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USING NATURAL DISASTER SCENARIOS TO BETTER UNDERSTAND EMERGENCY MANAGEMENT REQUIREMENTS

Annual project report 2014-2015

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Cover: To help agencies prepare for future disasters, research is modelling the potential impact of disasters that are beyond our experience, such as a major earthquake affecting a capital city.

Photo: John Mccombe, New Zealand Rural Fire Service

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EXECUTIVE SUMMARY

This project aims to produce realistic natural disaster event scenarios to help emergency managers understand and prepare for eventual natural disasters. Scenarios consist of numerical data such as maps and tables representing the impacts of a plausible natural disaster scenarios; plausibility is determined by analyzing past event occurrence, intensity and impact data. Scenarios are created by using a suite of analysis tools including statistical inference, expert elicitation and comparative analysis in order to create abstract representations of an event, which is as close to reality as possible.

Over the past year, this project has delivered its first two complete scenarios, namely, an earthquake of magnitude 6.0 occuring in the Para fault underneath Adelaide CBD, and a tropical cyclone affecting SE Queensland (to be delivered third quarter 2015). The outcomes of the Adelaide scenario comprise:

- Total aggregated damage to residential and commercial properties
- Maps showing the distribution and intensity of damage to buildings and casualties
- Distribution of infrastructure and essential facilities (hospitals, schools, roads, etc) that would be destroyed in such an event
- Comparative analysis with past events

These outcomes and their detailed interpretation were delivered in a corresponding technical note. Results were presented to end-users in a workshop held in Adelaide including representatives of SAFECOM and other SA government agencies including SA police and DPTI. According feedback from end-users, future scenarios should:

- Take into account the distribution of vulnerable populations (elderly, disabled)
- Account for the relationship between different infrastructure systems (e.g. how damage to roads impacts hospital operations).
- Cost of response and cost-benfit analysis of mitigation measures

Following this, work on year 2 scenarios has begun. A workshop was held with NSW SES end user to determine appropriate scenario events of interest to their agency. This complemented comments and suggestions drawn from the full end-user community at the most recent RAF. Resultant scenarios to be explored over the coming year will be:

1. A sequence of minor and major flood events in NSW
2. Heatwave mortality during a major event in VIC
3. Tropical cyclone induced flooding in SE Qld and northern NSW

END USER STATEMENT

Simon Opper, Emergency and Risk Management Branch, SES, NSW

Management of natural hazards, their impacts and their interactions in communities using structured mathematical and information system approaches is a critically important evolution of disaster management. Other sectors of industry and commerce use a variety of computational network and information modelling approaches to solve large and complex interconnected problems. These need to be applied to disasters. So the next few years will see disaster managers developing more formally adopted approaches to network, agent-based and least cost based methodologies and the research outlined in this poster will be part of the groundswell which will assist in understanding the adaption and innovation of these approaches to disasters.

INTRODUCTION

Government agencies, including those responsible for emergency management, response and policymaking, need to prepare for natural disasters and other emergencies before they happen. One thing we can predict about natural disasters is that they are unpredictable! In many instances, emergency responders or government planners have to deal with unforeseen consequences of disasters without parallel in past events; one such example is the extensive damage to infrastructure in Christchurch following the Darfield earthquake in October 2010.

Realistic disaster scenarios can be used to facilitate emergency management, response planning and policymaking. They allow end-users to visualise the impacts of plausible events before they happen. For the purposes of this project, we define 'disaster scenarios' as a collection of maps, data and descriptive information of human and material losses due to a natural hazard event.

We qualify these scenarios as 'realistic' for two reasons: first, we will develop scenarios for events that haven't occurred but have a moderate likelihood of occurring and causing extensive damage during a person's lifetime; second, we will model as many details as possible from these events.

The main tool we will use to accomplish this will be the so-called catastrophe loss models, or CAT-models for short. These are mathematical representations of natural disaster events, usually developed from statistical analysis of past event data, guided by technical knowledge and expert judgement. CAT-models usually consist of three modules: a hazard module, which expresses the probability and intensity of natural processes leading to damage; a vulnerability module, which calculates the amount of human or material loss due to a natural hazard process; and a exposure module, which provides the location and quantity of assets at risk. As an example, an earthquake loss model hazard module provides the likelihood of a given level of ground-motion at an arbitrary location due to an earthquake; the vulnerability model provides an estimate of damage and casualty from a given level of ground-motion; and the exposure module provides the number and quality of assets (building type, number of people, etc.) at a given location.

PROJECT BACKGROUND

The aim of this project is to develop a number of realistic disaster scenarios, according to the definition given above, and present their results using an integrated visualisation tool. The research part of this project consists of studying Australian-specific vulnerability and hazard information, to be used in the development of the scenarios. The technical part consists creating a visualisation tool for the scenarios with feedback from end-users.

WHAT THE PROJECT HAS BEEN UP TO

The Adelaide earthquake scenario was released at the end of April this year (2015), with the tropical cyclone scenario to be deilivered in late August/early September. Delivery of the Adelaide scenario was followed by workshops with end users to gather feedback and help define the scope for next year's scenarios.

Based on end-user feedback, limitations of the current modelling approach to be considered for future scenarios included:

- Long-range effects of natural disaster damage, for example, how damage to roads will affect access to hospitals
- Including population vulnerability (elderly, low-socio economic strata) into sociological impact assessements
- Assessing the cost of response into financial impact assessments
- Explore the use of scenario models to exemplify the cost-benefit of retrofitting

In addition to the direct scenario modelling work undertaken, researchers were involved with post-event damage survey work, which serves as a source of validation for model and sub-model components and overall modelling approaches. Over the last year two damage/impact surveys were carried out by researchers from both Risk Frontiers and UQ, both in conjunction with the Cyclone Testing Station from James Cook University. These were:

- 27 November Supercell thunderstorm, Brisbane (Qld)
- Tropical Cyclone Marcia (Rockhampton, Yeppoon region), North Queensland

Both surveys involved interaction with the QLD Fire and Emergency Services agency.

Following the RAF held in Sydney in early 2015 several end user meetings were held to determine scenarios to be explored over the coming year. These shall include:

FLOOD SCENARIO FOR NSW

We will develop a flood scenario for NSW that will answer questions about resource utilization in the build-up to a large event. Large floods in Australia tend to be preceded by multiple small events; this scenario will consider the damage caused by these small events as well the 'major' large event/s occurring at the end of the build up period. To do this, Risk Frontiers will use the stage vulnerability curves from its catastrophe loss models, flood hazard data from the national flood information database (NFID), historical river gauge and storm data, and past loss experiences. These datasets will be used to estimate a scenario that is consistent with past experience in regards to event extension and duration. This scenario will aim at calculating damage to residential homes, road blockages, and infrastructure. An example of such event is the Great Flood of 1954, which

affected multiple catchments around Lismore NSW – whose exposure today is approximately 6 times that of 1954 (Roche et. al. YEAR).

HEATWAVE SCENARIO FOR AUSTRALIA

Heatwaves are the deadliest natural hazard in Australia according to Coates et al. (2013) and research within this BNHCRC. In this scenario Risk Frontiers will study the impact of heatwave in the human and building environments of Australia. The heatwave scenario – its temporal and spatial extentions, will be determined from a large analysis exercise of the gridded temperature dataset provided by the Australia Bureau of meteorology. This scenario will explore the extreme heat factor (EHF, Nairn et al 2013) as a predictor of heatwave mortality by comparing back-calculated values of EHF (courtesy of Daniel Argueso, UNSW) with historical heatwave fatality record. Risk Frontiers has already developed a methodology to produce heatwave footprints, which can be overlain to census data of vulnerable population – mostly elderly populations – and be used to estimate how resources will be drawn under such conditions.

TROPICAL CYCLONE INDUCED FLOODING

The tropical cyclone wind damage scenario model developed during the first phase of this project will be extended to include rainfall and subsequent riverine flooding. Riverine flooding is a major contributor to the overall impact of tropical cyclones, with many of the most significant flood events in tropical Australia being the results of decaying tropical cyclone system (e.g. 1954 floods in northern NSW and the 1974 Brisbane floods). A scenario with characteristics similar to both the 1954 and 1974 events will be developed and both wind and flooding impacts will be simulated. Methods to estimate the compounding impacts of these two sub-hazards will be explored. The possibility of using this type of scenario as a forecast tool will also be studied, following recommendations from the 2015 RAF.

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