs. The exposure information list comprises of buildings, people, infrastructure sectors, industries, business, economic and primary industries. Further a review on existing exposure information systems to be conducted to understand the current practices that support disaster management. This process will enable the project to highlight the gaps and

priorities. Based on the experiences, existing information systems are not comprehensive enough and lack of consistency across the nation. Improvement in the availability of relevant, consistent and high quality exposure information will assist decision making in planning, preparedness, response and recovery of DRR and to respond at federal, state and local government levels. An exposure information framework will assist in developing and promoting more unified national information capabilities.

The information available may not be suitable for diverse range of activities and levels of governance. The project is preparing a reliability framework for the end users to understand the provenance of the data and its reliability for their specific use.

This comprehensive framework provides guidelines to the exposure data custodians to build nationally consistent, robust and reliable exposure information systems for the nation.

PROJECT BACKGROUND

A good understanding of the risk of natural hazards is vital to minimize their potential impact (Middlemann, 2007). An understanding of hazard, exposure and vulnerability is fundamental in any rigorous analysis of the risk posed by natural hazards. Exposure is the collection of elements at risk to potential losses or that may suffer damage due to a hazard impact. Exposure refers to the communities, businesses, services, lifeline utilities and infrastructure subjected to risk. Exposure information is fundamental in the development of risk-assessment models for natural hazards, lifeline and infrastructure failures and also consequences of climate change. Exposure data is also highly useful to underpin early warning systems and support national priority outcomes as described in the National Disaster Resilience Strategy (NSDR) referenced in COAG, 2011: Understanding risks; reducing the risks in the built environment; and, supporting capabilities for disaster resilience. To be effective the framework should be aligned with the National Emergency Risk Assessment Guidelines (NEMC, 2014).

GA has developed the National Exposure Information System (NEXIS), which provides exposure information about building attributes at a range of resolutions (Nadimpalli, 2007). NEXIS development was initiated in response to the Council of Australian Governments Report (COAG, 2003) to establish a nationally consistent system of data collection, research and analysis to ensure a sound knowledge base on natural disasters and disaster mitigation. NEXIS provides physical exposure such as building counts as well as statistical aggregations of buildings at different geographic areas to assess the quantitative risk from natural hazards. The aim of developing NEXIS was to support GA's risk assessment capabilities and the Government's climate change adaptation policy framework. NEXIS information has supported several climate change adaptation initiatives including climate change risks to Australia's coast.

Decision making at all levels of the disaster governance process is very complex and depends on multiple attributes, objectives, criteria and functions. A nationally consistent exposure information framework for natural hazard risk reduction provides pathways to strengthen existing information capabilities such as NEXIS and forms the basis of an essential element for decision making.

WHAT THE PROJECT HAS BEEN UP TO

This research project to develop an Australian Natural Hazards Exposure Information framework (ANHEF) is funded by Bushfire and Natural Hazards CRC (BNHCRC). The annual report outlines the achievements and progress of the project milestones in 2016-17.

The business-economic exposure information framework is completed and submitted on 30 September 2016 (Nadimpalli et al., 2016). Natural disasters disrupt business, affecting not only the economy of a region and the community. Businesses with an understanding of their risk from natural hazards are able to develop disaster management plans. This is the first attempt at developing a nationally consistent framework for business and economic exposure information and identifying the complex exposure data requirements that are important for enabling a better understanding of business vulnerability to natural disasters. The business-economic exposure is categorized into micro- and macro- economic analysis. The information requirements for micro-economic analysis or business continuity is primarily at the asset level with details such as type, revenue, cash flow, employees, size, diversity, assets and liabilities, etc, required. Whereas the elements identified at the national level are intended for macro-economic level analysis about the impacts of natural hazards on the nation's Gross Domestic Product.

Reliable and consistent information on natural hazard exposure is important for disaster management and decision making. Data reliability framework is a critical component in the ANHEF and can underpin exposure information systems to ensure the quality of the data is informed to the end users. The project has reviewed literature, different data reliability indicators and current practices. Building from ISO data quality evaluation procedures as well as data provenance models, exposure information reliability framework is proposed. The reliability indicators are complex to implement thresholds uniformly for all users. It is suggested that the data custodians implement some initial reliability thresholds and encourage the users to modify as per their requirements and communicate back for improvement. The reliability framework report is completed (Vidyattama, 2017-under review) and is under review to submit as a milestone report.

The ANHEF is completed (Nadimpalli, et al., 2017-under review) and presents the exposure elements required to develop information systems to support various phases of disaster risk reduction from a variety of natural hazards at different levels of governance. The framework consists of a comprehensive list of exposure information requirements, standard attribution for national consistency, available datasets to build upon the existing information systems and suggestions. The collective views of data managers, researchers and end-users have formed the basis for exposure information requirements to develop the information framework that will support vulnerability assessments for disaster risk reduction and socio-economic impact analysis.

The ANHEF categorises the information provision into three levels depending on user requirements such as policy and planning; response and recovery; and research and analysis. The fundamental information and common elements

that underpin the entire exposure framework, such as spatial enablement, land-use categorisation, insurance status and metadata are outlined in the ANHEF.

Buildings are vulnerable from the impact of natural hazards and malevolent acts. The exposure elements of buildings considered are usage, form, structural system, number of storeys, number of basements, wall type, roof type, size, age, attachments, replacement value and contents value. Building exposure element requirements, existing data sources and suggestions for the models to derive the information are outlined in the ANHEF.

Infrastructure is the lifeline support for communities, the economy and disaster response. The infrastructure sectors considered are transportation, energy, communication, urban water supply, waste management and hazardous substances. Infrastructure assets are vulnerable to the impact of natural hazards and malevolent acts and also their own failure. The infrastructure sectors exposure element requirements of end-user and researchers, existing data sources and suggestions are outlined in ANHEF.

Information on heavy industries exposed to natural hazards is critical to the economy and safety of workers. Major industries, particularly the manufacturing sector, are considered within the scope of this exposure component. An industrial site has many unique elements that are at risk and contribute to the value chain of the economy. For major industries, the exposure element requirements of end-users, researchers and the insurance industry, existing data sources and suggestions are outlined in ANHEF.

The primary industries sector includes agriculture, fishing, forestry and mining. The types of natural hazards or the climatic conditions and factors that impact on this sector in Australia include drought, water security, soil fertility, weeds, global warming and biosecurity. Primary industries exposure element requirements, existing data sources and suggestions are outlined in the ANHEF.

Australian communities are varied in their composition and in their level of exposure to disaster risk (COAG, 2011). Factors that can influence disaster management and resilience include remoteness, population density, mobility, socio-economic status, age profile and communication skills. The population exposure elements requirements of end-users and researchers, existing data sources and suggestions are outlined in ANHEF.

The ANHEF has identified the exposure components, elements and standard attributes through a comprehensive review of literature and engaging with stakeholders. The report highlights the relevant data that exists and identifies the gaps and overlaps in data. A critical element for the utilisation road map would be a communicating strategy to a range of stakeholders about the importance of the ANHEF and how it will assist them in impact assessments.

PUBLICATIONS LIST

Nadimpalli, K. and Vidyattama, Y. (2016) Natural Hazards Exposure Information Framework – Reliability Index for Decision Makers, Abstract, AFACConference 2016.

Nadimpalli, K., Mohanty, I., Kalantri, M. and Rajabifard, A. (2016) Business Exposure Information Framework, Milestone Report – September 2016, Bushfire and Natural Hazards CRC, Australia.

Vidyattama, Y (2017) Data Relibility Framework for Natural Hazards Exposure Information Framework, Milestone Report – June 2017, Bushfire and Natural Hazards CRC, Australia. (Under Review)

Nadimpalli, K., Mohanty, I., Kalantri, M. and Rajabifard, A. (2017) Australian Natural Hazards Exposure Information Framework, Milestone Report - June 2017, Bushfire and Natural Hazards CRC, Australia. (Under Review)

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REFERENCES

1. *COAG 2011, National strategy for disaster resilience - building the resilience of our nation to disaster, Commonwealth of Australia 2011, ISBN: 978-1-921725-42-5*
2. *HFA, 2005 Hyogo Framework for Action 2005 - 2015: Building the resilience of nations and communities to disasters. International Strategy for Disaster Risk Reduction, United Nations, World Conference on Disaster Reduction 2005, Kobe, Hyogo, Japan.*
3. *Middelmann, M. H., (Editor) (2007) Natural Hazards in Australia. Identifying Risk Analysis Requirements, Geoscience Australia, Canberra.*
4. *Nadimpalli, K., Edwards, M. and Mullaly, D. (2007) 'National Exposure Information System (NEXIS) For Australia: Risk Assessment Opportunities', In Oxley, L. and Kulasiri, D. (eds) MODSIM 2007 International* Congress on Modelling and Simulation. Modelling and Simulation Society of Australia and New Zealand, December 2007, pp. 1674-1680. ISBN : 978-0-9758400-4-7
5. National Emergency Management Committee (2010) 'National Emergency Risk Assessment Guidelines', Tasmanian State Emergency Service, Hobart.
6. National Emergency Management Committee (2011) National Strategy for Disaster Resilience. Australian Emergency Management Institute, Attorney-General's Department, Australian Government.
7. NEMC, 2010 National Emergency Risk Assessment Guidelines, Tasmanian State Emergency Service, Hobart, ISBN 978-0-9805965-1-9