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THIS ISSUE'S COVER STORY:

What the research reports from the Victorian Bushfires Royal Commission revealed?

Employing geospatial methods in emergency management.

Is Tasmania prepared for Tsunami?

How to get the most out of remote sensing in the emergency management cycle.

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Please note that contributions to the Australian Journal of Emergency Management are reviewed. Academic papers (denoted by Ⓡ) are peer reviewed to appropriate academic standards by independent, qualified experts.

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ABOUT THE JOURNAL

The Australian Journal of Emergency Management is Australia's premier Journal in emergency management. Its format and content is developed with reference to peak emergency management organisations and the emergency management sectors—nationally and internationally. The Journal focuses on both the academic and practitioner reader and its aim is to strengthen capabilities in the sector by documenting, growing and disseminating an emergency management body of knowledge. The Journal strongly supports the role of the Australian Emergency Management Institute (AEMI) as a national centre of excellence for knowledge and skills development in the emergency management sector. Papers are published in all areas of emergency management. The Journal emphasises empirical reports but may include specialised theoretical, methodological, case study and review papers and opinion pieces.

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This photo won the National Highly Commended Award and the ACT Highly Commended Award in the individual category in the 2010 National Emergency Management volunteers Photographic Competition.

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Foreword

By Raelene Thompson, Executive Director of the Australian Emergency Management Institute.

This edition of AJEM introduces new research about disaster resilience in the context of climate change adaptation, football match security, tsunami, foot and mouth disease, bushfire/post-Black Saturday, remote sensing and business continuity. It also has 'opinion pieces' on bushfire and on coastal planning. What a range of topics the emergency management world covers, in this new national security focussed era.

The Australian Emergency Management Institute (AEMI) at Mt Macedon is proud to produce AJEM on behalf of the Attorney-General's Department, as a contribution to the development of national capacity in the emergency management sector. AEMI is embarking on a new era of revitalisation as a national Centre of Excellence for the delivery of knowledge and skills development within the emergency management sector.

I am pleased to have been recently appointed as the Executive Director of AEMI, taking up my post from the beginning of September, 2010. Since then I have met many in the emergency management sector, including from the vast AEMI alumni, members of the National Emergency Management Committee and Community Engagement Subcommittee (that AEMI provides Secretariat for) and members of the Volunteer sector.

Let me introduce myself to you with some background information:

- My previous appointment was head of the eHealth Group in the Department of Health and Ageing (DoHA). This role was responsible for the strategic direction and delivery of eHealth in Australia, working with all jurisdictions and across government.
- My previous experience also includes responsibilities as State Manager for DoHA in Victoria, in the areas of rural health, indigenous health, aged care general practice and in the Office of Health Protection related to communicable diseases surveillance. In 2007-8 I was the State Manager of the Aged Care Standards and Accreditation Agency in Victoria.
- I have over 25 years experience in the Commonwealth public service across a range of portfolios, including social security, employment and workplace relations, and heath and ageing.

The residential courses offer the opportunity to meet and network with other emergency management professionals.

Experts revise an Australian Emergency manual on recovery from disaster.

Lectures in the Macedon Ranges Theatre.

The AEMI library informs and supports the emergency management sector.

The institute is surrounded by extensive European style gardens.

I know that AEMI has been playing an important role in the national emergency management landscape for over five decades. AEMI deserves its time-honoured reputation as Australia's premier emergency management education and knowledge facility.

I know that the emergency sector is a key element of a just and secure society in Australia. I pay particular tribute to the emergency management volunteers, and to those in the multi-cultural and indigenous communities who also contribute so much to the nation.

Please feel free to contact me if you want to discuss the products and services based at AEMI, including courses and workshops, research activity and community awareness activities such as AJEM, the national 'Emergency Management in Australia' website, schools program and the national Library/resource centre.

As AEMI continues its quest towards a Centre of Excellence, one of the important priorities that we are focussed on is the training needs analysis that we have recently conducted. Over the coming months, the analysis of the sector's views about what education or training AEMI needs to provide, will inform the redevelopment and continuous improvement of our curriculum, ensuring an alignment of our courses and other activities with the needs of the sector.

I would like to take the opportunity to thank all those who participated in the TNA. We will provide more detail information about this in a future AJEM edition.

Opinion: Emergencies and land use planning

By David Place, Chief Executive Officer of the South Australian Fire and Emergency Services Commission (SAFECOM) and Marc Bellette, Australian Emergency Management Institute, Mt. Macedon.

Given the plethora of workshops, conferences and working groups on climate change you might at first wonder why AEMI recently ran the 'Risk, Emergencies and Land Use Planning in Coastal Australia' workshop at the Australian Emergency Management Institute (AEMI) at Mount Macedon?

The AEMI developed the workshop as a response to requests from emergency management industry concerns about the paucity of information that links climate change and emergency management. Despite the large number of papers presented at a recent international conference on climate change, attendees noted the scarcity of land use planning and climate change topics specifically related to emergency management. This fact was alarming not only because emergency management and land use planning are thought to be critical to the climate-changed future, the information flow between people in these and engineering communities will create the best possible outcomes for safer communities.

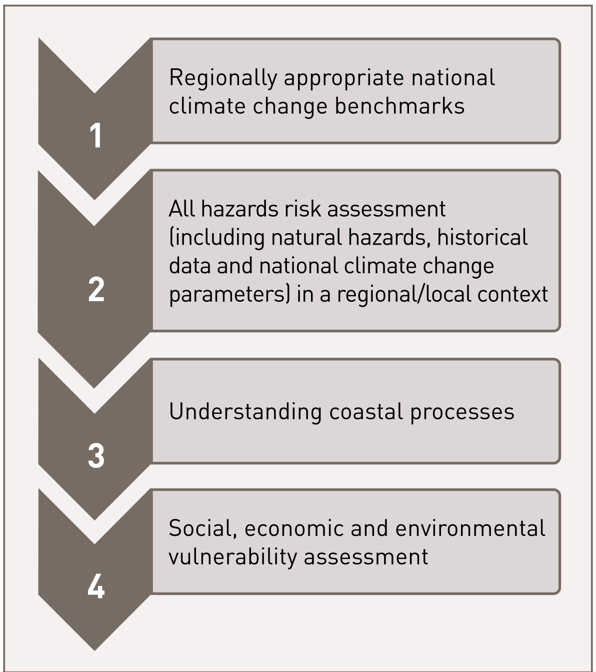
Achieving a community understanding of the likely climate scenarios and the potential policy responses through land use planning and emergency management is important in shaping Australia's future. But does a conundrum between land use planning and emergency management exist? Planners are often focused on managing a diverse and complex range of land use and societal issues that are often politically sensitive, whereas emergency managers are primarily faced with the daily concerns of risk reduction and the safety and security of the community[1]. They are at first glance two unlikely groups to share a common goal. Yet on the topic of climate change adaptation this workshop revealed a strong common vision to avert future catastrophes by working closely with local and regional communities. Meanwhile the barriers to achieving safe coastal communities are many and they include diverse community views on the likely effects of emerging risks of climate change, and on-going short, medium and long term political and economic pressures that drive poor land use planning decisions.

Controls such as land use zoning, development assessment conditions, building codes, floor/site levels, setbacks (coast and rivers), buffers, drainage and detention basins (sea walls and levees), access and egress routes are examples of suitable planning responses to mitigate emergencies under climate change scenarios[2]. The planning provisions for these responses are usually a balance between costs of development and the acceptable risks. By determining these minimum acceptable safety standards, the true cost of emergency management is usually considered a residual risk and is not taken into account. Whilst this residual risk has (or has not) been tolerable for development now, increases in likelihood and consequences of emergencies as a result of climate change will affect this balance in decision making with a need to give more weight to considering controls. Existing zoning (the right to build), hazard exposure, information about hazards, population projections and growth, politics and land affordability and availability are all constraints in land use decision making

The aims of emergency management, (to protect life (no loss), property (minimise loss) and the environment (minimise and conserve)) should be achieved during the response to a major event, but also there is a duty to the public to achieve these aims both prior (planning and preparation) and after (recovery) events. Whilst land use planning needs to consider many real and potential constraints which are acknowledged in the decision making process, the constraints of emergency management providers (both now and in the future) are poorly considered or given adequate importance. Such constraints include limited resources/capability, uncertainty about the timing of hazards and their scale, community behaviours and attitudes about emergencies, and a societal misconception that emergency services are primarily focused on response activities (with little input to planning, preparation and recovery). Legacy issues of poor or minimal land use planning, and short term politics are also factors constraining the activities of emergency service organisations.

A central issue is that the cost of residual risk is borne by the individual property owner at the time of an event, not the developer or indeed the original property owner who may have accepted the risk given their land tenure. All levels of government inherit residual risk second

[1] David King, workshop keynote speaker.
[2] The first three paragraphs of this section summarise a workshop activity led by Steve Opper.



Four knowledge needs planners and emergency managers require from science and engineering to support decision-making.

hand through the direct impact on property owners and their possessions. These costs for both the land owner and governments are likely to increase significantly in coastal areas given the climate change scenarios. When land use planning decisions are made with assumptions about the magnitude of events and the likely behaviour of the public (that they will all evacuate by a given time for example) it should be incumbent on a land use planning decision to prove that these assumptions are likely to be correct. Government can support this decision making through a number of initiatives. The workshop participants identified four knowledge needs that both planners and emergency managers require from science and engineering to support decision making. The agreed criteria for choosing these items were that they should be important, efficient, useful, achievable, defensible, and urgent (often urgency relates to political decision making).

The four areas identified were as follows (seen as a cascading succession of topics rather than in order of priority): regionally appropriate national climate change benchmarks; all hazards risk assessment (including natural hazards, historical data, and national climate change parameters) in a regional/local context; understanding coastal processes; social, economic and environmental vulnerability assessment. Work groups identified the key need and components for each of these four priorities.

Going forward, the workshop gained consensus on the need for consistent policy framework between emergency management, planning and science that includes the following three elements:

- data accessible to the planning, engineering and emergency management communities; and
- professional links (relationships between stakeholders present at the workshop and incorporating those not represented); and
- communication and community education (clear, and delivered with meaning).

A major area identified for developing the capability is education and training. Courses currently available in Australia that relate to this need are few. Currently a climate adaption and planning professional development course has been piloted by Planning Institute of Australia (PIA) and is now available as a PIA accredited course for planning professionals (with a non emergency management focus). The University of Queensland has developed a number of modules for teaching climate change adaptation that identify elements of risk management and emergency management principles[3]. The current status or roll-out of these modules is not known. AEMI conducts a Risk Based Land Use Planning course, but this does not specifically contain material on climate change issues[4], which is also true for the University of Sydney which runs a post-graduate course in risk based land use planning[5].

One challenge to incorporating emergency management into university undergraduate programs is the funding arrangements, as such subjects only support small student cohorts (<~30 students)[6]. Therefore the opportunities that a University has in meeting the professional development needs of emergency managers tend to be in post graduate studies. There is a gap between the qualification level of obtainment of many emergency service professionals and post-graduate studies.

Participants endorsed the approach and principles of the *Draft National Planning Principles for Climate Change* presented and discussed at the workshop. This document is a product of the Planning Officials Group (POG) of the Local Government and Planning Ministers' Council (LGPMC). The report arose from the proceedings of an expert Think Tank on National Planning Principles for Climate Change (Brisbane, 8 March 2010). As workshop chair, I intend to commend the full workshop report to the National Emergency Management Committee (NEMC) and to promote to the NEMC that this workshop should be the first of others to explore land use planning as a treatment for natural hazards.

To obtain a copy of the full workshop **Marc Bellette** may be contacted at the Australian Emergency Management Institute at marc.bellette@ag.gov.au

[3] Marc Bellette, workshop comments.
[4] ibid.
[5] Steve Opper, workshop comments.
[6] Alison Cotterell, ,workshop comments.

Opinion: Community bushfire safety and possible future steps for research led policy

By Dr Marc Bellette, Strategy and Research, Australian Emergency Management Institute.

The paper *community bushfire Safety: a review of post-Black Saturday research* by Whittaker and Handmer (pages 7 – 13 of this edition) provides an important and timely review of studies of bushfire community safety. This appears to be the first attempt to systematically review various studies (n = 9) post-Black Saturday. It is encouraging to read that there has been a developing research focus on community awareness and attitudes, planning and preparedness arising from Black Saturday. The findings by Whittaker and Handmer show challenges for agencies in navigating our communities through pending policy changes. This is demonstrated in the paper by the suggestion that community understanding of Code Red FDR is limited, and the finding that 'many people intend to wait for advice or until they are directly threatened'. In the context of evolving policy, these findings (and others presented in the paper) are important in understanding how agencies should communicate with the public, and what information should be given. In this way, a role for research to lead policy exists; *research-led* policy.

People often accept research findings at face value, whilst emergency managers need an *in-depth* clarity of research given the consequences if their decisions are incorrect. This means an understanding of methodological design, interpretation of results, and the level of confidence (essentially *trust*) that can be attributed to research findings. If new policies are to be informed by research then it has to be assured that its recommendations are likely to be corrective and not maladaptive to what is intended. To this end, study approaches, assumptions and limitations of research methods need to be understood not by researchers alone, but communicated to policy makers in a manner they understand. As a small but important case in point, Whittaker and Handmer report that a 95% confidence interval is typical in social research, but do emergency management policy makers understand that this means that there is a 1 in 20 chance that the research findings are incorrect? Are policy makers happy or unhappy with this level of confidence?

The nine studies are all inductive research (moving from specific observations to broader generalisations). Many of the nine studies used frequency counts in analysing results. Whilst counts of responses can be informative, further questions and statistical analysis of the data would be well worthwhile given the amount of work done in the survey stages. Searching for correlations between discrete community behaviours and uncovering demographic correlates would be interesting. Studies that use multivariate statistics (particularly widely used techniques in quantitative social research such as Principal Components Analysis and Multi-dimensional Scaling) are highly suited to research aims that seek to explore, discover, understand and investigate (as are the reported aims of many of the nine reports reviewed by this paper). The generation of hypotheses of the causal relationships behind community behaviours could then be tested leading to a more robust set of findings for future policy.

In early October, I attended the APEC Emergency Preparedness Working Group International Conference on Managing Forest Fires, in Khabarovsk, Russia. We are not alone in our challenges. Large fires this year in Russia, central Asia and the Americas have demonstrated that fires are a growing global problem. Australia's progress in communication with the community, policy and research is of interest to the international fire management community; particularly as most fires throughout the world are have anthropogenic causes and consequences. Developing research on community safety and behaviours in the international context of forest fire management would be timely.

About the author

Dr Marc Bellette has a PhD in fire ecology, and is interested in land management of forests and woodlands of Victoria. He has held positions as Associate Lecturer at La Trobe University, and position of Lecturer with the University of Melbourne. He currently works for the Australian Emergency Management Institute in the Research and Strategy Group.

Editors note: The April 2011 edition of AJEM will have a special focus on bushfire. Contributions to the debate are welcome.

Community bushfire safety: a review of post-Black Saturday research

Dr. Joshua Whittaker and Prof. John Handmer analyse the research reports presented to the recent Victorian Bushfires Royal Commission.

ABSTRACT

Following the 'Black Saturday' bushfires of 7 February 2009, a number of research reports on community bushfire safety were presented to the Victorian Bushfires Royal Commission. These include reports from the CFA, OESC, Bushfire CRC and Department of Justice. These reports have different research aims and employ a range of methods and samples. Some reports investigate community safety issues during the Black Saturday bushfires, while others examine preparedness and intentions for future fires. This paper reviews these reports to identify common findings, inconsistencies and gaps relating to community safety during bushfires, and discusses the implications of methodological differences for research findings.

Introduction

Saturday 7 February 2009 brought predictions of the worst fire weather conditions in the Australian state of Victoria's history. The weather conditions were significantly worse than predicted with a record high in the state capital's CBD (Melbourne) of 46.5 degrees Celsius and higher temperatures elsewhere. The day came after a severe and protracted drought, with most of Victoria receiving below average rainfall in the previous 12 years and the area surrounding Melbourne receiving the lowest rainfall on record (Teague *et al.* 2009, p.36). 173 people lost their lives and more than 2000 homes were destroyed in the fires, as well as significant dollar losses and long-lasting intangible impacts on those affected. Approximately 6000 households were directly affected by the fires and thousands more were severely disrupted. In addition to the lives lost from the fires, health authorities estimate that the January heatwave contributed to the deaths of another 374 people (Department of Human Services 2009). The research reports reviewed in this paper are concerned only with bushfires.

A number of research reports on human behaviour and bushfire safety (referred to in this paper as 'community safety') have been presented to the Victorian Bushfires Royal Commission, including reports from the Country Fire Authority (CFA), Office of the Emergency Services Commissioner (OESC), Bushfire Cooperative Research Centre (CRC) and Department of Justice. These reports have different research aims and employ a range of methods and samples. Some reports investigate household safety issues during the Black Saturday bushfires, while others examine preparedness and intentions for future fires.

The OESC commissioned a study to review the post-fire research reports that were presented to the Commission. The aim of the study was: to identify common findings, inconsistencies and gaps relating to community bushfire safety; to document the implications of methodological differences for the research findings; and to suggest areas where further research and agency efforts are needed. This paper summarises aspects of that study. While the findings set out below are well-supported by data, it is important to recognise that generalised statements inevitably conceal the variation and complexity of individual and community attitudes, intentions and behaviours. Nevertheless, by examining and bringing together results from many reports through a systematic analysis, this study has produced well-grounded results. The detail of each report and of our analysis can be found in the full report prepared for the OESC (Whittaker and Handmer 2010).

Approach

Most reviews of individual studies are in narrative form. Among their shortcomings, narrative reviews typically do not discuss how studies were selected for inclusion (the sample of studies is typically based on the author's whim, rather than on clear criteria), or provide explicit criteria for the assessment of the quality of, or the impacts identified by, different studies. This tends to hide any bias by the author(s), and importantly does not allow for findings to be replicated. In the medical and health sciences this has led to concern about the quality of reviews on which evidence based practice depends (Hemingway and Brereton 2009).

The idea of a systematic review evolved from these concerns with the intention of applying the same rigour in secondary research as is expected in primary research: "a systematic review is an overview of primary studies which contains an explicit statement of objectives, materials, and methods and has been conducted according to explicit and reproducible methodology" (Greenhalgh 1997). A meta-analysis is a statistical synthesis of the results of a number of primary studies that addressed the same question in a similar or ideally the same way. These approaches are now very widely used and have become routine in medical science (e.g. see the Cochrane Collaboration), and the techniques of systematic reviewing are developing rapidly (Hemingway and Brereton 2009).

Despite the apparent benefits, systematic reviews are subject to a number of important criticisms (Greenhalgh 1997; Hemingway and Brereton 2009). Many reviews do not follow the ideal review process. A major failing is often the selection of studies to include, with unpublished material often being ignored. Another issue is the combination of studies undertaken with different aims at different times and places (Eysenck 1995).

Here we do not undertake a full systematic review, but attempt to address some of the fundamentals of that approach, in particular the issues of study inclusion, quality, and interpretation of findings in the context of the individual study aims and methodology. The quality of research was assessed before inclusion, but this was not done using external blind peer reviewing.

All of the post-fire studies prepared for the Royal Commission were assessed as being of reasonable quality and are included, although the study on refuges of last resort is not included in most of the analysis due to its specific focus. It should be noted that none have been published in the scientific literature at this stage, but some were subject to review as part of internal quality control processes.

The research reports

For this study we reviewed the major community safety research reports presented to the Royal Commission, with the exception of a report dealing solely with fatalities (Handmer *et al.* 2010). These included reports from the CFA, the OESC, the Bushfire CRC and the Department of Justice.

Table 1 presents detail of the nine studies that were reviewed, including the aims, methods of data collection, sampling, timing and analysis of each, and their implications for research findings[1]. Readers are referred to the full review (Whittaker and Handmer 2010) and the individual studies (listed at the end of this paper) for more detailed discussions of research methodologies and findings.

Research aims and methods

The aims of a research project shape results by guiding the questions researchers ask and the methods that are used to investigate them. Aims vary and are a key issue in comparison. A distinction can be drawn between the reports that aim to investigate general attitudes, intentions and behaviours related to bushfire risk, and those that aim to investigate aspects of a specific event or threat. The OESC, Department of Justice and first CFA reports all investigate general attitudes, intentions and behaviours to bushfire risk, with a focus on what people *intend* to do in various circumstances. In contrast, the second CFA report and both Bushfire CRC reports focus on actual behaviours and responses to specific events or threats, in addition to intentions. For example, the CFA report investigates responses to an actual declaration of a Code Red/catastrophic bushfire danger day, and both Bushfire CRC reports investigate both intended and actual responses to the 7 February bushfires.

While reports on general bushfire risk present findings on levels of awareness, preparedness and intended actions for future fires, they do not necessarily indicate how people will respond when confronted with a bushfire.

Questionnaires were the most common form of data collection. Questionnaires are a time and cost effective method of collecting large amounts of data that can be analysed relatively easily and quickly. The questionnaires used by the OESC, Department of Justice and CFA generated *quantitative* data. Those used by the Bushfire CRC research group contained both pre-coded responses and open-ended questions. These open-ended questions allowed respondents to explain their responses in their own terms and produced *qualitative* data. The Bushfire CRC research group's first report was based on interviews that produced only qualitative data.

All methods of data collection contain inherent biases. For example, a landline phone survey is likely to exclude those who favour mobile phone use and/or do not have landlines – often younger people. Online surveys are likely to exclude those who do not have personal access to a computer and/or the internet, or who make limited use of the internet – often older people. There is potential for bias in any survey where a disproportionate number of people from an identifiable group do not respond.

All of the studies took measures to avoid sampling bias, such as taking a large, random sample and filling certain demographic and geographical quotas (Table 1). Findings may therefore be said to be more or less representative of the populations from which each sample was drawn. Studies by the Department of Justice, OESC and CFA variously sampled populations in the 52 high bushfire risk townships (as designated by the CFA), Fire Danger Rating (FDR) districts, and the state as a whole. Studies by the Bushfire CRC were principally concerned with community safety during the Black Saturday fires and

[1] The Department of Justice and OESC both produced two reports from their respective research projects. Our review considers each pair concurrently.

therefore sampled populations within the impacted areas. These studies did not employ random sampling strategies due to the relatively small size of the impacted population and the need to collect as much data as possible. Clearly, people with recent experience of fire are more likely to be aware of fire-related issues and be more sensitive to safety concerns.

All of the studies were undertaken after the Black Saturday bushfires. Consequently, the data collected for each report is influenced by respondents' recollections of the fires, subsequent media coverage, and heightened concern about the 2009/10 fire season. The semi-structured interviews undertaken by the Bushfire CRC immediately after the fires will have been influenced least by outside sources. Those conducted later in the year are likely to have been influenced by the considerable media coverage and new advice from agencies.

Review of key research findings

Analysis of the research reports identified a range of findings related to the following issues:

- Awareness and attitudes to bushfire risk;
- Planning and preparedness;
- Awareness and understanding of the Code Red Fire Danger Rating (FDR)[2];
- Intended responses to Code Red declarations;
- Decisions about when to leave and where to go; and
- Intended responses for the 2008/09 and 2009/10 fire seasons;
- Actions taken during bushfires.

Readers are directed to the full report for a more detailed discussion of key research findings (Whittaker and Handmer 2010).

High level of awareness

The reports revealed a generally high level of bushfire awareness in high fire risk areas, with Department of Justice and Bushfire CRC research reporting that around 80% of respondents considered themselves at risk. This is consistent with CFA research that found high levels of acceptance of personal responsibility for bushfire safety, with more than 90% of respondents agreeing that: a bushfire may impact on their property; they must be self-sufficient in the event of a fire; and they are responsible for their home and property during the bushfire season.

However, interviews conducted immediately after the Black Saturday fires by the Bushfire CRC revealed that many people living in suburban locations had not considered themselves at risk prior to 7 February. This was confirmed in the CRC mail survey, where a greater proportion of respondents from fire affected parts of Bendigo (60%) and Horsham (49%) reported that they hadn't considered or decided what they would do if a fire occurred, or had decided that they didn't need to do anything.

Of course, findings related to bushfire awareness will have been influenced by recollections of the Black Saturday fires, subsequent media coverage and heightened concern about the 2009/10 fire season.

Variation in fire plans and preparedness

The reports reveal a great deal of variation in planning and preparedness. Reports by the Department of Justice, Bushfire CRC and CFA and all found that around two-thirds of households had fire plans, with around 20-25% having a written plan. However, the Bushfire CRC's interviews with households affected by the fires revealed considerable variation in the quality of fire plans and their effectiveness during the fires. It also found that many people were not prepared for the severity of the February 7 fires. Around half of those surveyed by the Bushfire CRC rated their preparedness as high or very high; however, three-quarters wanted to be more prepared, suggesting that self-reported levels of awareness may be somewhat overstated.

Limited understanding of Code Red FDR

The research suggests a limited understanding of the new FDR system. CFA research found that around 60% of residents in high fire risk areas were aware that Code Red is the highest level of danger and that on Code Red days emergency services' advice is to leave early. However, Department of Justice research found lower levels of understanding in high bushfire risk areas, with around one-fifth of respondents identifying Code Red as the highest FDR and one-third aware emergency services' advice is to leave on these days.

There are a number of reasons why these findings are not strictly comparable. The CFA asked respondents if they knew what the highest fire danger rating is now called, providing them with a number of pre-coded response (e.g. 'Code Red/catastrophic'; 'Other description – extreme, severe, very high'). In contrast, the Department of Justice asked respondents to explain what the Code Red FDR means to them, recording responses verbatim. The findings presented in the report were generated by classifying responses into a much broader range of categories (e.g. 'Evacuate/get out/get ready to leave'; 'It's the worst case/the highest rating'; 'Put our fire plan into action' etc.). All of these and other responses could conceivably be considered 'correct' given the question asked respondents what Code Red *means to them*. The Department of Justice research also considered closely-related responses such as 'It's the worst case/the highest rating' and 'It's catastrophic' separately.

[2] Following the February 2009 fires, AFAC convened a national workshop to review the fire danger rating (FDR) system and accompanying warning messages. The new highest fire danger rating is called 'Catastrophic' or 'Code Red'.

Had these responses been grouped together, the research would most likely have found that a higher proportion of people understood a Code Red warning to mean the highest or catastrophic fire danger. Reanalysis of the Department of Justice data could be useful.

Waiting

The reports consistently found that many people intend to wait for advice from emergency services or until they are directly threatened before taking action. CFA and OESC research found that around one-quarter of those who intend to leave would wait for advice from emergency services before leaving. Bushfire CRC research found that one-quarter of those affected by the Black Saturday fires intended to wait and see what the fires were like, or until they were directly threatened, before deciding to stay or go. This is supported by research into actual responses to the fires, which found that half of those who left considered themselves to have left 'late' or 'very late' and that one-third of those who stayed to defend left during the fire.

Table 1: Summary of the reports examined.

Report(s)	Primary aim(s)	Method of data collection/analysis
Where are they going? People movement during bushfires **AND** *Household locational intentions during bushfire threats* (OESC)	Explore why, when and how people intend to leave their properties; Discover people's intentions to stay or go on Code Red days; Understand what 'places of last resort' mean to people.	Questionnaire comprised mostly of short, pre-coded questions; Administered via landline telephone interviews; Frequency counts.
Summer fire campaign: benchmark research **AND** *Wave 1 Research* (Department of Justice)	Assess impact of the Department's 'Summer Fire Campaign' on bushfire awareness and preparedness.	Questionnaire comprised mostly of short, pre-coded questions; Administered online and via Computer Assisted Telephone Interviewing (CATI); Frequency counts.
Behaviour and intentions of households in high bushfire risk areas (CFA)	Determine the extent to which the February 7th fires, subsequent media coverage and new messages have resulted in modified community behaviour and intentions.	Questionnaire comprised mostly of short, pre-coded questions; Administered via telephone interviews; Frequency counts and cross-tabulations.
Behaviour and intentions of households on code red days (CFA)	Investigate the behaviour and intentions of householders in the fire danger districts during Code Red or catastrophic bushfire danger days.	Questionnaire comprised mostly of short, pre-coded questions; Administered via telephone interviews; Frequency counts and cross-tabulations.
Research results from the February 7th Victorian fires: first report on human behaviour and community safety issues (Bushfire CRC)	Investigate the human behavioural factors that influenced patterns of life and property loss/survival during the February 7th fires; Provide qualitative insights into human behaviour and community safety issues arising from the fires.	Semi-structured interview comprised of open-ended questions; Interview questions explore a common set of issues or topics, but questions may ask different questions, phrase questions differently, and ask questions in a different order; Qualitative analysis.
Research results from the February 7th Victorian fires: second report on human behaviour and community safety issues (Bushfire CRC)	Investigate the human behavioural factors that influenced patterns of life and property loss/survival during the February 7th fires; Present quantitative data on human behaviour and community safety issues arising from the fires.	Questionnaire comprised of short, pre-coded questions and some open-ended questions; Administered via mail; Frequency counts and limited cross-tabulations.
Use of informal places of shelter and last resort on 7 February 2009 (Bushfire CRC)	Examine evidence concerning 'unofficial places of last resort shelter' during the February 7th fires.	Multiple sources of secondary data; Qualitative analysis.

Variation in intended responses

The research reports present varied findings relating to people's intended responses to bushfires. Research by the OESC and CFA found that during the 2008/09 bushfire season around two-thirds of those in high bushfire risk areas intended to leave their homes, while around 30% intended to stay. However, the Bushfire CRC's survey of those directly affected by the Black Saturday fires found that half had intended to stay, with 19% reporting their intention to leave and 26% intending to 'wait-and-see'. Similar differences can be seen in findings related to intentions for the 2009/10 fire season.

These differences reflect variation in the samples and timing of the research, as well as how questions were asked and data coded. For example, one OESC finding classified responses as 'leave' or 'stay and defend'. The Bushfire CRC questionnaire included a much broader range of responses, including: 'leave as soon as you know there is a fire threatening your town or suburb'; 'wait to see what the bushfire is like before making a decision'; and 'hadn't thought about it'. Nevertheless, this does not explain the significantly higher proportion of Bushfire CRC respondents who intended to stay and defend in 2008/09. This discrepancy could reflect the influence on the OESC

Sample	Timing	Implications for research findings
Random sample of 616 households within the 52 high bushfire risk townships, which are represented in the sample to reflect their significance within the total population.	Late October to early November 2009	Primary focus on intended rather than actual behaviour /actions.
Benchmark research: 300 respondents from the 52 high bushfire risk towns (telephone interviews) and 507 respondents from the general Victorian pop. via an online panel, with quotas placed on age, gender and location to ensure a representative sample (online survey); *Wave 1 research:* as above, with a sample of 300 respondents for the telephone interviews and 503 respondents for the online survey.	5-10th October 2009 (Benchmark) 10-17th December 2009 (Wave 1)	Focus on impact of Campaign in raising awareness and preparedness levels.
Random sample of 400 households within the 52 high bushfire risk townships, which are represented in the sample to reflect their significance within the total population.	mid-December 2009	Primary focus on intended rather than actual behaviour /actions. Concerned with *changes* in behaviour and intentions.
Random sample of 602 households within the Wimmera, Northern Country and North East FDR districts.	14-21st January 2010	Findings related to respondents' awareness and responses to an actual Code Red warning.
'Opportunistic' sample of 301 residents affected by the 7 February fires. Sample covers a range of different locations, communities and fire intensities, as well as different outcomes in terms of human behaviour and community safety.	12th February to mid-April 2009	Focus on a specific bushfire event. Concerned with intended and actual behaviour.
Sample of 1104 (final sample 1315) households within areas affected by the February 7th bushfires.	October to December 2009	Focus on a specific bushfire event. Concerned with intended and actual behaviour.
N/A	Initial interviews collected in 12th February to mid-April 2009. Supplementary work undertaken in late 2009.	Focus on a specific bushfire event and issue (unofficial places of shelter). A primary focus on actual behaviour.

study of media coverage and new key messages that emphasise leaving on the people's recollections of past intentions. Those who actually experienced the February 7th fires are more likely to have reflected on their real intentions prior to the fires and how these related to their actual response.

Research also suggests a gender dimension to intended responses, with women more likely to want to leave than men. This is supported by other recent bushfire research (Proudley 2008; Handmer et al. 2010; Haynes et al. 2010).

Major gap between intentions and actions

A number of the reports identify significant disparities between expressed intentions and actual responses to bushfire risk. Research by the Department of Justice, OESC and CFA found that 50-60% of residents intended to leave for Code Red days, with more than 60% intending to leave the night before or early in the morning. However, the CFA's research following the declaration of a Code Red day in three FDR districts found that very few acted on their intention. It found that two-thirds of residents were at home on the day. Of the third that weren't at home, just 1.5% left because it was a Code Red day. Furthermore, intentions appear to be influenced by perceived false alarms, with around three-quarters of residents indicating that they would not leave early on future Code Red days.

The Bushfire CRC's research into responses to the Black Saturday fires found that a significantly higher proportion of respondents (around half) stayed to defend than is suggested by research into intended responses for the 2008-09 fire season. Highlighting the gap between intentions and actions, it found that half of those who intended to leave safely endangered themselves by leaving late, while a third of those who stayed to defend left at some stage during the fire. The study also highlights confusion about what it means to 'leave early' (see also Tibbits and Whittaker 2007).

Differences due to different methodologies

Most of the differences between the research reports are minor and can be explained by variations in the aims, methods of data collection, samples, timing and methods of analysis that were undertaken for each study.

A fundamental point of difference between the studies is whether they examine people's actual experiences and responses to bushfires, or their attitudes and intended responses to future bushfires. Differences in the way questions are worded and the response options that are provided also account for some of the differences. For example, telephone surveys required rapid responses generally according to pre-defined categories, while face-to-face interviews and mail surveys allow respondents to reflect more and provide a wider range of responses.

Small variations would be expected between studies even where they used identical samples, methods and survey questions. This is due to the uncertainties involved in any sampling. For the quantitative surveys reviewed here, the expected variation is generally within plus or minus 5% (at a 95% confidence level, which is the level typically employed in survey research). Greater variation can be expected in qualitative research due to the more subjective and interpretive nature of analysis. The quantitative reports all had adequate sample sizes ranging from about 500 to 1350. However, as different sampling strategies were used some reports were based on people with greater awareness and interest in bushfire risk, which would be expected to return higher scores for awareness, knowledge and preparation.

Conclusions

The review identified a range of common findings across the reports. The reports suggest high levels of bushfire awareness in high risk areas (around 80%), but lower levels in more suburban locations. Note that recollections of the 2009 fires, subsequent media coverage and heightened concern about the 2009/10 fire season are likely to have raised levels of awareness above what they would otherwise have been. The reports also suggest that around two-thirds of households in bushfire risk areas have fire plans, with around one-quarter having a written plan. Importantly, however, there is considerable variation in the quality of people's plans and preparedness, and therefore in their effectiveness during fires. There appears to be a moderate level of understanding of the new Code Red FDR, with around 60% of residents understanding that 'Code Red' refers to the highest level of fire danger and that emergency services' advice is to leave early on these days. The reports confirm that many residents intend to wait for advice from emergency services or until they are directly threatened before taking action. Around one-quarter of those who intend to leave would wait for advice from emergency services.

The disparity between intentions and actions is a major issue for fire and emergency services. Research demonstrates that what people intend to do and what they actually do during a bushfire can vary considerably, with actual responses often more risky. It is clear that understanding and good intentions do not necessarily equate to and are not good predictors of appropriate actions. Fire and emergency services must continue to raise awareness and promote better planning and preparedness in bushfire risk areas, especially for the minority who remain unaware of the risk. However, future research should concentrate on resolving the very large gap between good intentions and appropriate actions.

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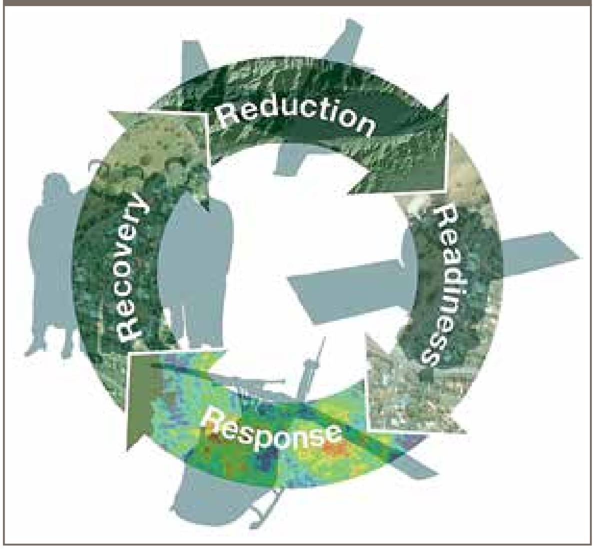
Incorporating remote sensing into emergency management

Karen Joyce, Kim Wright, Vince Ambrosia and Sergey Samsonov highlight some uses of remote sensing in emergency management.

ABSTRACT

There are few examples where remote sensing is incorporated seamlessly into all stages of the emergency management cycle. To achieve this, a collaborative effort is required from emergency managers, policy planners, and remote sensing technical staff that may not always be co-located, or even working for the same organisation. Remotely sensed imagery is becoming cheaper and more readily available, and some satellites and constellations are targeting (at least partially) the emergency management / emergency response community in recognition of the value remotely sensed imagery can provide to decision makers. In this article we highlight some of the uses of remote sensing with respect to emergency management, and encourage emergency managers to seek the support of technical staff to incorporate remote sensing into emergency management planning.

FIGURE 1. The emergency management cycle shown here using New Zealand terminology. Remote sensing can assist emergency managers with all phases of the cycle but requires collaboration between emergency managers and remote sensing technicians.



Introduction

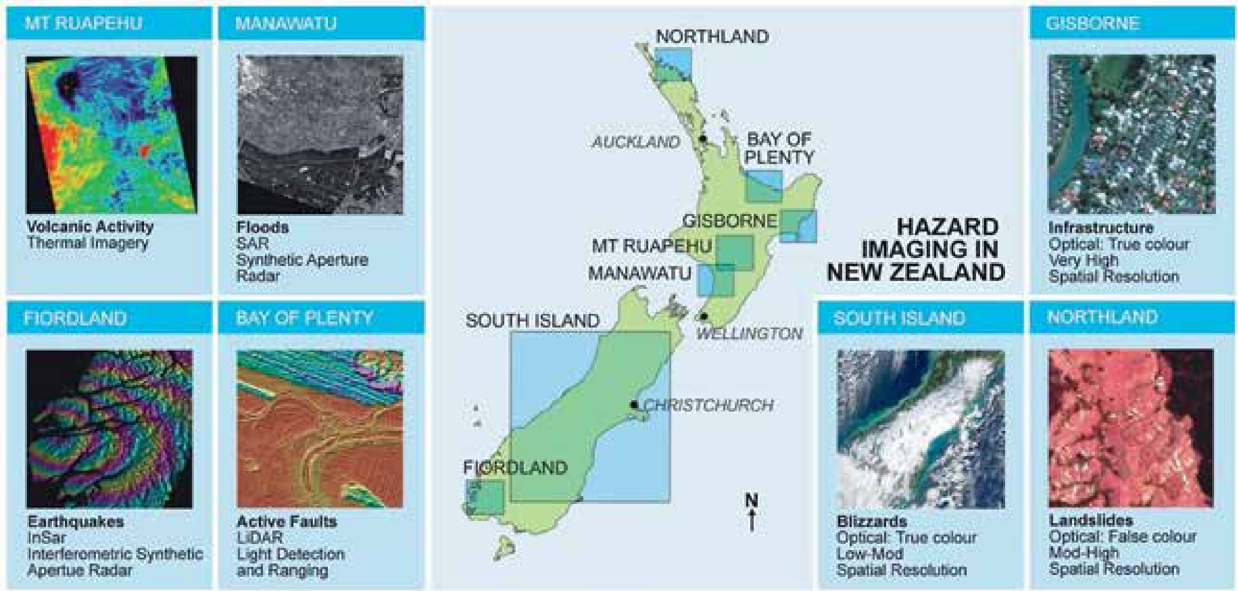
Remote sensing (satellite imagery and aerial photography) can provide a valuable source of information throughout the emergency management cycle (Figure 1), helping to understand spatial phenomena, and providing scientists and authorities with objective data sources for decision making.
It can be used to assist risk reduction initiatives through identification of hazard zones associated with flood plains, coastal inundation and erosion, and active faults. It can also be used to verify hazard and loss models by measuring the location and magnitude of actual events. Imagery is widely used by meteorologists for providing weather forecasting and warnings of potentially severe weather events, providing the public and emergency responders with information that can assist decision making around short term readiness (preparedness). These images are commonly presented in print, television and on the internet, and they are well accepted by viewers around the world.

Imagery of fires, volcanic eruptions, and flooding are often used by the media during the response phase for the visual impact that they provide. If people in potentially at-risk locations personalise the risk, they are more likely to take readiness actions such as making emergency plans for contact and evacuation, and / or assembling emergency kits. Remote sensing images of similar communities experiencing hazards, or of the progress of a hazard such as a fire front, can assist with this personalisation process. For agencies that respond to emergencies, remote sensing imagery provides a method of assessing the magnitude of hazard impacts, areas most affected, and where key transport and other infrastructure links have been disrupted or destroyed. Remote sensing can also be used to provide information on the rate of recovery in an area post emergency, based on indicators such as debris removal, vegetation regrowth, and reconstruction. Additional examples of emergency management related applications of remote sensing are described in Table 1, while some specific data types related to this table are shown in Figure 2.

Table 1: Emergency management application examples using remotely sensed imagery

Application	Type of Data	Data Description	Disadvantage	Example
Building and infrastructure, damage assessment	Very high spatial resolution optical	Black and white, colour, or colour infrared imagery where the pixel size is <4m (i.e. can detect individual buildings). May be from an airborne or satellite platform.	Expensive, large volumes of data, generally only able to be used for local assessment (e.g. city or town scale)	Infrastructure mapping using true colour pansharpened Quickbird imagery of an urban area in Gisborne
Local to regional scale mapping and damage assessment.	Moderate - High spatial resolution optical	Black and white, colour, or colour infrared imagery where the pixel size is 4-30m. Buildings can be seen but not adequately delimited.	Limited level of detail for infrastructure mapping	Regional mapping of landcover and storm induced widespread landsliding in Northland using SPOT-5
Synoptic and frequent mapping at continent or country scale, weather forecasting, coastal upwelling and algal blooms	Low spatial resolution optical	Black and white, colour, or colour infrared imagery where the pixel size is 4-30m. Buildings cannot be seen.	Low levels of detail	Extent of snow cover following storms in the South Island using MODIS. Sediment flows into the sea on the west coast due to rain and landsliding are also apparent
Weather forecasting, hotspot mapping (fires, volcanoes), sea surface temperature	Thermal imagery	Relatively coarse spatial resolution providing temperature information either locally or regionally dependent on the sensor	Satellite thermal data has relatively low spatial detail	Monitoring Crater Lake temperatures with ASTER as part of a suite of tools to assess volcanic activity on Mt Ruapehu
Flood mapping (penetrates through cloud), search and rescue (can be used at night), oil spills	Synthetic Aperture Radar	Active microwave sensor that is capable of acquiring data in harsh weather and lighting conditions not suitable for optical sensors, such as dense cloud or smoke coverage	Generally coarser resolution than that able to be achieved with optical imagery; Can be difficult to interpret	Radarsat imagery of inundated areas during the Manawatu floods
Monitoring sub centimetre surface deformations caused by earthquakes, landslides, volcanic activity, ground water extraction	Interferometric Synthetic Aperture Radar	Technique utilising wavelength phase changes in multiple SAR images in time series over a set area of interest	Noise from changes unrelated to landform such as vegetation growth and soil moisture variability	Using ALOS PALSAR to measure the amount of ground deformation following a magnitude 7.8 earthquake off the coast of Fiordland
Building and infrastructure mapping, forest fuel loads, fault identification, flood plain mapping	LiDAR	Very high spatial resolution Imagery usually obtained from an airborne platform for the purpose of providing elevation information. Also used for building and tree height measurements	Expensive, large volumes of data, generally only able to be used for local assessment (e.g. city or town scale)	Active fault and floodplain mapping with airborne LiDAR

FIGURE 2. Data types and examples. Note that the extent rectangles are not to scale and are indicative of location only.



In order to successfully use remote sensing for emergency management, physical indicators of features or attributes within the emergency management cycle that are measureable in imagery need to be identified. At that point, selection of the most appropriate remotely sensed data set is possible by answering the following questions:

a. What is the event of interest and what types of physical changes in the environment are expected as a result?

b. Where and how large is the affected area?

c. How much detail is required e.g. is it necessary to see individual houses or more important to see region-wide patterns?

d. What is the speed and duration of change in the environment?

e. How much money can you afford to spend?

No single image data source will provide the optimal solution under all circumstances. In addition, there is a necessary trade off between the amount of detail available within an image, its spatial coverage, and frequency of acquisition. Prioritising the information requirements (e.g. detail vs. coverage) will assist the data selection process. Specific requirements may also depend on the relevant phase of the emergency management cycle.

In the reduction (prevention) phase, the focus for remote sensing is often on mapping landscape features such as land cover / land use, and the location of potentially hazardous features or processes to avoid when developing infrastructure (e.g. active faults, flood plains). During the readiness (preparedness) phase, the emphasis is on monitoring these features or processes, developing models for forecasting purposes, and using maps and models for training and education. In the response phase, the timely acquisition of data and provision of information to emergency services is critical. Much of the attention will be placed on identifying infrastructure that has been damaged or is likely to be at risk in the near future (e.g. housing in the path of a bush fire). Finally, during the recovery phase, the focus will shift to long term monitoring of debris removal, vegetation regeneration, and reconstruction.

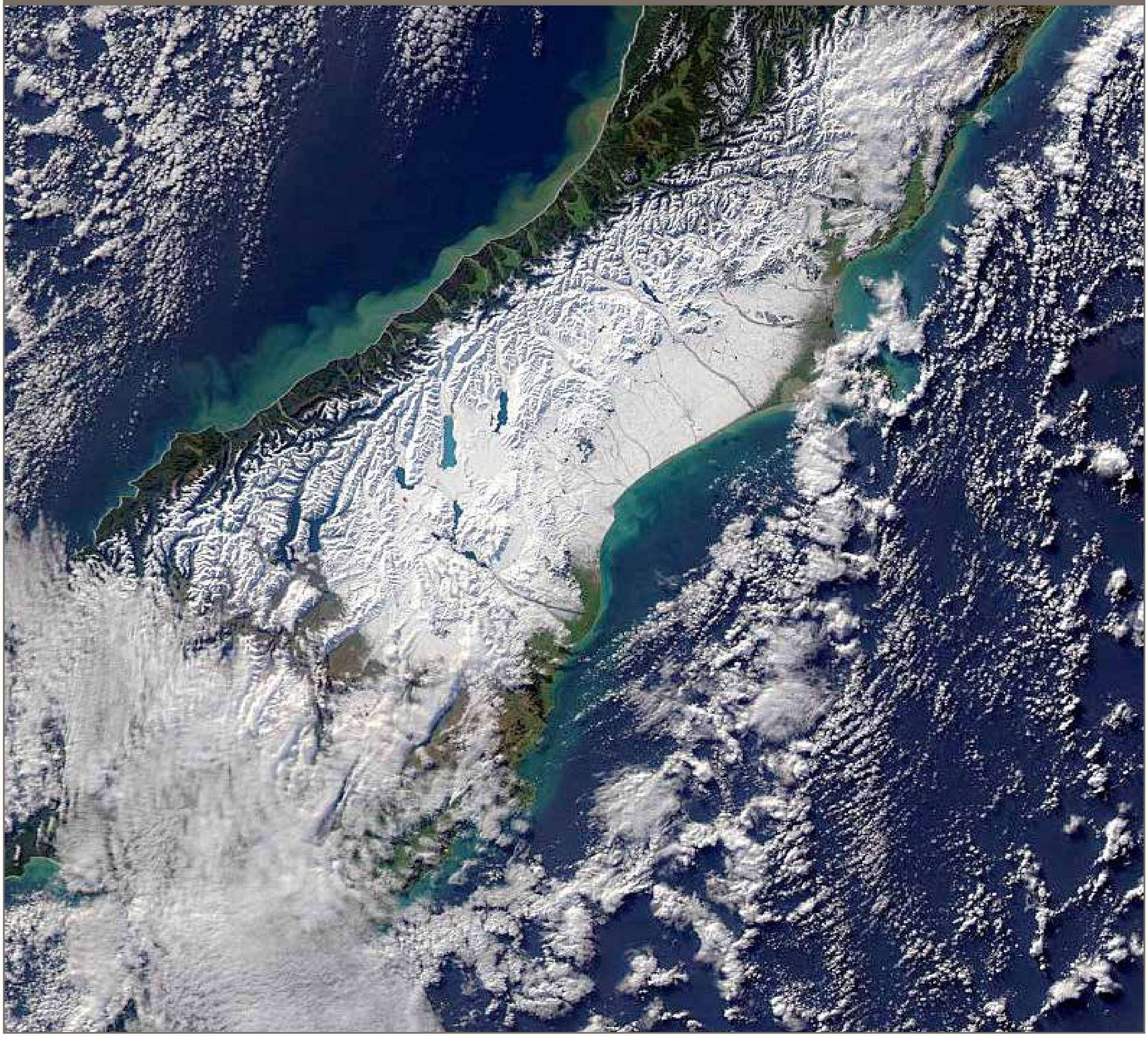
Remote sensing applications

1. Reduction

Remote sensing can be used directly for hazard identification (e.g. flood plain modelling, slope stability and landslide susceptibility) and also for extent mapping; using images to record large area / high consequence events (Figure 3) to add to hazards databases and assist hazard modelling). Remote sensing can also be used to derive hazard-independent information that can be used for risk reduction by mitigating vulnerabilities. For example building vulnerability, commonly termed fragility, can be determined using baseline building, infrastructure, and topographic mapping data for risk and consequence modelling. An excellent example of the use of remote sensing for hazard identification is provided with LiDAR (Light Detection and Ranging) mapping of active fault locations (Begg & Mouslopoulou, 2009 in press). Airborne LiDAR data penetrates through vegetation canopies to provide extremely high spatial resolution digital elevation information that can be used to detect the effects of faulting on the landscape. LiDAR data is also frequently used by councils to generate flood hazard maps.

Remotely sensed data acquisitions can be used to inform land use planning, a key tool that authorities and communities employ to avoid or mitigate hazard risk (Burby, 1998). By identifying the location and characteristics of hazards, land use planning methods

FIGURE 3. Snow storm, South Island, New Zealand June, 2006 captured by the MODIS sensor on NASA's Aqua satellite. Mapping of large area and / or high consequence hazard events enables expansion and verification of existing hazard and consequence models to incorporate extreme events.



can be applied to address the risk these hazards pose. Planning methods include mapping hazard zones (location and range of hazard impact) and identifying the probability of occurrence. Hazard maps are applied to developed and green field (undeveloped) land and options for risk treatment determined. Treatment options can include measures such as setback zones (no development within the hazard zone, e.g. proximal to active faults or within coastal erosion or inundation zones), or special building codes (e.g. minimum floor heights above base flood level) can be introduced to reduce the risk to assets and people (Godschalk et al., 1998). Understanding hazard information is one of a number of critical factors influencing individual and group decision making for risk management (Paton & Johnston, 2001). Where hazard information is readily available to the public in a variety of forms, including maps, there is a greater likelihood of public support for risk reduction initiatives introduced through land use planning (Burby, 2001).

Collecting asset data via high spatial resolution remote sensing allows for identification of infrastructure and buildings in hazardous locations, which can then be targeted for plans to strengthen or re-locate. Asset data is also essential for hazard consequence modelling, whereby hazard data is combined with asset data and fragility (vulnerability) information to determine potential losses. Building fragility to hazards is based on such factors as construction materials (e.g. earthquake, volcanic ash fall, tsunami hazard), engineering design (e.g. tsunami, landslide, earthquake hazard), building height (wind), floor areas (earthquake), proximity of other structures and vegetation (fire), roof pitch angle (e.g. ash fall, snow hazard), and floor height (e.g. flood, tsunami hazard). Remote sensing methods for collecting building and infrastructure data require high to very high resolution satellite or airborne imagery. Optical imagery is often complemented by LiDAR data, which can not only aid in detecting building edges, but is also used for calculating building heights. Incorporation of remotely sensed data into a GIS is vital during this phase for recording spatial attributes and combining with other data sets.

Remote sensing technology can also be applied to measure the success of risk reduction initiatives. A common method for addressing flood risk is the construction of levees to contain flood waters for an event of a given magnitude. Aerial reconnaissance during major flooding events can identify whether levees are performing to design standard and can identify areas of weakness, overtopping or failure. Monitoring of non-structural risk reduction initiates is also possible. To address coastal hazard erosion and inundation risk, many communities choose non-structural options such as beach renourishment and dune restoration. In Florida, airborne LiDAR captured over time has been applied to measure coastal erosion from hazards, alongside the success of non-structural beach restoration methods through determining changes to beach morphology (Shrestha et al., 2005). Another example of measuring the effects of risk reduction initiatives is analysing post-event images of rainfall induced landslides on land with different vegetation cover. From analysis of aerial photographs (oblique and vertical) of an event in 2004 which impacted the lower North Island of New Zealand, it was determined that vegetation cover played an important role in reducing loss of productive soil, and in reducing landslide hazard to assets (Hancox & Wright, 2005).

2. Readiness

Readiness activities and planning are undertaken at a number of levels to increase resilience and response capability for individuals, households, organisations, and states or nations. The provision of good hazard and asset information to support these activities is essential. Crucial in this phase is to prepare an archive of, and gain familiarity with, the most up to date spatial information including (but not limited to) imagery, digital elevation models, and vector data. This information is required to assist with damage assessment during the response and recovery phases.

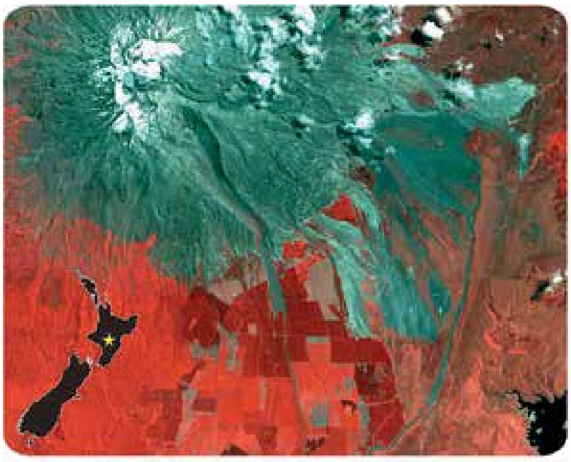
Remotely sensed data are used to produce high resolution hazard and risk maps, which are used by authorities to communicate information about location and range of hazards to their communities. If individuals believe that a hazard is likely to affect them detrimentally within an understandable and pertinent timeframe, they are more likely to take actions to prepare. These actions might include having emergency supplies in the home, an action plan for evacuation and emergency contact with other household members, first aid training or training as a civil defence volunteer. The principle of risk perception aiding preparedness applies to both static and dynamic hazards, e.g. fault trace or flood plain mapping vs. cyclone or bushfire progression. Remotely sensed images showing the progression of a bushfire front or the track of a cyclone are commonly used by emergency managers via the media to inform the public of where hazards are occurring and where they are likely to impact as they evolve. As community resilience research has shown, awareness of hazards is not the only factor in triggering actual preparedness actions; however it is one significant driver (Paton, 2006; Paton & Johnston, 2001; Ronan & Johnston, 2005).

From local to national scales, obtaining an overall picture of the hazardscape by identifying at–risk areas, and priority hazards for resources and planning is essential. Granger (2000) discusses the development of information infrastructure for emergency management in Pacific Island nations, based on remotely sensed data, and GIS interpretation. For countries with limited budgets, collaboration to purchase remotely sensed data for emergency planning is beneficial because of cost savings, the opportunities for skill and process sharing, and the consistency of data for modelling (Granger, 2000).

Hazard modelling is important for readiness, as for many hazards residual risk dictates that an effective emergency response will be the most practical solution for emergency management. For example, New Zealand has several active volcanoes; Mt Ruapehu is the largest of these. Ruapehu is a national park with two commercial ski fields in operation on its slopes. Depending on the time of year, visitors to the mountain are engaged in a variety of recreational, educational and scientific activities. The greatest hazards associated with the volcano are eruptive events and lahar flow (Carrivick et al., 2009). The volcano has a crater lake at the summit which produces periodic large lahars during eruptions and tephra dam bursts. In acknowledgement of the potential hazard to the nearby railway, state highway, and recreation areas, extensive modelling of potential lahar flow paths and velocities was undertaken based on high resolution remotely sensed data (Carrivick et al., 2009). The path later was verified using aerial photography, LiDAR, ASTER (Figure 4), and PALSAR imagery following a lahar in March 2007 (Joyce et al., 2009). The modelling provided the necessary hazard information for authorities to manage the risk through a suite of preparedness activities. A bund (levee) was constructed to prevent lahar flow onto the main highway; and a comprehensive monitoring and alarm system was constructed to detect lahar break outs. An integrated response plan involving emergency managers, police, the fire service, road managers, railways operators, ski field staff, scientists and national park managers, was developed to stop all trains outside the hazard zone, close the highway, trigger warnings and response plans at the ski fields (move people to ridges away from flow paths), and locate and evacuate any hikers or workers in hazard zones within the national park (Leonard et al., 2005).

Lahar flows and eruptions remain an ongoing hazard at Mt Ruapehu. To assist with preparedness for these hazards, remote sensing is part of the suite of monitoring systems employed to detect changes in volcanic activity. A combination of synthetic aperture radar, thermal imagery, and UV / visible imagery is acquired on a routine basis for monitoring deformation, Crater Lake temperatures and gaseous emissions respectively.

FIGURE 4. Mt Ruapehu before and after the lahar captured by the ASTER sensor on NASA's Terra satellite. The path of the lahar can be seen as a bright feature originating at the summit Crater Lake, flowing down the eastern flank of the mountain and finally down the Whangaehu River.



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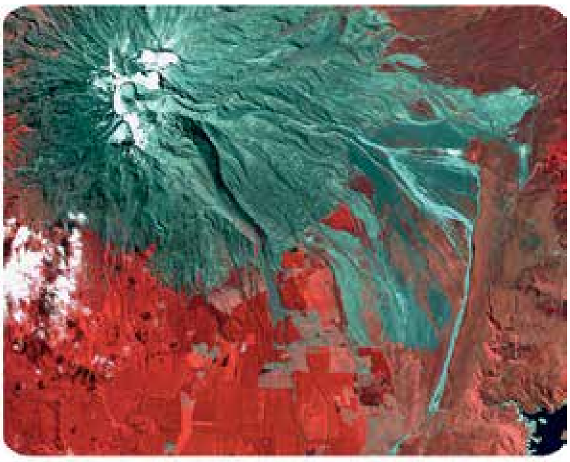

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As timeliness is a critical factor in the response phase, it is important to have systems in place pre-event to aid with appropriate data selection so that crucial decisions need not be made under the severe time constraints that are necessitated by rapid response. Preparation may therefore involve developing a range of scenarios representing potential impacts that require rapid response at a set location, and applying the principles of data selection and processing in advance. In this way, the decisions regarding remote sensing in the response phase can actually be made during the readiness phase. This should be done as a collaborative exercise between both remote sensing experts and emergency management agencies.

3. Response

Response activities are primarily focussed on protecting life and property during emergencies. Activities such as evacuations, search and rescue, sandbagging along riverbanks, evaluating building safety, establishing immediate emergency shelter, setting up command posts and other short-term tasks fall into the response phase. Remote sensing can be used during this phase to provide immediate damage assessment if the data can be provided in a timely manner, and also to assist evacuation plans through the combination of observing weather patterns and hazard behaviour (e.g. fire front approaches, water level rises). Ideally, recovery activities commence coincident with the response phase, to ensure an integrated process for holistic recovery. This means that damage assessments undertaken via remote sensing during the response phase will also be integral to the recovery phase.

Despite the often spectacular nature of imagery captured during an emergency event, the use of remote sensing during the response phase has experienced mixed levels of success, particularly in the case of satellite platforms. Regional scale imagery of effects associated with the development of fire fronts (hot spot detection), volcanic eruptions (gas and ash emissions), or tropical cyclones (inundation) is generally successful where the area of impact is sufficiently large. For example, Geoscience Australia currently utilise thermal-infrared satellite data to provide synoptic, 2-4 times-daily hot-spot detection of fire across Australia and New Zealand, while GNS Science uses ultra violet imagery to monitor sulphur dioxide emissions from volcanoes in New Zealand and across the southwest Pacific, allowing aircraft to avoid potentially hazardous volcanic ash and gas plumes. Providing local scale imagery for damage assessment purposes is more challenging due to the less frequent overpass times by satellites capable of acquiring imagery with high levels of spatial detail.

Relatively recent initiatives within the space science community are addressing the need for providing remotely sensed imagery for the purposes of emergency response. The launch of satellite constellations such as Rapid Eye and the Disaster Monitoring Constellation (International collaboration between Algeria, China, Nigeria, Turkey and the UK) are designed to provide more frequent moderate to high resolution imagery than that achievable with a single satellite. There are also avenues for collaboration between international organisations for data acquisition and provision in the event of emergencies, such as the International Charter for Space Based Disasters (Ito, 2005), and Sentinel Asia (Kaku et al., 2006). While potentially providing a considerable amount of data, neither of these tools can yet be used for immediate or first response due to the current time delay between requesting and receiving data. As such, research into airborne platforms has proven to be of greater utility for rapid data and information provision.

Between 2006 and 2008, the National Aeronautics and Space Administration (NASA) and the U.S. Forest Service collaborated to evaluate and demonstrate the use of long-duration, large Unmanned Airborne Systems (UAS), innovative sensing systems, real-time onboard processing, and data delivery and visualisation technologies to improve the delivery and usefulness of remote sensing data on wildfire events. The objectives were to demonstrate the capabilities of providing sensor-derived, GIS-compatible, geo-rectified, processed data on wildfire conditions to incident management teams within 15-minutes of acquisition from the sensors on the UAS (Figure 5). The characteristics of this system render it ideal for emergency response events that are not just isolated to wildfire. Data were used to support the emergency evacuation decision of the entire population of the community, an effective demonstration of the criticality of near-real-time remote sensing information supporting emergency management operations.

One of the key factors to the success of this system is the provision of not only data, but of information that can be ingested and utilised immediately by emergency managers to aid their decision making. Part of this speed of information delivery is attributed to the autonomous processing onboard the UAS to create geo-rectified image raster products (GeoTIFF) and hot-spot detection vector files (.shp files). The products generated with this system are transmitted via the onboard telemetry system, through a communications satellite to servers on the ground, where they are automatically processed into files compatible with Google Earth and made available in near-real-time at NASA servers. The combination of the near-real-time imagery and the simple Google Earth visualisation capabilities are a powerful tool that requires minimal (or no) training in its employment. Embedding a remote sensing specialist within the emergency management team can further assist with data integration, information understanding, and fielding specialized requests.

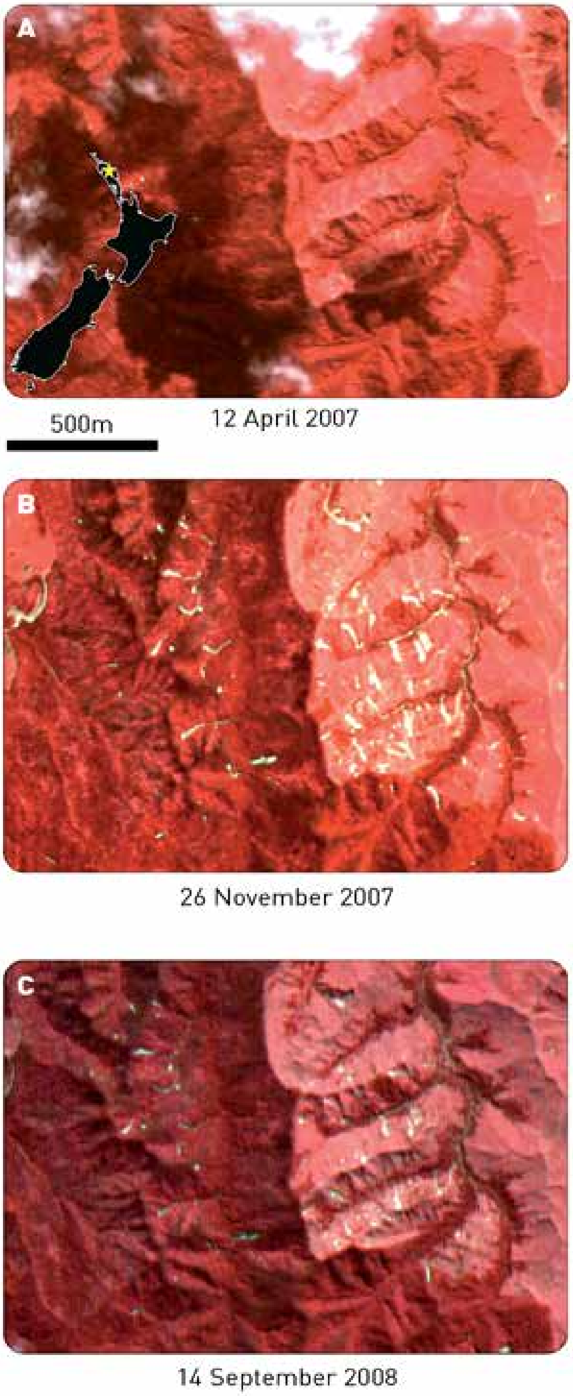
The key components to the "usefulness" of the data were the timeliness of the information (from acquisition to product delivery) and the simple format in which the data was available for visualisation and decision-making. While these factors are important at all stages of the emergency management cycle, they become particularly critical during the response phase, where rapid decision making is most important. The provision of simple hotspot information also means that the emergency management team is not overwhelmed with too much data or too many visualisation options. The choice of using Google Earth as a "front-end" display of the data was a careful decision to provide information in a format and software system that was easily operated and readily available to the fire management community. Fire Incident Command team members do not have the time to "learn" new software capabilities or new tools while they are in the midst of a major wildfire management activity. Google Earth provided a user-friendly capability to allow quick data integration, zoom capabilities, 3-D visualisation and ease of use.

4. Recovery

The use of remote sensing to aid or monitor recovery is perhaps the least developed application of this technology. However, this is an area where the remote sensing community could contribute a great deal through the provision of objective time series analysis over large areas with both high and medium levels of spatial detail. In other specialisations, time series analysis of remotely sensed data is an established technique. Environmental applications such as deforestation and urban sprawl are common targets. In each case, the monitoring objective is clear. During recovery, there are often some very clear indicators that can easily be measured and monitored with remote sensing imagery. Some of these indicators include construction and subsequent removal of medium and long-term emergency shelters; debris removal; commencement and completion of new construction or reconstruction (buildings, bridges, roads); vegetation regrowth; and reduction of siltation from waterways after flooding events.

FIGURE 5. Imagery displayed for the incident response team in San Diego.

FIGURE 6. Recovery of vegetation after a widespread landsliding event in northern New Zealand, July 2007. (a) SPOT-5 CIR obtained before the event; (b) SPOT-5 CIR obtained shortly after the event; (c) ALOS AVNIR-2 CIR imagery obtained one year later.



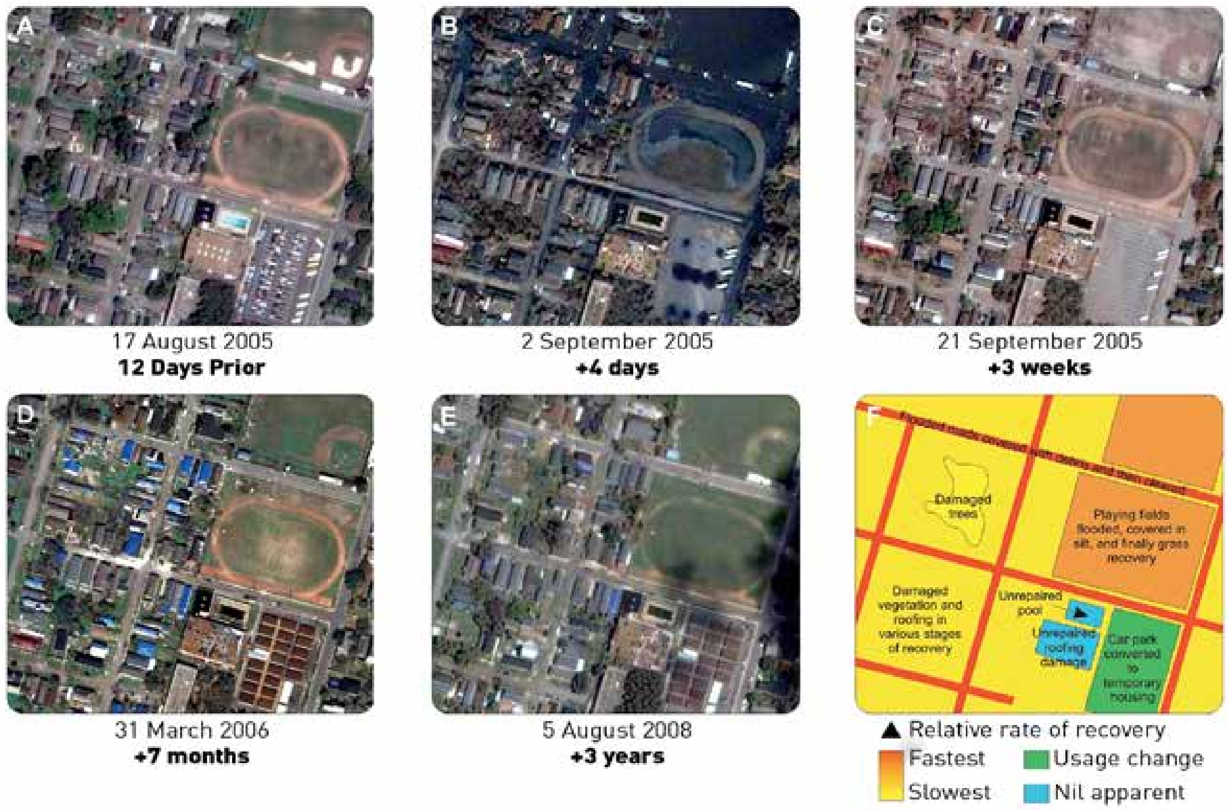
Recovery rates following a widespread landsliding event in northern New Zealand can also be seen from a series of SPOT-5 and ALOS AVNIR-2 imagery (Figure 6). Here the landsliding is apparent as bright scars in the colour infra red imagery acquired four months after the event (Figure 6b). One year later, recovery of many of the grassy slopes on the eastern portion of the image can be seen, while the landslides in the western region are also becoming overgrown (Figure 6c). In an area that was covered with many thousand landslides (Joyce et al., 2008), satellite remote sensing is the only time and cost effective manner of data collection for understanding land cover or land use recovery in the area. Similar techniques could be used to look at native habitat regeneration following bushfires.

Using high spatial resolution, the amount of housing reconstruction can at least be visually identified by the presence and absence of blue tarpaulins covering roofs following Hurricane Katrina (Hill et al., 2006). Conceivably an automated detection method could be developed to identify these quickly and repeatedly in a time series dataset. The authors also provide a list of other recovery related features observable over time with high spatial data, such as building reconstruction, vegetation regrowth, presence of earth moving equipment, and debris removal (Hill et al., 2006). In Figure 7, the progression of recovery in a small area of New Orleans can be seen with high resolution data. Notable features in the image acquired a week before the hurricane are a large car park, sporting fields, and residential housing (Figure 7a). The progression clearly shows inundation in this area (Figure 7b), and remaining sediment shortly after the water subsidence (Figure 7c). By March 2006, temporary housing is evident in the location of the car park (Figure 7d), and is still visible three years after the event, though the number of roofs covered in blue tarpaulins has decreased (Figure 7e). An analysis of the relative rate of change is given in Figure 7f, demonstrating that impervious surfaces and lines of communication such as roads moved towards recovery quite quickly after the event, while mature vegetation takes somewhat longer. Some roofing damage and a swimming pool appear to remain in an unrepaired state three years after the event. The key here is that a time series of data is vital to determine if any change is occurring, and to further extract rates of change.

Pre-event recovery planning is the process of identifying at–risk land uses prior to hazard events and considering how these land uses will be repaired, reconstructed or relocated following damage (Becker et al., 2008). With regards to pre-event recovery planning, remote sensing can be used to identify areas outside hazard zones that would be suitable for relocation of land uses that cannot be recovered. It can also be used for determining how many community facilities are at risk and what the priorities will be for recovery managers (e.g. critical lifelines infrastructure, schools, and other assets that contribute to rapid and holistic community recovery).

Analysis of time series imagery could also help to monitor the effectiveness of different recovery strategies. By extracting recovery rates from data acquired at appropriate time intervals, this assessment could help guide recovery plans for future events of a similar nature. This would also help identify areas of residual risk that require ongoing monitoring until the physical recovery process is completed.

FIGURE 7. Time series of high resolution imagery in New Orleans (a) Before Hurricane Katrina; (b) Soon after the height of the storm; (c-e) Various time intervals following the recovery process; and (f) Interpreted rate of recovery. Images are © Digital Globe and Google Earth 2009.



Conclusions

Remote sensing can be used to inform many aspects of the emergency management cycle. An exhaustive coverage of all potential applications would be impossible in a single article; however we have shown several good examples from which inspiration can be sought for future use. It is important to consider all aspects of emergency management, rather than focussing on emergency response. Incorporating remote sensing into reduction and readiness activities, can also educate politicians, emergency management staff, remote sensing technicians, and the community about the applications of remote sensing to emergency management so that they are familiar with its use under a response and inherently pressured situation.

The key to facilitate the usefulness of remote sensing data in support of the emergency management community is being able to provide the appropriate information in a spectrally, temporally, and spatially relevant context. Additionally, one must be aware of the information requirements of that emergency management community, and must tailor the remote sensing information to meet those needs. That can only come through close collaboration between the emergency management community and the remote sensing / geospatial community.

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‘Reducing the loss’: Using high-resolution vulnerability assessments to enhance tsunami risk reduction strategies

Using Manly, Sydney as a case study, Dall’Osso and Dominey-Howes explore the implications for enhancing tsunami risk management based upon high-resolution assessments of building vulnerability.

ABSTRACT

Australia is at risk from tsunamis and recent work has identified the need for detailed models to assess the vulnerability of buildings to damage during tsunamis. Such models will be useful for underpinning the development of land-use zoning regulations, the identification of appropriate design standards and construction codes and in outlining community relevant tsunami disaster risk reduction strategies by local emergency managers. Such strategies might include the identification of coastal areas that require evacuation, the identification of specific buildings that might be the focus of search and rescue efforts, and the demarcation of ‘safe’ evacuation areas and structures within expected tsunami flood zones. We use the results of a very high-resolution assessment of building vulnerability to tsunami (using the PTVA-3 Model) at Manly, Sydney to illustrate how vulnerability assessments could be used to enhance tsunami risk reduction.

Introduction

The coasts of Australia are at risk from tsunamis. Dominey-Howes (2007) indicates that more than 40 tsunamis have affected Australia since 1788. The 2004 Indian Ocean and 2006 Java tsunamis both resulted in flooding of low-lying coastal areas of NW Western Australia. More recently, the 2007 Solomon Islands and 2009 New Zealand tsunamis were both recorded on tide gauges along the eastern seaboard of Australia although there was no significant inundation associated with these events.

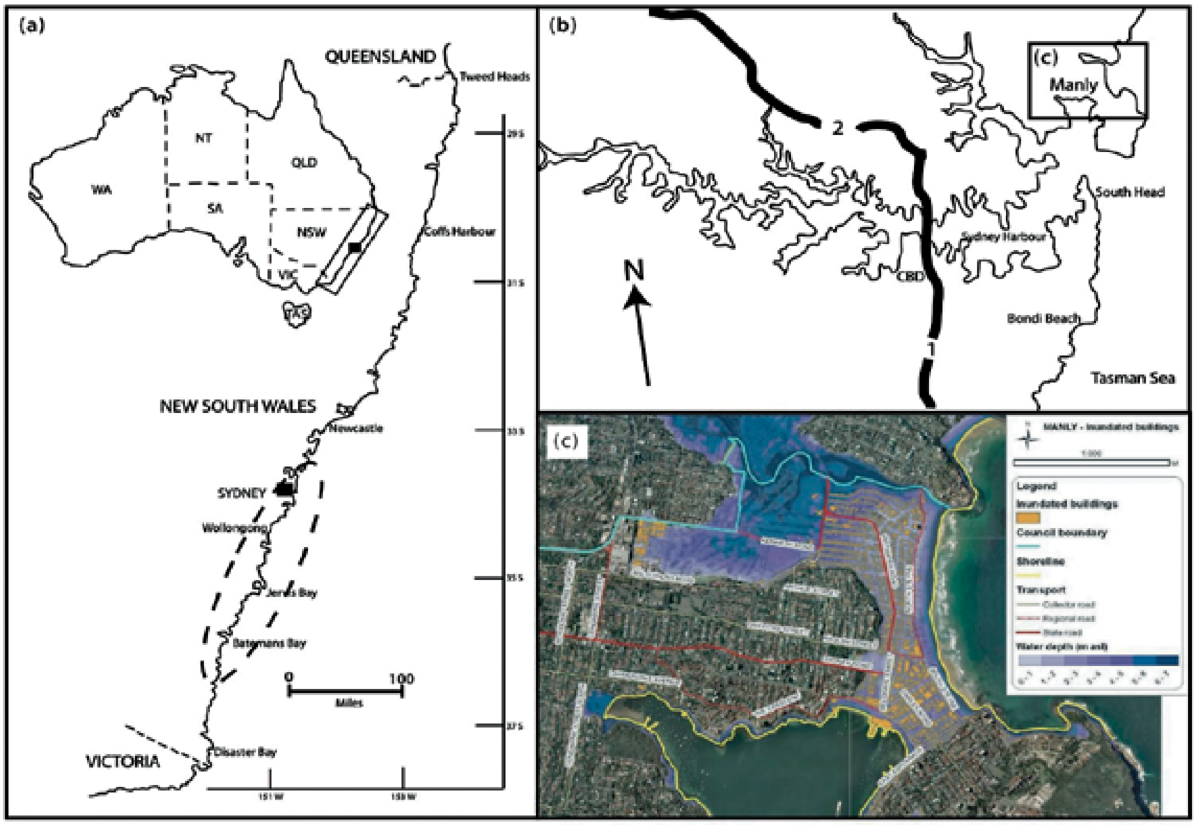
For the coast of New South Wales (NSW) (Figure 1a), tide-gauge records show that historically, only small tsunamis have occurred (Dominey-Howes, 2007). Reported geological evidence however, suggests that megatsunami many times larger than the 2004 Indian Ocean event may have occurred many times during the last 10,000 years – a period in earth history called the Holocene (for original references, see the reviews of Dominey-Howes, 2007 and Dominey-Howes *et al*., 2006). This geological work has led to the development of what has been referred to as the ‘Australian Megatsunami Hypothesis’ or ‘AMH’ (Goff *et al*., 2003; Dominey-Howes *et al*., 2006). The evidence for the ‘AMH’ is very controversial (Felton and Crook, 2003; Goff and McFadgen, 2003; Goff *et al*., 2003; Noormets *et al*., 2004). First, some of the proposed evidence for megatsunami has clearly been incorrectly interpreted (Dominey-Howes *et al*., 2006). Second, there appears to be a ‘disjunct’ or mismatch between the historic record of small frequent events and the Holocene record of large infrequent tsunami (Dominey-Howes, 2007; Goff and Dominey-Howes, 2010). Last, no independent verification of the sources of these events has been undertaken—a vital component for understanding risk (Dawson, 1999). Bryant (2008) however, advocates a cosmogenic source for these events although this hypothesis also remains to be proven.

If the ‘AMH’ can be independently validated, it has profound implications for the coastal vulnerability of NSW and government agencies (such as the NSW State Emergency Service (NSW SES)) are very likely and understandably, completely unprepared for such events. Further, it indicates that we should not be complacent about the potential magnitude of future tsunamis even though only small events have occurred in the past. For example, the proposed Holocene megatsunami occurred in coastal areas of NSW where more than 330,000 people now live within 1 km of the coastline and at no more than +10 metres above sea level (m asl) (Bird and Dominey-Howes, 2006; 2008). More than 20% of these people are over the age of

FIGURE 1. (a) Broad location of the study region of Sydney located in New South Wales, SE Australia. The hatched oval encompassing the region north of Sydney south to beyond Batemans Bay is the region reported to have been affected by Holocene megatsunamis. NSW = New South Wales, NT = Northern Territory, SA = South Australia, TAS = Tasmania, VIC = Victoria, WA = Western Australia.

(b) Simplified map of the Sydney Harbour region with Manly located NE of the CBD. Highways 1 and 2 are shown.

(c) Detailed GIS map of Manly. Area of inundation (including relative water depths above land surface) associated with the tsunami referred to are shown in blue. Principal features are highlighted and buildings inundated by the tsunami are indicated in orange.



65 (Opper and Gissing, 2005). Furthermore, within the Sydney region, approximately 400,000 property addresses are located less than 3 km from the coast and about 200,000 are less than +15 m asl (Chen and McAneney, 2006). These properties have a combined value of more than $150 billion. Given this massive exposure, it is of concern that our understanding of the regional tsunami risk remains limited and unverified and that no work has been undertaken to assess the 'vulnerability' of coastal buildings.

Hall *et al.*, (2008) outlined an extremely useful 'step-by-step scientific process' to gather information useful for assessing the risk to Australia's coasts from tsunamis. The first part of this process defines all likely sources of tsunamis, estimates their frequencies and then propagates tsunami waves from these sources to shallow water adjacent to the coast providing a probabilistic wave height for any particular return period of interest. The second step of the process utilises inundation modelling to examine exactly how far inland and to what elevation above normal sea level a particular tsunami might flood.
At the present time, in Australia, Geoscience Australia is the agency that undertakes these tasks.

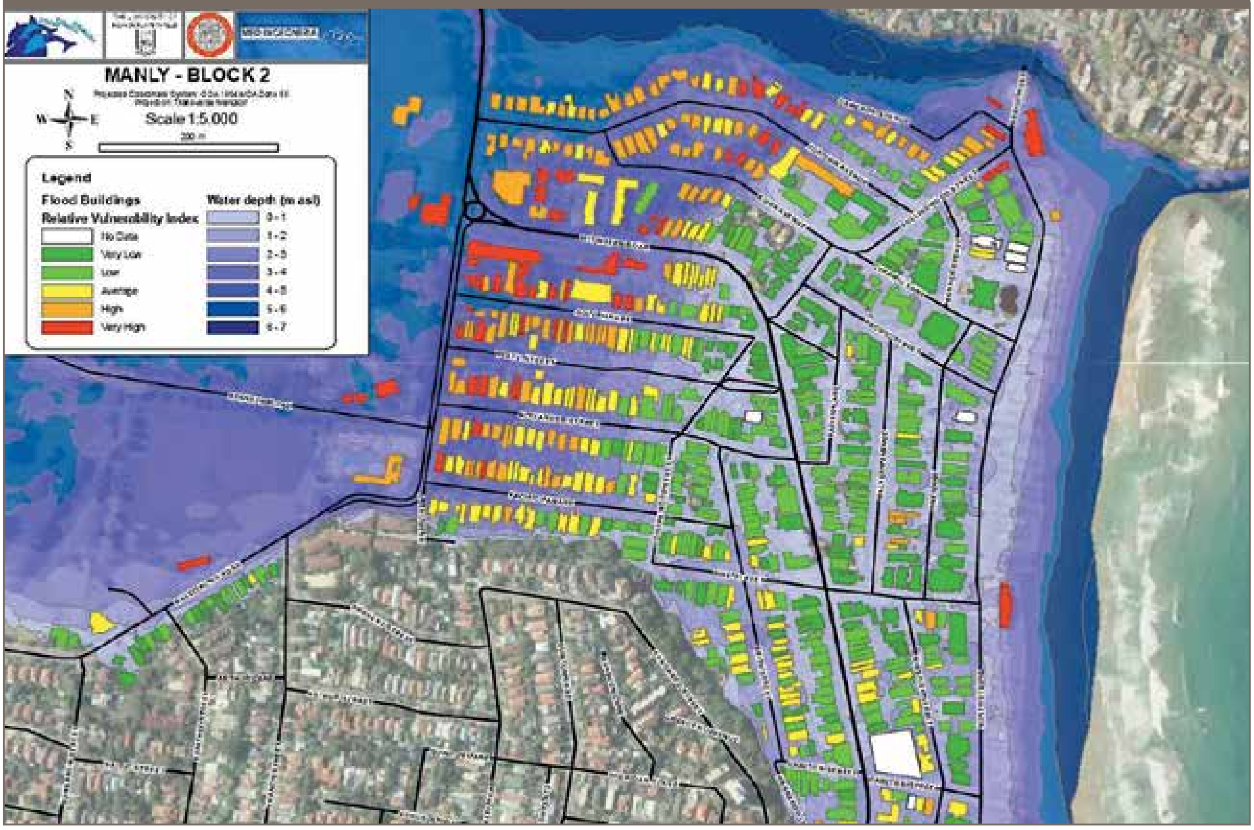
The final step in the scientific process described by Hall *et al.*, (2008) is to map the 'exposure' of (for example) buildings within the expected inundation zone and then assess the 'vulnerability' of those structures to damage associated with that event. So far though, this last step has not been undertaken by any official government agency or emergency service.

Assessing the vulnerability of buildings to tsunami damage using the PTVA Model

Only one model has been developed that assesses the vulnerability of buildings to damage from tsunamis. This model – the Papathoma Tsunami Vulnerability Assessment (or PTVA) Model has been described in detail in Papathoma *et al.*, (2003) and Papathoma and Dominey-Howes (2003). It was then validated by Dominey-Howes and Papathoma-Köhle (2007) and Dall'Osso *et al.*, (2010) and applied to different case studies by Papathoma *et al.*, (2003), Papathoma and Dominey-Howes (2003) and Dominey-Howes *et al.*, (2010). Broadly speaking the model collects and

FIGURE 2. The Manly study area divided in to four (4) 'Blocks' for ease of results presentation. This paper just deals with Blocks 2 and 3.

FIGURE 3. Tsunami inundation and water depth in Block 2, Manly. The RVI scores of every building of all classes located within the inundation zone are indicated.



integrates engineering attributes about buildings together with information about the tsunami and the natural environment in order to calculate a 'Relative Vulnerability Index' (RVI) score or rank for each building.

Recently, Dall'Osso *et al.*, (2009a) presented a newly revised and improved version of the model – PTVA-3. Further, Dall'Osso *et al.*, (2009b) applied the PTVA-3 model to a case study in Manly, Sydney (Figure 1b, c). They undertook an assessment of 1100+ individual buildings located within the expected flood zone associated with a particular tsunami scenario. The scenario is fully described in Dall'Osso *et al.*, (2009b) and the area of Manly forecast to be inundated is shown in Figure 1c. Since the area inundated was large, they presented their assessment of building vulnerability in four separate blocks (referred to as 'Manly, Block 1 to 4) (Figure 2).

For a full description of the results of the case study, see Dall'Osso *et al.*, (2009b). However, their main findings are shown in Table 1. They divided the buildings in to nine classes and assessed the RVI scores of each building in each class. Table 1 indicates that of the 1100+ buildings they assessed, the majority of the building stock is residential followed by commercial. The absolute number of buildings in each class assessed as having a particular RVI score are indicated in columns 3 to 7 of Table 1. An example of the spatial distribution of all buildings in Block 2 of different classes, together with their RVI scores is shown in Figure 3. It is clear therefore, that the application of the PTVA-3 Model to individual buildings located within an expected inundation zone can provide very high-resolution information about the spatial vulnerability of buildings and by analogy, the population in that area.

Enhancing tsunami risk reduction strategies using high-resolution vulnerability assessments

Many different stakeholders will be interested in the management of risk associated with tsunamis. However, here we focus on Australian Local Government Authorities (LGA's) (including their Local Emergency Management Officers (LEMO's)) together with their local units of the State Emergency Service (SES) who are at the sharp end of dealing with hazardous events such as tsunamis.

Local government planners will be interested in a number of questions that include (but are not limited to):

- Which low-lying areas of coastal land are 'safe' to permit new and/or re- development?
- Are there any low-lying parcels of coastal land that are simply too 'unsafe' to permit any form of development?
- If development and/or re- development is permissible, should there be any forms of restrictions and if so, what?
- What building standards, codes and regulations should be applied to new development (and re-development) proposals to minimise the vulnerability of new structures built at the coast?
- For existing structures, what is their vulnerability and how (if at all) can that vulnerability be reduced?
- For any buildings assessed as having "High" or "Very High" RVI, what (if any) liability is faced by Local Government?

Local Government LEMO's and Emergency Service personnel will be interested in (amongst others) questions such as:

- Which areas of the coast are likely to experience flooding associated with a tsunami of a particular magnitude/return period?
- Which areas of low-lying coastal land will need to be evacuated in the event of a tsunami of a particular magnitude/return period?
- What areas can be identified as 'safe zones' to which people may be moved during an evacuation?
- What are the best routes to 'safe evacuation areas'?
- Which buildings are likely to be the most problematic or will require special attention or response (e.g., search and rescue) during a tsunami event of a particular magnitude? For example, where are the schools and nursing homes?
- In the event that it is not possible to move all people located within the expected inundation zone into 'safe' evacuation areas, which buildings provide the best options for 'vertical evacuation' above the maximum expected flood level?

We are not qualified to address these questions but it is clear that the approach we have developed and tested and which is detailed in Dall'Osso *et al.*, (2009a, b) does provide the sort of high-resolution data needed by decision makers to tackle these important questions.

Maps displaying 'exposure' during inundation such as Figures 1c and 3, will be useful for guiding decision making processes related to land-use zoning. It is apparent that having accurate information about flow depth above ground surface will be useful for those organisations who make decisions about development proposals, building design and regulation. We are aware that prohibiting development of coastal landscape areas is neither desirable or in many cases, practical. However, data generated by models and approaches like ours certainly can help to guide decision making to ensure new, and re- developed, structures are constructed to a standard that reduces risk to an affordable minimum.

Some of the individual buildings located in Block 2 (Figure 3) are directly owned and managed by the Manly LGA. Table 1 indicates that some seven (7) LGA buildings in the whole Manly area that would be affected by a tsunami are assessed as having "High" or "Very High" RVI scores. In many ways, local taxes and environmental levies paid by residents in this LGA are used (in part) for the upkeep of buildings owned and managed by the authority. Therefore, the LGA might use the results of an assessment like that described by Dall'Osso *et al.*, (2009b) to prioritise actions that help to reduce the vulnerability of these buildings and enhance the capacity of the LGA to recover after a tsunami event.

FIGURE 4. Evacuation areas and 'safe' buildings for evacuation, Block 2, Manly.

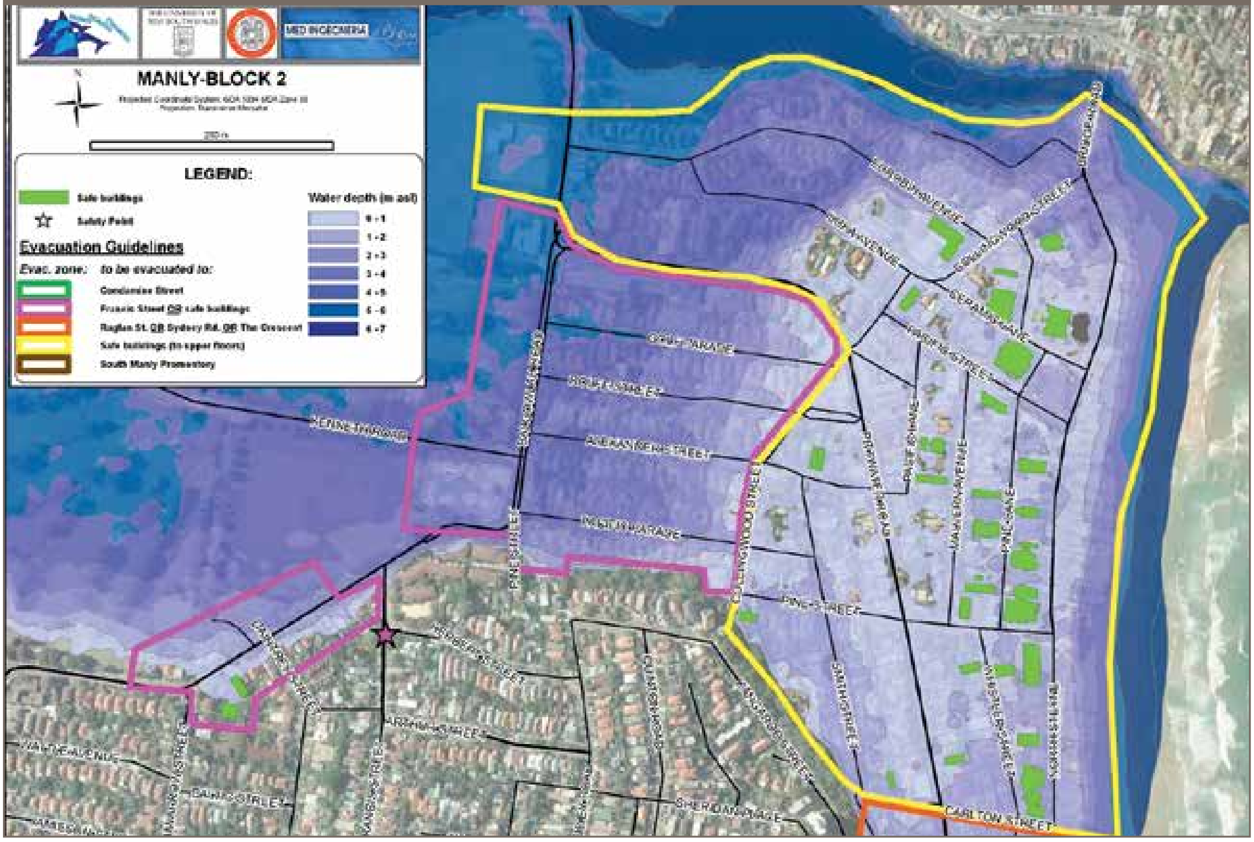


FIGURE 5. Evacuation areas and 'safe' buildings for evacuation, Block 3, Manly.

Once again, we are not making recommendations but are pointing towards where, and how, our work might assist local decision makers.

We have used some of the results generated by Dall'Osso *et al.*, (2009b) to explore the potential identification of areas that might be classified as 'safe evacuation areas' during a tsunami. Figures 4 and 5 display those areas we think could be the subject of evacuation orders. Where appropriate, in each area, we have identified individual buildings that could be used for vertical evacuation above the maximum expected flood level. In Figures 4 and 5, these individual buildings are coloured green. These buildings are identified from the PTVA-3 Model analysis carried out by Dall'Osso *et al.*, (2009b) because they have the lowest RVI values and because their upper floors lie well above the expected maximum flood height. That is, these buildings have at least two floors above the expected maximum flood level. Once again, it should be noted that we are not making recommendations that these specific buildings should be designated 'safe evacuation structures', merely that such analysis can lead to the identification of such buildings. It is for others to determine which are most suitable.

The type of work carried out by Dall'Osso *et al.*, (2009b) is extremely valuable. For example, Figure 4 shows that the recommended 'evacuation area' that bounds Golf Parade, Rolfe Street, Alexander Street, Pacific Parade and Pine Street does not contain a single building that would be 'safe' to evacuate in to during a tsunami associated with their scenario. That is, all buildings would be almost fully inundated and many would be severely damaged, if not completely destroyed. Therefore, people that occupy these buildings would need to fully evacuate the whole area. Having information like this means that the Emergency Services can pre-plan the best evacuation routes, implement signage at street level and develop and engage in community education and outreach programs. The value of such 'draft' evacuation maps has recently been presented and discussed in Dall'Osso and Dominey-Howes (2010). Conversely, the large evacuation area of Figure 4 parallel with the coast has many individual buildings we assess as useful for vertical evacuation (although the western ends of Eurobin Avenue and Iluka Avenue are some what problematic).

Figure 5 shows the mixed residential and commercial area of Manly CBD. Although the flow depth above ground surface is rather high in the tsunami scenario examined in this case, many individual buildings are assessed as being appropriate for vertical evacuation. Given that the ocean beach at Manly is a favourite with beach going visitors to the area and can be heavily populated on a sunny weekend in the summer, the close proximity of many buildings suitable for vertical evacuation, is somewhat reassuring.

Conclusion

As our cities expand, the exposure of our built environment to hazards such as tsunamis increases. Australia is at risk to tsunamis. The 2004 Indian Ocean tsunami was catastrophic. In some areas like Banda Aceh city, near complete devastation of the urban landscape occurred. Abandoning coastal regions affected by hazards such as tsunamis is simply not possible for a variety of reasons. Therefore, in order to enhance tsunami risk reduction strategies, high-resolution assessments of building vulnerability are required. Such assessments provide the building blocks upon which appropriate risk reduction strategies may be formulated. Recent work by Dall'Osso *et al.*, (2009a, b) using a newly revised and improved PTVA-3 Model has been shown to be useful for providing very high-resolution assessments of the vulnerability of individual building structures to tsunamis of particular magnitudes. In this paper, we have taken the outputs from Dall'Osso *et al.*, (2009b) and shown where and how they may be used to address important questions of relevance to local government and emergency services officers. We use a detailed case study from Manly, Sydney to explore these questions and options. We have not made specific recommendations since in our view, it is the role of responsible professional decision makers to best decide how such data might be used.

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R

Confronting an unfamiliar hazard: Tsunami preparedness in Tasmania

Douglas Paton, Mai Frandsen and David Johnston examine perceptions of risk of tsunami in Tasmania and discuss a US tsunami preparedness predictor model to see whether it might be useful in Tasmanian communities.

ABSTRACT

Recognition of the fact that Australian coastal communities can experience tsunami within hours of their being detected led to the development of the Australian Tsunami Warning System. If the benefits of this system are to be fully realized, members of communities susceptible to experiencing tsunami must be prepared to respond within this timeframe. This paper discusses how a lack of experience of tsunami hazards in communities in Tasmania that has resulted in low perception of risk being attributed to this hazard, with levels of preparedness being correspondingly low. The paper then discusses whether a model that has demonstrated an ability to predict preparedness in areas in the United States where tsunami risk is accepted can be applied in Tasmanian communities. Following demonstration that this model is not a good predictor when people are dealing with a hazard with low risk acceptance, an alternative model is presented and its utility evaluated. The role of planning and risk beliefs is also discussed.

Introduction

The December 24th 2004 Indian Ocean tsunami stimulated an unprecedented international effort to develop tsunami early warning capability, including the Australian Tsunami Warning System (Bird & Dominey-Howes, 2006; Geoscience Australia, 2007). This initiative is justified because northwest, northeast and eastern Australia face some 8,000 kilometres of active tectonic plate boundaries capable of producing tsunami which could reach its shores within two to four hours (Australian Bureau of Meteorology, 2008). The benefits accruing from this initiative have been demonstrated several times. Tsunami warnings were issued on April 2nd 2007, September 30th 2007, and 16th July 2009. The last two events generated small (25-30cm) tsunami in Tasmania. The warning system was also activated in response to the tsunami generated off Samoa on September 28th 2009.

Being able to issue warnings in a timely manner makes a significant contribution to managing risk. However, given that tsunami could reach Australian shores within hours, the effectiveness of any warning system is also a function of whether people are prepared (e.g., having an emergency kit, developing and practicing family response plans) and able to respond within the time frame afforded by the warning process (Bird & Dominey-Howes, 2006; Paton et al, 2008; Pincock, 2007).

If the benefits of the warning system are to be fully realised, facilitating people's preparedness to respond effectively is essential. This issue is examined here by testing a model that has been shown to predict preparedness in communities in which tsunami risk is accepted (Paton et al., 2008; Paton et al., 2009) using data from communities on the eastern seaboard of Tasmania.

Modelling tsunami preparedness

Full details of the model being tested here can be found in Paton et al. (2008). In summary, the model proposes that preparedness is the outcome of a process that commences with peoples' outcome expectancy beliefs (i.e., people's belief in the ability of the proposed mitigation actions to actually increase their safety). If people hold negative outcome expectancy beliefs (NOE), it is hypothesised that this reduces the likelihood of their preparing. If people hold positive outcome expectancy (POE) beliefs, their perception of receiving the resources needed to act (empowerment) is mediated by the social (involvement in community life, collective efficacy) processes used to articulate members' needs and expectations. Finally, the model proposes that trust (in civic sources of hazard and risk information) mediates the relationship between empowerment and preparing (see Figure 1). Preparation was assessed using a measure of tsunami preparedness proposed by Horikawa and Shuto (1983). However, given the prevailing low level of actual preparedness (see below), intention to prepare was used as the dependent variable.

This paper discusses two variables not included in the original model; planning and risk rejection. The planning measure was included because this variable has been implicated as a predictor of people's

TABLE 1. Questionnaire Sections, Measures, Item Number and Scoring Range.

Measure	Adapted From	Item No.	Scoring Range
Risk Rejection	Paton et al. (2001)	4	1 (Strongly disagree) - 5 (Strongly agree)
Positive Outcome Expectancy	Bennet & Murphy (1997)	4	1 (Strongly disagree) - 5 (Strongly agree)
Negative Outcome Expectancy	Bennet & Murphy (1997)	4	1 (Strongly disagree) - 5 (Strongly agree)
Intention to Prepare	Paton et al., (2005)	5	1 (No), 2 (Possibly), 3 (Definitely)
Collective Efficacy	Zaccaro et al., (1995)	12	1 (Very Low) - 5 (Very High)
Empowerment	Speer & Peterson (2000)	4	1 (Not at all) - 5 (Always)
Trust	Dillon & Phillips (2001).	5	1 (Strongly disagree) - 5 (Strongly agree)
Community Involvement	Bishop et al., (2000)	10	1 (Strongly disagree) - 5 (Strongly agree)
Planning	Greenglass (2002)	14	1 (Not at all true) - 4 (Completely true)

ability to take action to deal with environmental threats (Schwarzer, 2001). The risk rejection measure was included to examine whether a lack of belief in the ability of a hazard to pose a threat influenced preparedness behaviour. The specific hypotheses generated by the inclusion of these variables are discussed below.

Methods

Data were collected from communities (St Helens, Scamander, Orford, Lauderdale, Blackman's Bay, and Kingston) on the Tasmanian East coast. Only randomly selected households located at or below the 10 metres above sea level contour were targeted. This datum was selected to reflect the expected magnitude of a tsunami impacting Tasmania. Some 1000 Questionnaires were distributed in July and August 2008. The items comprising the questionnaire are described in Table 1. Data on gender, age, home ownership, and residence were also collected.

Because the model proposes that several independent variables interact to account for differences in levels of adoption of house protective measures, Structural Equation Model (SEM) was selected for the analysis. SEM can calculate multiple and inter-related dependence relationships simultaneously, allowing it to test the model as a whole and define how well the data fit (Goodness-of-Fit) the hypothesized model (Byrne, 2001).

While it was originally intended to use preparedness as the dependent variable, low levels of adoption of tsunami preparedness measures (see below) precluded this option. Intention to Prepare (which has proved a reliable predictor of preparing (Lindell & Whitney, 2000; Paton et al., 2005)) was thus treated as the endogenous (dependent) latent variable and Risk Rejection, Positive Outcome Expectancy, Negative Outcome Expectancy, Collective Efficacy, Community Involvement, Empowerment, Trust, and Planning as the exogenous (independent) latent variables.
The items used to assess each of these constructs were considered as observed variables.

Results

Some 136 questionnaires were returned, giving a return rate of 13.6%. Gender was equally represented (50.7% male). The most common age bracket was 45-64 years (51.5%). Some 85% of participants owned their homes and 92 % lived permanently in the areas surveyed. The average number of years participants had lived in their current house and in the area was 12 and 18 years respectively.

Of the 136 questionnaires returned, fewer than 10 percent (deemed acceptable by Byrne, 2001) contained 'missing completely at random' data points and were replaced using the mean substitution method (Tabachnick & Fidell, 2007). The means, standard deviations, and ranges of the variables are listed in Table 2. An appraisal of histograms for skewness and kurtosis revealed that all variables were normally distributed. Inter-correlations between variables showed no evidence of multicollinearity or singularity. Inspection of scatterplots confirmed the linearity among latent variables. This also allowed for any outliers to be identified, of which there were none. Thus, the assumptions underlying SEM were upheld. Analysis was conducted (using AMOS 6), in two stages (Breckler, 1990). First the measurement model was tested to confirm that the measured variables did relate to the latent variables, and secondly, the structural models were tested to determine how well the theorised models fitted the data.

TABLE 2. Means, Standard Deviations, Cronbach's Alpha, and Range of Variables.

Variable	Mean	SD	Alpha	Range
Intention to Prepare	6.68	2.32	0.92	4-12
Collective Efficacy	12.26	3.87	0.96	4-20
Trust	11.74	3.71	0.89	4-20
Empowerment	9.55	3.09	0.86	4-18
Community Involvement	16.49	2.72	0.87	4-20
Risk Rejection	11.47	4.00	0.83	4-20
Positive Outcome Expectancy	12.40	3.91	0.76	4-20
Planning	12.66	1.93	0.79	8-17
Negative Outcome Expectancy	10.68	3.71	0.62	4-20
Note. SD = Standard Deviation				

The measurement model

Confirmatory factor analysis (CFA) using AMOS 6 was used to determine if the observed variables adequately loaded on the eight latent variables. As recommended by Reisinger & Mavondo (2006), multiple fit indices were reported. The likelihood-ratio chi-square (χ^2) statistic is the primary measure of overall fit, and non-significant differences indicate a good fit of the model to the data. Because of the sensitivity of the chi squared statistic to sample size, Hu and Bentler (1999) recommend using the chi-square/df ratio (CMIN/DF). CMIN/DF ratios that are close to one suggest a very good model fit, while values < 2 indicate a good fit (Hu & Bentler, 1999; Reisinger & Mavondo, 2006). The Root Mean Square Error of Approximation (RMSEA) assesses the amount of error present in the fit and is considered to produce accurate assumptions about model quality, with values < 0.05 suggesting a good fit to the data, while values between 0.05-0.08 reflect an adequate fit (Reisinger & Mavondo, 2006). Values of the Comparative Fit Index (CFI) and Incremental Fit Index (IFI) greater than 0.95 are considered to reflect a good fit to the data (Reisinger & Mavondo, 2006; Streiner, 2006).

For the CFA analysis, the likelihood-ratio χ^2 test indicated that the observed data varied significantly from the model (χ^2 (433, n = 136) = 523, p = .002). However, with small samples, the calculated χ^2 may lead to inaccurate probability levels. Consequently, because they are least biased by sample size (Bentler, 1990; Hu & Bentler, 1998; Reisinger & Mavondo, 2006), the Comparative Fit (CFI) and Incremental Fit (IFI) indices were also used to assess the fit of the proposed model. Values over .95 indicate a good fit if the χ^2 is significant (Streiner, 2006). The obtained indices (CFI = .961, IFI = .962) indicate that the observed variables provided a good representation of the eight latent variables. A RMSEA of .039 and finding that the observed variables loaded significantly ($p < .01$) on their respective latent variables provided further support for the construct validity of the indicators (Streiner, 2006). Therefore, the variables used could be regarded as valid indicators and data analysis proceeded to test the structural models and to examine whether these variables could be used to predict tsunami preparedness.

The structural models

Three models were tested. Model 1 tested the original (Paton et al., 2008) model. Model 2 included the planning variable, and Model 3 added the risk rejection measure. In addition to the χ^2 value, the CMIN/df ratio is reported. Because of the sensitivity of the χ^2 statistic to sample size, Hu and Bentler (1999) recommend using the chi-square/df ratio (CMIN/DF). Ratios < 2 indicate a good fit (Hu & Bentler, 1999; Reisinger & Mavondo, 2006).

FIGURE 1. Summary of Model 1 Analysis (*p<0.05; ** p<0.01).

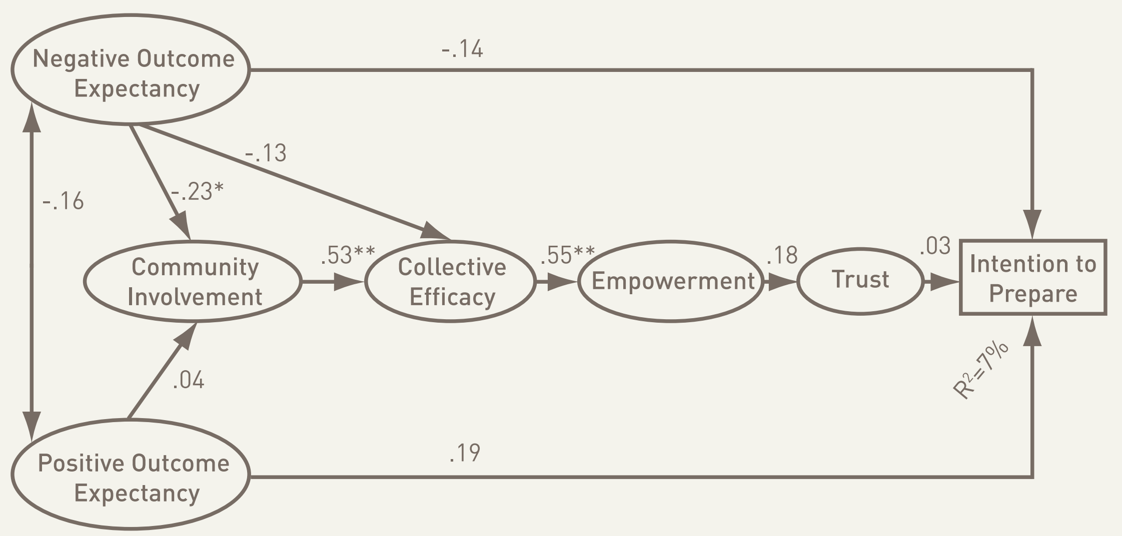


TABLE 3. Summary of Model Fit Indices for Proposed and Modified Structural Models.

Model	χ^2	p	CMIN/DF	RMSEA	RMSEA 90%	PCLOSE	CFI	IFI
Model 1	454.246	<.000	1.342	.052	.039-.064	.390	.942	.943
Model 2	386.968	<.04	1.141	.003	.009-.048	.971	.972	.973
Model 3	324.52	<.007	1.208	.039	.022-.053	.896	.968	.969

Model 1

For Model 1 (Figure 1), although the χ^2 value was significant, the CMIN/df ratio and the IFI, CFI, RMSEA and PCLOSE values indicated a moderate fit (Table 3). Nonetheless, its ability to account for only 7% of the variance in intention fails to provide support for it being a good predictor of tsunami preparedness.

The expected role of Trust (in civic source of risk/hazard information) was not supported. The very poor relationship between trust and intention (Figure 1) suggests it is unlikely that this could be attributed to the small sample size. Although inconsistent with previous literature (e.g. Haynes et al., 2008; Paton et al, 2008), this could reflect tsunami not being recognised as a hazard (see below). Trust only becomes significant when a need to make decisions under conditions of uncertainty increases people's reliance on agencies to provide information (Paton, 2008). If a hazard is not recognized as such, people will not face uncertainty and thus have no need to evaluate the source of the information, making whether or not people trust a source irrelevant. This suggestion remains tentative until further research is undertaken.

Although Negative Outcome Expectancy and Positive Outcome Expectancy (Figure 1) did reveal relationships in the expected direction and with the expected sign, they just failed to reach significance. This could be attributed to the small sample size. Another tentative explanation is that, as a result of a general disbelief in the ability of tsunami to pose a threat in the areas surveyed (see below), people would not have had to think about the need for tsunami mitigation measures. As a consequence, they would have had no reason to consider whether mitigation measures would be effective. Since the outcome expectancy measures assess beliefs about the effectiveness of mitigation measures relative to the actions of a specific hazard, the lack of any need for people to have considered this question could account for a failure to find support for the hypothesised role of the outcome expectancy variables.

Model 2

Because 'planning' has been identified as a predictor of volitional behaviour (Sutton, 2008), a second objective was to expand the model by examining the role of planning. Planning was assessed using the planning subscale of the proactive coping inventory (Greenglass, 2002). It was originally hypothesised that planning would mediate the relationship between trust and intentions. However, because the Model 1 analysis indicated that trust did not play a significant role as a predictor, it was excluded and the analysis re-run using planning (Figure 2). This model provided a better fit to the data.

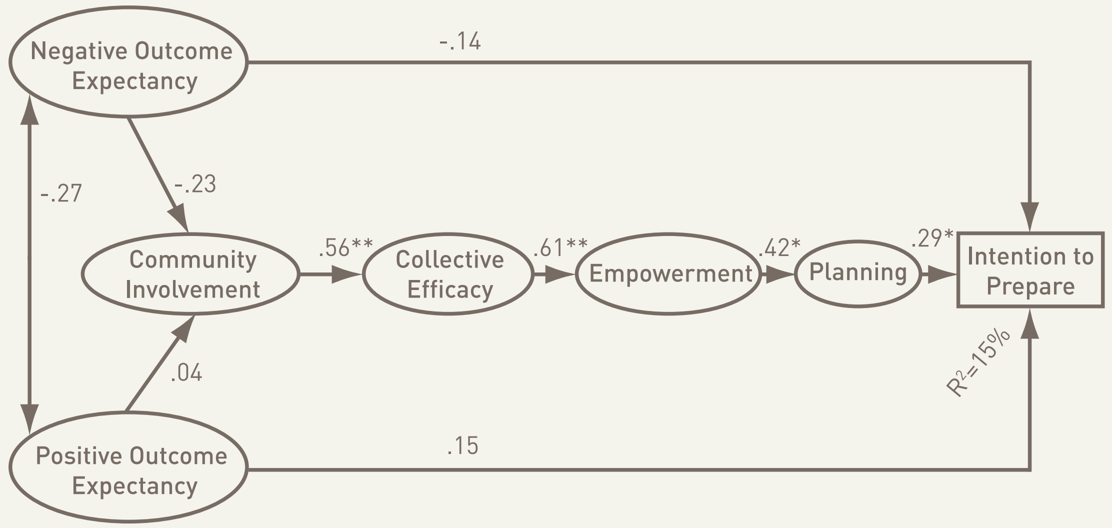
Although the χ^2 remained significant, the CMIN/df ratio and fit indices (Table 3) indicate that the data are a good fit to the model. Furthermore, this model accounted for 15% of the variance in intentions to prepare. While still relatively low, this was considerably better than Model 1. As with Model 1, the hypothesised paths for NOE and POE just failed to reach significance (see possible explanations offered above). This analysis offered support for the value of planning as a predictor. The final model examined how risk beliefs influenced intention to prepare.

Examining tsunami preparedness in Australia is complicated by tsunami not generally being recognised as a hazard (Frandsen, 2008). Frandsen interviewed residents in Tasmanian coastal communities about tsunami preparedness. She found that only 1 of 29 people (3%) interviewed believed that tsunami posed a risk to their community. The reasons people offered to account for their belief that tsunami did not pose a risk to Tasmanian coastal communities included their being unaware of any history of tsunami in the area, the lack of apparent causes of tsunami in the area making it unlikely that a tsunami could occur in their location, and no experience or evidence to suggest that a risk existed. If people do not perceive a risk, they are unlikely to prepare. Indeed, in the present study, only 15% of respondents had adopted any preparedness measures (and the preparedness measures that were in place had often been adopted to prepare for hazards such as storm surges rather than tsunami per se).

Model 3

The Risk Rejection measure (Paton et al., 2001) asked respondents to indicate the extent to which they agreed with questions such as 'the location of tsunami will be far from here' and 'the likelihood that tsunami will occur here has been exaggerated.' The higher the score, the less people perceive risk from a specific hazard. Based on work on factors influencing the adoption of protective actions in the health literature, it was hypothesised that an inverse relationship would exist between Risk Rejection and Intentions (Schwarzer, 2001). This hypothesis was supported. However, the modification indices produced for the Model 3 analysis suggested an alternative model. The data were a good fit to the model (Table 3) and accounted for 26% of the variance in intention (Figure 3).

FIGURE 2. Summary of Model 2 Analysis (*p<0.05; ** p<0.01).



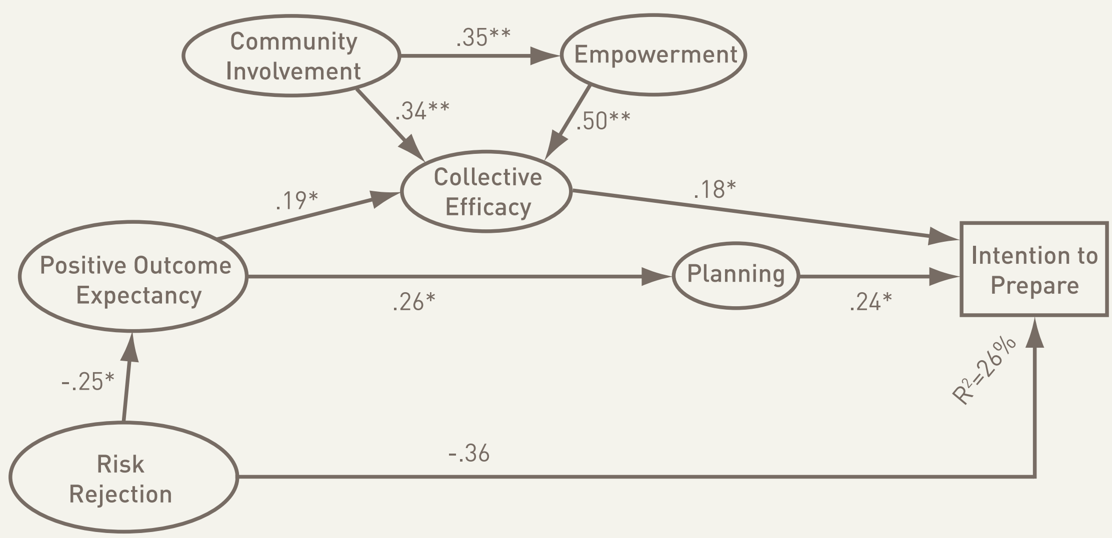
Discussion

The proposed model (Paton et al., 2008) did not provide a good fit to the data. The exclusion of trust and the inclusion of 'planning' and 'risk rejection' variables increased both model fit and its ability to account for differences in levels of intention to prepare for tsunami. Model 3 identified paths not anticipated in the original model.

It is possible that alternative models can be identified which fit the data better than, or as well as, the original model (Reisinger & Mavondo, 2006). Model 3 retains the basic relationship between personal (e.g., POE, risk rejection) and social context factors, but differs from the original (Paton et al., 2008) in that they played relatively more independent roles in the process. Because the specific arrangement of variables in Model 3 (Figure 3) was derived from the modification indices furnished by the SEM analysis, it is important to justify the observed relationships theoretically if a discussion of their implications is to be warranted.

A relationship between community connectedness and collective efficacy has been observed (Hobfoll et al., 2002; Sampson, Raudenbach & Earls, 1997) and several reviews (Dalton, Elias & Wandersman, 2007; Wandersman & Florin, 1990) identified a relationship between empowerment and collective efficacy and between involvement in community life and empowerment. In addition to providing a theoretically robust platform to discuss the revised model, the importance of confirming a role for community involvement, collective efficacy and empowerment derives from the key role these factors play as predictors of both risk beliefs (Lion, Meertens, & Bot,

FIGURE 3. Summary of Model 3 Analysis (*p<0.05; ** p<0.01).



2002; Siegrist & Cvetkovich, 2000) and the measures people take to mitigate risk (McGee & Russell, 2003; Paton et al., 2005).

The analyses provided support for Planning as a predictor of intentions, indicating that planning increases the likelihood that people will convert beliefs in the efficacy of preparing (POE) into a commitment to act (Gollwitzer, 1999). Model 3 provided partial support for the suggestion that high risk rejection (or low risk acceptance) could influence outcome expectancy beliefs. The negative relationship between risk rejection and POE (Figure 3) suggests that the less risk is attributed to a hazard, the less likely it is that people need to make judgements about whether mitigation measures are effective (which is what POE assesses), reducing the role of outcome expectancy in the process.

Conclusion

The small sample size may have reflected the low salience of tsunami hazards. If people do not believe that tsunami could pose a threat to them, they are less likely to respond to a survey on this topic. However, because the covariances which underlie SEM are sensitive to small sample size it had implications for the analysis. To accommodate this, fit indices considered least biased (CFI and IFI) were used to test model fit (Bentler, 1990; Hu & Bentler, 1998).

While the role of the hypothesised variables was supported, the relationships between them differed somewhat from those proposed in the original model (Paton et al., 2008). The hypothesised role for negative outcome expectancy was not supported and the roles of community involvement and empowerment were mediated by collective efficacy. The finding of a direct and indirect role for risk beliefs was novel. The possibility of these relationships resulting from the lack of familiarity with the hazard was discussed.

The analyses provide a basis for developing hypotheses for predicting tsunami preparedness in coastal communities in Australia that do not have a history of confronting this hazard. The findings highlight the importance of including community competencies and developing acceptance of the risk posed by tsunami in the public education component of tsunami risk management strategies. That is, facilitating hazard preparedness is not just about making information available to people. It is also about ensuring that community members have access to the social networks that influence the development and enactment of their risk beliefs (e.g., community involvement, community participation), the competencies (e.g., collective efficacy) required to identify how to respond to infrequent, uncertain events, and the ability to identify how to put strategies into action (e.g., planning). This work highlights a need for the community preparedness elements of risk management to be based on community engagement principles and integrated with community development strategies.

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Farmers' search for information during the UK foot-and-mouth disease crisis – what can we learn?

Christine Hagar explores the information needs of a Cumbrian farming community in England during the 2001 foot-and-mouth disease outbreak.

ABSTRACT

This paper reports on the findings of a study which explored the multiple information needs that faced the Cumbrian farming community in the north-west of England during the 2001 UK foot-and-mouth disease outbreak. Findings highlighted the importance of: changes in information needs at different stages of the crisis, context in which information seeking took place, overlap of information and emotional needs, formal and informal channels of information seeking during the crisis, farmers as information providers as well as information seekers, sense-making approach to information seeking during the crisis, trusted information sources, need for a mix of ICTs during the crisis, ICTs as a catalyst for innovation during the crisis, place and space and new venues and meeting places for communities in a crisis, and providing a local response to a national crisis.

Introduction

This paper reports on the findings of a study which explored the multiple information needs that faced the Cumbrian farming community in the north-west of England during the biggest foot-and-mouth (FMD) (1) outbreak to affect the UK farming system. The main research questions were: What were the information needs of farmers during the FMD crisis? How did farmers seek information during the crisis? and Why was it difficult for farmers to acquire the information they needed during the crisis? This study also addressed the role of ICTs in the crisis by asking the questions: How did farmers use ICTs to meet these information needs? and How did ICTs support the Cumbrian community during the crisis? A mixed method approach was used to collect the data which was gathered via semi-structured interviews with farmers and their families, members of the farming community network Pentalk (www.pentalk.org) and personnel from BBC Radio Cumbria. As well as interviews, data also came from a number of publicly available resources. Triangulation, i.e., drawing on different accounts, produced a fuller interpretation and understanding of the situation, enhancing the ability to address the research questions. Documents (2) gave supporting data to the interviews; insight into the national FMD picture; and reports of events and experiences of farmers in other regions of the UK. Data were analyzed for the types of information farmers needed during the crisis, the sources and providers of information, sources of trusted information, the methods used to access the information, changes in the use of ICTs during the crisis and the impact of ICTs on community building.

Findings

Results highlighted the importance of:

- Changes in information needs at different stages of the crisis
- Context in which information seeking took place
- Overlap of information and emotional needs
- Formal and informal channels of information seeking during the crisis
- Farmers as information providers as well as information seekers
- Sense-making approach to information seeking during the crisis
- Trusted information sources
- Need for a mix of ICTs during the crisis
- ICTs as a catalyst for innovation during the crisis
- Place and space and new venues and meeting places for communities in a crisis
- Providing a local response to a national crisis

Before discussing each of these issues, it is useful to summarize the characteristics of the FMD for comparative purposes, as no two crises are the same. Crises are "an interruption in the reproduction of economic, cultural, social and /or political life" (Johnston, 2002, p.123-5). The FMD outbreak was an interruption of all four. It affected the rural economy including agricultural markets, farmers' channels for communication, and social life, and destabilized the UK Government. The nature and scale of the epidemic was unprecedented in modern farming history. Although, FMD was similar to other crises in having economic and emotional impacts, it was unique in other respects. Unlike many other disasters, the FMD crisis was an animal disease crisis and although not transferable to people, it had a major impact on the lives of Cumbrian farmers. Unlike many disasters, 9/11, the Asian Tsunami or Hurricane Katrina where the length of the crisis event is short, the FMD crisis lasted for over 6 months. It was a crisis that spread and no one knew when it would end. Also unique to the FMD crisis was the simultaneous impact on farmers' work and home worlds, since these were in the same place.

Changes in information needs at different stages of the crisis

Farmers' information needs can be divided broadly into two parts. First, information was required at the different stages of the crisis: at the beginning of the crisis farmers were desperate to know about the origin of the disease; identifying the disease; finding out where the disease was spreading and whose farms had been infected; information on eradication including the slaughter and disposal of animals and, information about cleansing of the farm. Secondly, information was required on the complex system of biosecurity measures (3) introduced by the government.

Context in which information seeking took place

It is important to recognize the socio-cultural and political contexts in which farmers were seeking information. Farmers live in close-knit communities and are very much an oral community where information is passed on by word of mouth. Information is acquired from family, immediate farming neighbors and farmers who often live in the same valley. In the socio-cultural context, farmers were physically isolated, their daily routines disrupted, unable to exchange information, gossip and 'crack' in their usual meeting places. Farmers' means of accessing their usual "ecology of sources" (Williamson, 1998) changed. Their normal channels of communication were disrupted from one which was primarily face- to- face to one in which technologies were the main methods of communication. Normally farmers know where to go for their information: they exchange information at auction-marts, at farmers' discussion groups, in the pub and, in meeting each other during their work. In the crisis this changed; they were seeking information in an environment where many diverse actors, networks and agencies were responding to the crisis.

In a political context, farmers were seeking information in an environment where government disease control measures were complex: policies and strategies were continuously being adjusted to deal with the emerging situation; legal requirements and implementation on the ground were subject to continual change in order to address problems as they developed. Farmers' information seeking was hindered by the government response, one which was severely criticized for shortcomings in the information gathering and processing and methods of communication (Anderson, 2002). Information from the government was often not forthcoming, was not delivered at the 'right' time and at the 'right' place and was often contradictory. This study adds to McConnell & Stark's (2002) work which argues that the management of crisis is often driven by 'politics' as opposed to 'rationality'.

Formal and informal channels of information seeking during the crisis

When information needs are not being met, in the intense conditions of a crisis people seek information in formal and informal channels. Four stages can be identified in the FMD crisis: 1) the initial stages of the crisis when farmers sought information from informal channels, through friends and neighboring farmers, when information from the government was not forthcoming; 2) as FMD spread and legislation was implemented farmers sought information from the formal channels of government agencies and vets; 3) a return to informal channels as information from the government was lacking, not timely, or contradictory and, 4) desperate for information, farmers resorted to formal and informal channels. One of the major findings of this research is that when formal channels of information do not answer questions informal channels fill the gap. In a crisis, informal channels of information become even more important as people seek information from people who they know and trust. In addition, a two-way exchange happens, as the people seeking information also become the providers of information.

Sense-making approach to information seeking during the crisis

The findings of this study add to Dervin's sense-making approach in information seeking, as farmers were seeking meaning, an understanding of the crisis, not knowing how the disease spread and why the outbreak had occurred. They wanted to know: Why was the crisis happening? Did it really have to happen? How did FMD spread? Why did one farmer get it and not another? How had the virus got there in the first place?
There were many gaps in the information; it conflicted with earlier information or information from other sources; and it was disseminated and received too late. Farmers were trying to create a narrative that made sense and fill in the gaps of their information needs, by trying to interpret rumor and gossip. The crisis was an extremely emotional time for farmers, and ambiguity was accentuated by the emotional tensions that often made farmers unwilling to accept the facts or consequence. This study highlights that in the extreme conditions of a crisis, making sense of information becomes even more critical. Also, as information is spread via rumor and gossip it becomes exaggerated.

Overlap of information and emotional needs

While the focus of this research was farmers' information needs, one of the findings of this study was the overlap of social and emotional needs with information needs and vice versa. For example, farmers often began seeking information about how to deal with a particular process and would find themselves seeking information and social support at the same time. Alternatively, when farmers were seeking information they often found themselves being provided with emotional support. This follows Chatman's argument that people cross information boundaries when information is perceived to be critical (Chatman, 1991). As Figley (1985) argues, social support plays a critical role in people's abilities to cope with and recover from disaster. In a crisis, information providers become the providers of social support and those in positions of providing social support become information providers. It is important for this change of roles to be recognized in order to prepare individuals and organizations for future crises.

Trusted information sources

One of the key findings to emerge in answering the question of why it was so difficult to meet farmers' information needs, was the need for trusted sources of information. In a crisis, trusted information takes on greater significance. Decisions have to be made about which sources of information and which information providers to trust. These decisions were critical as by acting upon trusted information, farmers could shape and influence the nature of the crisis. As distrust of the government intensified, an existing trust divide between farmers and the government intensified. Generally farmers trusted anyone who had a local connection (except local government) and with whom they were familiar. Further, during a crisis, individuals must deal with information overload, from official and multiple unofficial sources. This increases uncertainty and the difficulty of making decisions about who and what are trustworthy sources of information.

As farmers distrusted much of the information that reached them, this lack of trust led to people making up stories, rumors and gossip. Consequently, much of the information that farmers were seeking and receiving was second-and third-hand. In a crisis, it is difficult to ignore rumors and gossip, as people seek information and explanations. Key questions are, How do we distinguish between rumor and gossip and information, and how do we decide how reliable is the information content?

The information uncertainty of the crisis and need for confirmation that farmers were doing the 'right thing' influenced their patterns of information seeking. Uncertainty brought about a need to compare different information sources. Even though farmers began to distrust the information about infected farms that was published on the Department for Environment, Food & Rural Affairs (DEFRA) website, some still felt the need to continue checking the website. We need to consider: Do people trust face-to-face contexts more than other environments, for example the Internet? This is discussed later in this chapter.

Need for a mix of technologies

Farmers' use of technologies, and the ability of the technologies to cope with a high demand for information and social support during the outbreak, highlights the need for a mix of technologies to be available in a crisis, and the importance of having multiple responses and multiple supports. A range of technologies is needed to disseminate and communicate information, and different technological choices are needed to accommodate different user communities and user preferences. This study adds to Dutta-Bergman's (2004) argument that users of a medium that satisfies a particular functional need also use other media types to fulfill that need. His notion of channel complementarity suggests that new media forms co-exist with traditional media forms in fulfilling specific communicative functions. In this study, farmers needed a mix of technologies to meet their information needs and to provide more channels of communication to accommodate users' preferred choice of technology.

At the outset of FMD farmers' access to technologies varied. Few farmers had access to the Internet and others were unable to receive local radio reception. During the crisis, access to technologies was interrupted, as the telephone infrastructure could not cope with the quantity of calls as telephone lines quickly became jammed but access to other technologies, the Internet and e-mail increased. Television may offer significant broadcast capabilities for information, but as this research shows, during the crisis, isolated farmers preferred to use a technology where they could interact and receive an instant response. This mix of technologies in a crisis also needs to be considered in other contexts where there is different access levels to ICTs, for example, in Africa while there are only two telephone lines for every hundred people, there are twenty radio receivers.

The crisis became a catalyst for ICT innovation as alternative means for exchange of information were set up, such as the Radio Cumbria website, interactive radio programs, new help-lines and online diaries. As technologies of memory storage change, cultural understanding of crises may also change. For example, in this research, online diaries allowed the collection of data that helped interpret the crisis, and leave a more permanent and available record for others to read.

One of the major challenges for farmers in their information seeking was assessing the trustworthiness of information. An emerging area of research (Guerra, Zizzo, Dutton & Peltu (2003) focuses on the relationship between technology and trust, asking questions such as: What is the effect of ICTs on trust? What effect does the Internet have on trust? Although there is no definitive research on the impact of different media on one person's trust in another (Dutton & Shepherd, 2003), a key assumption has been that the Internet will undermine trust because it eliminates face-to-face interaction. In the FMD crisis the majority of farmers were in the early adoption stage of using the Internet and were assessing the trustworthiness of the technology. Making this assessment in the context of a crisis made this a complex process.

Trust in online sources can be enhanced by effectively making information accessible on the web and in chat rooms (Ben-Ner & Putterman, 2002). Farmers who had the appropriate skills to interpret online information could enhance their ability to authenticate the value of information, thereby encouraging trust. However, others could be overwhelmed by the mass of information, creating an increased risk of negative outcomes from using the Internet. This raises concerns about the inequalities caused by variations in the skills of different social groups (Guerra et al, 2003), such as farmers. There are strong arguments that trust can be enhanced by making effective use of online social networks available through Internet-based interactions (Ben-Ner & Putterman, 2002), such as the Pentalk Network. (4) Thus, in a crisis it is important for new spaces to be

created where people can exchange information and provided social support.

E-mail gave farmers another medium in which to talk, and enabled the quick dissemination of rumors and gossip. In a crisis, the Internet also allows rumors and gossip to be spread globally (Frost, 2000).

How would ICTs be used in a future FMD crisis Farmers talk to each other on their cell phones, Internet use is widespread and broadband is more widely available. However, interviews revealed that in another crisis, farmers would still consider the traditional technologies of the telephone and radio to be important. One of the recommendations of the Anderson Inquiry (2002) stated:

> *In any future outbreak, the local media should be used to the full. DEFRA should provide tailored information to local radio stations or local newspapers in time for their deadlines, working with the Government Office network and the Government News Network...*

Cohen & Willis (2004) contend that:

> *Radio audiences seek out the medium following national trauma as a way in which to help bridge the gap between self and others, local and distant, and to create and identify with interpretive communities of listeners through attention to a unified message* (p595).

During the FMD crisis, local radio was an extremely important source of information and social support for farmers. As Gardener remarked (2003):

> *Sometimes looked down upon as the "poor relation" of television, and certainly old- fashioned compared to the Internet, radio today has become the one to watch... portable communication medium, the most widespread and the most economic; proving itself versatile enough to go hand-in-hand with the Web.*

Some argue that radio will remain the most important media for the poor while new media proponents argue that the broadcast monologue will be replaced by the Internet dialogue.

Place and space and new venues and meeting places for communities in a crisis

This study brings the dimension of a crisis to discussions about place and space. Sproull & Kiesler (1991) wrote of communities brought together by interest rather than geographical co-location. Wellman (2001) writes that the rise of the Internet has resulted in a shift from "place-to-place" communities, in which socialization occurs among families, to specialized online communities. Writings by Rheingold (2002) and Castells (2001) suggest that the idea of place does matter, and that the separation between cyber and geographic places is possibly just a transitional phase that results from the juvenile stage of these technologies.

The FMD crisis certainly created a kind of placelessness, as well as a new place in cyberspace, necessitated as physical meetings became impossible while human contact became essential, and sustainable via the Internet. The farming community is naturally geographically dispersed but at the same time has strong local ties. Yet this move into cyberspace occurred against the background of a very real and immediate attachment to place. The crisis created a greater attachment to place as the impacts of the disease targeted farmers' local, physical region, one that many had farmed as families for generations. Yet it created a detachment from place as farmers were cut off from contact with other farms, family and the rural community, and found refuge in phone and internet connections. The crisis created a strengthened identification with physical place at the same time it denied access to that place, and as new technologies offered placeless interaction.

As a result of the crisis new spaces of interaction developed, and a new sense of community (Bennett et al, 2002; Wall, 2002). Pentalk created a virtual space where farmers formed a 'new' community during the crisis, creating new connections at a local level. Not only did new spaces emerge for social interaction but also new associations were established, e.g., the Pentalk coordinators, when they could, met face-to-face to discuss the development of the network, thereby providing a new dimension to the increasingly restricted movement of the offline community. The offline and online communities were separate but also integrated (Haythornthwaite & Hagar, 2005), each supporting the other.

Along with specialized communities, people also belong to multiple communities: of work, family, interest, practice, etc., some enacted locally, but also globally. Internet connections made it possible for Cumbrian farmers to create and maintain global communities. Pentalk enabled the farmers to extend their work community internationally. Again, paradoxically, the need for international contact was driven by geographically local conditions.

ICTs as a catalyst for innovation during the crisis

As demonstrated by the Pentalk Network, the Internet can be used to set up a rapid-response website, designed to centralize and aid the control of information flow during a crisis, and providing crisis response updates. The significance of a crisis lies in the fact that it may produce a new fundamental outlook; it can be both a danger and an opportunity. Crises can create imbalanced, disorganized chaos or serve as a catalyst for new and positive changes such as the Pentalk community network described here. This is a particularly interesting study because the Pentalk Network was one of the few positive initiatives to have emerged from the FMD crisis. Pentalk helped contribute to the survival of farming in Cumbria during the crisis and post crisis.

Providing a local response to a national crisis

The case study of the Pentalk Network gives valuable insight into how a local community responded to a major national crisis, serving a population for whom work and home were in the same place. While further research is needed to fully explore the role of ICTs and the Internet during crises, this case shows that the network serves as more than just an information dissemination mechanism. The Pentalk Network acted as an important resource and site for interpersonal contact, information dissemination, and information discussion, each of which were particularly important during the crisis. Pentalk serves as an example for community leaders and administrators of a successful innovation and a sustainable one.

There is a degree of skepticism about how real some community networking projects are. The major challenge confronting local community-technology installations worldwide is how they can be sustainable in the longer term (Gurstein, 2001). Pentalk, which emerged from a crisis, has become sustainable. When the crisis ended, not only did the network carry on but also it rapidly spread to the whole of Cumbria. The attention paid to the social, cultural and organizational contexts in which the network was developed and used have contributed to this success.

Pentalk's success may be attributable to its focus on the specific needs of the farming community, first by reacting in response to a crisis, and second by continuing to help in ways that directly address community needs. Keeping the scheme purely for farmers and aiming at providing basic skills has contributed to its success. Current training that addresses government demands for online reporting, and a continued focus on farm needs and farm activity, have continued to encourage farmers to become involved. Also important has been the way work has moved from a central organizer to local coordinators, people embedded in the farming community, and conversant with its needs and members. This provides Pentalk with a base of engaged participants who are close to local needs, and again are responsive to contemporary informational and technology needs.

Discussions have been held with representatives from other counties as to how similar schemes could be set up in other parts of the UK. If networks similar to Pentalk could be replicated in other areas, then the farming community would be in a much better position to deal with a future animal disease crisis, should one occur again. A new space created by Pentalk, called VetCall News has the potential to act as an early warning system should there be another occurrence of FMD. The creation of this online space allows farmers to receive and discuss the latest information online on unusual cases. Thus, Pentalk could help by providing a direct link between farmers and vets in identifying a new outbreak of FMD.

Community networks can play an important role in disseminating information and providing social support in crises. Lessons learned from this study of Pentalk can be implemented by other community networks involved in crisis response.

Summary

This research adds to crisis theory by analyzing complex information needs in a crisis and by exploring how information needs to be delivered for an effective crisis response. How effectively information is managed and information needs are met during a disaster can have a direct influence on how well the crisis is managed. Information needs to be integrated from a wide range of sources and be coordinated among a potentially large, diverse set of individuals and organizations.

This research also extends information seeking theory by enhancing an understanding of information seeking in a crisis. Studies in library and information science have highlighted the importance of context in information seeking (Kuhlthau ,1999; Jarvelin & Ingwersen, 2004) and sense-making (Dervin et al, 2003). This study highlights that in a crisis, the physical, social and political environment in which information seeking takes place may change. People have to think of new ways to find information and make sense of information (Dervin, 2003). Information seeking takes place in peoples' close social and professional networks, as local sources of information and local information providers are seen to be trustworthy. In a crisis a two-way exchange of information happens, when information and emotional needs are met by an information provider or an emotional supporter and the person seeking information is the provider of information.

The challenge in a crisis is: the effective delivery of information to many different actors; by officials who need to determine a quick response; by victims who need to know what to do and who may need assistance; by members of the public who want to find out what is happening or offer support and by the media to broadcast news (NRC, 2003).

Notes

1. FMD is an infectious viral disease affecting cloven-hoofed animals, in particular, cattle, sheep, pigs and goats. FMD spreads rapidly and is serious for animal health and for the economics of the livestock industry.
2. Reports from independent inquiries (non-government inquiries): The Cumbria Foot and Mouth Inquiry (2002), a proceeding which was also transmitted in its entirety by BBC Radio Cumbria (www.bbc.co.uk/cumbria); The Anderson Report (2002). *Foot and mouth disease 2001: Lessons to be Learned – Inquiry Report*; The Royal Society Report (2002) and the National Audit Office (2002) *The 2001 Outbreak of Foot and Mouth Disease*; The European

Parliament Temporary Committee on Foot and Mouth Disease (2002).

The Warmwell independent website (www.warmwell.com) set up at the beginning of the crisis which provides an archive of articles, reports, parliamentary proceedings and commentaries from individuals

The FMD archives of the Penrith Public Library. A collection of newspaper cuttings from local and national newspapers.

Personal diaries and accounts written in local and national newspapers (Plummer, 2001) were particularly useful for relating the farmers' individual daily and weekly stories and for mapping the changes in their needs and responses as the crisis progressed.

Recordings of local radio news reports and program, such as the BBC Radio Cumbria *Nightline* phone-in program broadcast during the crisis.

One interviewee gave access to a unique collection of supplementary data - a collection of documents which they had received in the mail and via fax during the crisis. This female farmer had kept the documents as memorabilia for her grand-children. These documents came mainly from MAFF/DEFRA and included: MAFF/DEFRA newsletters; information leaflets; Public Information Fact Sheets; licenses e.g. for the movement of cattle and for moving silage; instructions for enforcement measures; list of approved disinfectants and local NFU newsletters. This collection was particularly useful and original copies of licenses were seen which farmers had referred to in the interviews. Also the documents from MAFF/DEFRA enabled the content of information sheets to be viewed, instructions etc. described in the interviews and the method by which information was disseminated to farmers. Photocopies were taken of these documents, allowing me to refer to them during my research.

3. Restrictions were imposed on the movement of all animals and carcasses except under license, and on markets, fairs, 'gatherings of animals' and hunting activities. Of particular note was the use of 3km-radius 'protection zones' and 10km-radius 'surveillance' zones' in which there were various restrictions on the movement of animals, people and equipment, as well as on other activities. Complicated licensing procedures were introduced to control animal movements. When farmers requested to move stock, for example for grazing purposes, vets had to issue licenses. The vet assessed where farmers wanted to move the animals and then MAFF/DEFRA approved or disapproved the movement. Another element of disease control was the introduction by farmers, individuals, businesses and organizations (e.g., Cumbria County Council) of disinfectant footbaths or mats, usually situated at the entrance to property.

4. The Pentalk Network was a community network constructed at a time of the FMD crisis with the aid of farmers. It was set up to provide computers and IT training (particularly e-mail and the Internet) for farmers and their families at the height of the FMD crisis. It was clear that farmers needed to become computer literate very rapidly and that, often, they could not afford to buy a computer. They needed to be provided with one and they needed to be taught to use it speedily, in a way that provided them with functional skills. Pentalk supplied re-conditioned computers to farmers free of charge for six months, after which they could buy them for approximately US $450 or return them at no charge. Initial funding for the scheme came from a start up grant from the UK Learning and Skills Council, which was matched by the Rural Development Programme. Further funding came from the Department for Education and Skills (DfES). A Pentalk office was set up at the Penrith auction mart, which is normally the focus of the farming community. Pentalk served to connect farmers across Cumbria, by providing them with access to the Internet, e-mail and links via their web pages, where farmers could access news and information available from Government and other sources on the spread of the disease.

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Battle Rhythm in emergency management

Fred Wilson suggests that the concept of Battle Rhythm scheduling will lead to greater productivity and coordination among emergency management agencies.

ABSTRACT

Often, the senior or lead entity managing an emergency engages in an ad hoc approach to scheduling conferences and setting deadlines for the submission of reports. This can lead to the people actually having to provide the core data facing unreasonable timescales. Battle Rhythm is a military term that directs the establishment of an orchestrated and holistic timetable of current and future events. The use of the concept in emergency management will lead to greater productivity and ensure co-ordination among all the agencies involved in an emergency.

Introduction

No it is not a new dance craze. Battle rhythm is the military name for the maintenance of an ordered routine. As defined by the US Department of Defence it is *"A deliberate daily cycle of command, staff, and unit activities intended to synchronize current and future operations."* (DOD Dictionary[1])

To some extent we have our own individualised battle rhythm – the time at which we get up, shower, have breakfast, and transport ourselves to work to meet a designated start time has a fairly standardised approach. If we need to prepare for an early meeting or adapt to a change in transportation arrangements, the routine is adjusted to meet these and other emerging influences as the day progresses.

The organisation we work for usually has a scheduled approach to its business activities with board meetings, meal breaks and a number of other activities occurring at regular times. That allows the inputs to those activities and their relationship to external events, customer/supplier needs and other influences to be co-ordinated. If the organisation is geographically spread, and particularly if different time zones are involved, there is an additional co-ordination dimension to ensure that the battle rhythm of the individual parts of the organisation are harmonised.

Emergency management needs a rhythm. Each new emergency is not exactly like the last one and the challenge is to have a structure that can develop the battle rhythm required for the current emergency. Many factors can remain static – and the more that remain static the better – so that emergency management staff are familiar with a basic rhythm or standard routine that incorporates enduring practices, e.g. the Regional Controllers video-link or conference call is always at, say, 1100.

This paper examines some principles for establishing a battle rhythm for your organisation, before the emergency arises.

Background

The concept of developing and maintaining a strictly scheduled approach is not new in the military. Sun Tzu wrote of the need for consistency and constancy to promote discipline in the 6th Century B.C., the Roman Army maintained an inflexible routine, and standard timetables of unit activities remain pervasive in today's military. However, as warfare has become more spatially disparate across time zones, the development of integrated and synchronised planning, execution, assessment and review models has become more relevant.

The media, particularly the electronic media, must carry out a rhythmic activity to gather and present the news within strict deadlines, and their processes often involve recognition of time differences. In businesses such as the fast moving consumer goods industry, the lack of a holistic approach to integrated timing in the purchase/packing/distribution continuum can have devastating economic results.

What all these examples have in common is the recognition that if the leader or senior management delays their decision-making processes and subordinates also do so on down the chain, the impact at the lowest level can be catastrophic. The unit that must action the plan or activity is left with no time to adequately prepare. The consequences of that over time is a loss of confidence in the leader's ability, a less than optimum outcome, and a decline in morale.

[1] Department of Defence Dictionary of Military and Associated Terms – Joint Publication 1-02 accessed from www.js.pentagon.mil/doctrine/jel/doddict/natoterm_index.html 25 May 2009.

The concept of battle rhythm is not a US-orchestrated fad either. The principle, if not the name, is used widely such as in a recent UK national exercise, Winter Willow 2, conducted by the Department of Health involving 5,000 players, where an exercise battle rhythm was used to co-ordinate local, regional and national activities. Somewhat presciently, the scenario for the exercise was an influenza pandemic that had spread to the UK.

What does this mean for emergency management?

The response from some Emergency Managers may well be that "I knew that". They are confident that they have a schedule for the Emergency Operations Centre (EOC) that recognises the planning cycle[2], shift changes, meal breaks, etc. But what is missing in most jurisdictions is the recognition of the need for a battle rhythm that embraces all the entities involved in an emergency response. Consistently there is the imposition of changing deadlines for reporting data, unrealistic timescales for responding to draft new initiatives, and variable and arbitrary times for video and telephone conference calls. Many of these occur because a senior individual has not recognised that their time is only as important as their subordinate's time. Equally they do not practice preciseness themselves (while expecting it of others) and allow meetings and conferences to go over their allotted time because they permit a lack of focus to develop.

The promulgation of a battle rhythm is a key component of effective time management during an emergency. Not only does it shape the behaviour of leaders and senior management personnel, it provides the framework for consistency that individuals crave for and respond best to. It allows personnel at every level to understand the objectives for their shift and enhances unity of effort. Emergency responses can be likened to military operations and time-sensitive business activities. They achieve their goals in an optimum fashion if there is discipline, top-down and bottom-up, and a battle rhythm can promote that achievement.

How to design a Battle Rhythm

The responsibility for setting the high level parameters of a battle rhythm rests with the Lead Agency at whatever strategic level the emergency response is being conducted at, i.e. a national emergency by the national entity, a localised emergency by the regional or local entity of the Lead Agency.

Supporting agencies will have their own subordinate battle rhythm that is aligned with that of the Lead Agency and the deadlines that it sets. Lead Agencies therefore need to:

- establish the overarching battle rhythm as early as possible
- minimise the number of events in it to allow flexibility to supporting agencies
- consult with supporting agencies to ensure key deadlines can be met
- develop internal battle rhythm schedules that mesh with the strategic battle rhythm

It will usually be helpful for the Lead Agency to promulgate when shift changes are scheduled in the co-ordinating Emergency Operations Centre (EOC) in their battle rhythm. This alerts supporting agencies to the times when the Lead Agency will be less responsive to incoming calls. It also allows the planning cycle[2] to be interrelated and responsive.

The Lead Agency also needs to be aware of likely external pressures and deadlines, e.g. media deadlines and Ministerial deadlines, as these can impact on when planning cycles need to occur to ensure the appropriate information is available at the optimum time.

Detailed process

Designing a battle rhythm is an iterative process in establishing the most balanced and responsive structure. Personnel with the right skills and resources can use tools such as Microsoft Project and SmartDraw that automatically provide dependency links, but often a spreadsheet approach will work just as well.

Start with a weekly schedule that contains only strategic output activities. Weekend demands and resource availability will often be different, but as far as possible make the key events, e.g. Controller's meetings, media briefings and Sitrep issue times at the same time every day.

Then set the duration of activities. Limit co-ordination activities such as conference calls to no more than 30 minutes and be very strict in their observance – everyone will have experienced how a desultory meeting under poor chairmanship takes forever and disrupts downstream activities.

Then set the deadlines for when subordinate and supporting entities need to provide their inputs for consolidation into the key events. This time must be minimal and realistic – demanding key data from subordinates and supporters to allow leisurely consideration and collation at the co-ordinating EOC is counter-productive. Not only does it alienate the suppliers of the data, it also devalues the currency of the data as the most up-to-date information is not included.

Now overlay the shift roster and review the result to check for inconsistencies, conflicts and insufficient time allowed between sequential activities. There is little point for example in having the end of the Controller's meeting coinciding with the deadline for Incident Action Plan inputs, as the information from that meeting will not be incorporated into that planning cycle.

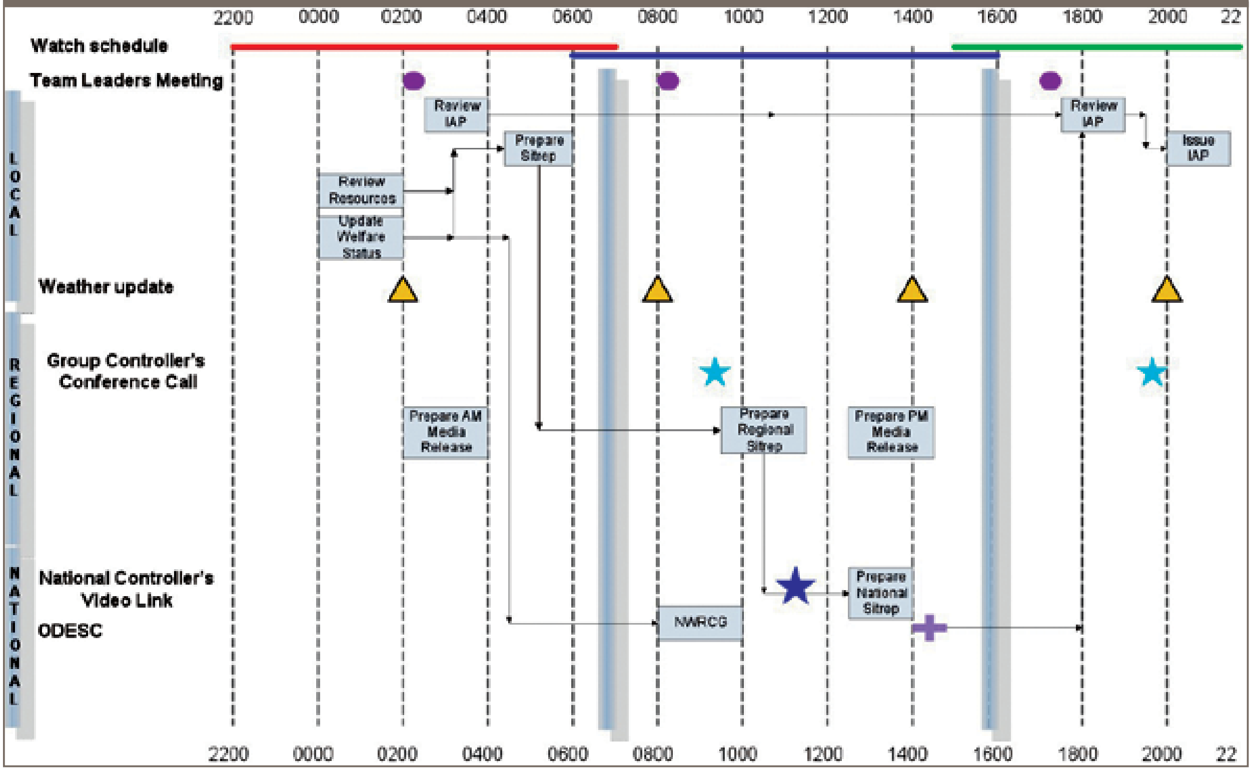
From the weekly schedule a more detailed daily schedule can be developed, both at the strategic and operational levels and by subordinate and supporting entities.

[2] In its simplest form the planning cycle is the continuous process of Plan-Execute-Evaluate-Review. There are many terminological differences and varying degrees of sophistication in planning cycle models developed by different authors. See for example http://images.google.com/images?q=planning%20cycle&hl=en&rls=com.microsoft:en-nz:IE-Address&rlz=1I7GGLR&um=1&ie=UTF-8&sa=N&tab=wi

Shown below is a portion of a simple battle rhythm on a Microsoft Excel spreadsheet which is easily modified, easily promulgated and easily printed out in hard copy.

	A	B C D	E	F	G	H	I	J
1				Strategic Level			Operational Level	
2	Time	Shift	Meetings	Activities	Outputs	Meetings	Activities	Outputs
3						Team Leaders		
4	0300							
5							Review IAP	
6	0400							
7								
8	0500							
9							Prepare AM Sitrep	Forward AM Sitrep
10	0600			Media briefing				Issue map revision
11							Weather update	
12	0700			Shift handover			Shift handover	
13				Prepare AM Sitrep				Velfare status report
14	0800					Team Leaders		
15			Conference call		Issue AM Sitrep			
16	0900						Draft IAP	
17						Velfare stakeholders		
18	1000							Issue IAP
19			Brief Minister					

Below is another style of a battle rhythm using a Visio presentation.



More sophisticated approaches have been used such as that by the Indiana Department of Homeland Security using the emergency management software WebEOC, where a webpage provides a countdown, automatic colour changes occur as an event approaches, and tone alerts sound at event start times.

It is not important how classy your battle rhythm is or how it is structured, but that you adopt the approach of a structured and co-ordinated management process that informs and guides the personnel involved, and is integrated and sympathetic with the management needs of other stakeholders. If you are a Lead Agency or the co-ordinating centre for subordinate or supporting agencies, then the need is even greater.

About the author

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Adapting emergency animal disease response strategies to contain and eradicate new incursions of invasive species

Using the example of the common Starling incursion in south-western Western Australia, Dr Andrew Woolnough shows that adapting an emergency animal disease response (EAD) approach was a valuable precursor to an on-going infestation containment and eradication strategy.

ABSTRACT

Existing plans to respond to an emergency animal disease (EAD) outbreak in Australia are comprehensive. The strategies described in EAD plans are generally subjected to a cycle of on-going testing and refining to be prepared for all likely scenarios during an emergency response. The strategies used in EAD management can equally be applied to other emergency responses. In this example, a new incursion of the Common starling, *Sturnus vulgaris*, was detected in south-western Western Australia. Using the strategies of an EAD response, the scope and extent of the new infestation were rapidly determined. The EAD response approach has since become a valuable precursor to an ongoing containment and eradication strategy. This example demonstrates that the generic principles of EAD response strategies have application in situations to rapidly contain and eradicate new incursions of invasive species and other biosecurity issues that require immediate action.

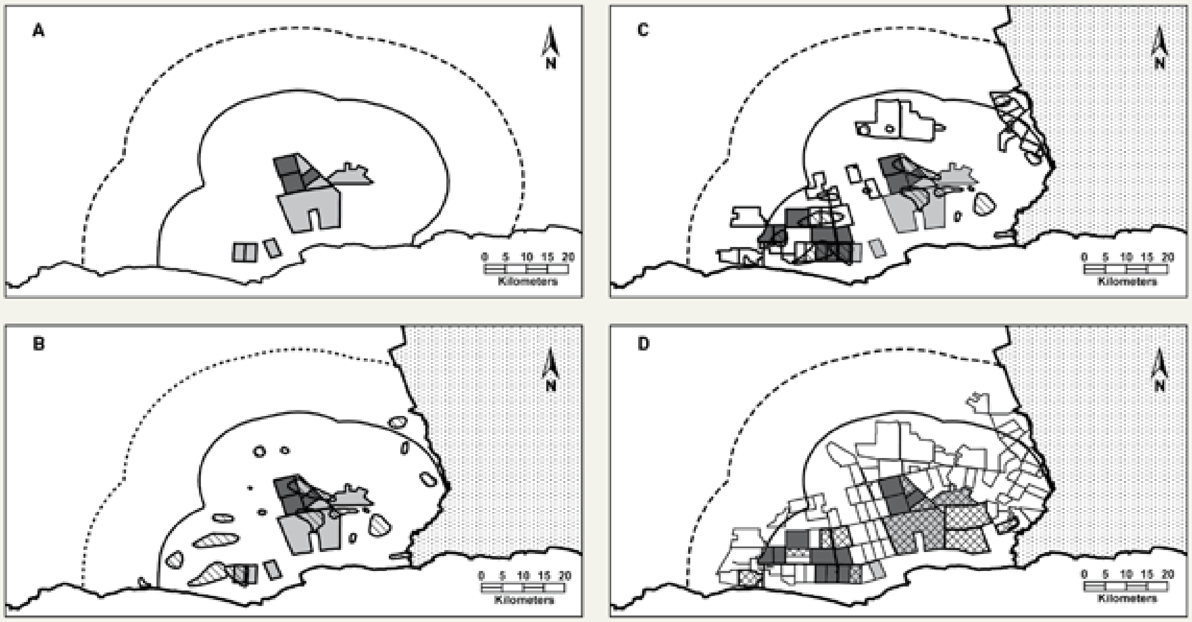
Introduction

Rapidly defining the extent of a new incursion of an invasive species shares similar challenges to emergency response strategies, particularly emergency animal disease (EAD) responses. In an EAD response, defining distinct areas such as infected premises (IP), restricted area (RA) or control area (CA) are vital for compartmentalising response strategies and minimising risks of further spread of organisms (Animal Health Australia 2002, Anon 2006). For EADs, declaration of designated areas is dependent on a number of factors. Many of these relate specifically to livestock production such as defining the industries involved, livestock movement patterns or livestock products. However, some factors are generic and could be used for defining potential areas for invasive species. These include identifying environmental factors and potential barriers, and understanding the species involved and the nature of the outbreak (Animal Health Australia 2001). A compartmentalisation approach to a new incursion of an invasive species would therefore maximise efficient use of resources, both to detect and define the new incursion in a timely manner and reduce the risk of spread. The incursion by Common starlings, *Sturnus vulgaris*, in south-western Western Australia was used to test these propositions.

The starling was originally introduced to south eastern Australia in the nineteenth century (Long 1981). As in other parts of the world, the starling spread rapidly and established large populations throughout eastern Australia, causing damage to agriculture and the environment and becoming a social nuisance (Tracey et al. 2007). The spread of starlings in Australia has been restricted by a number of geographic barriers including deserts. Movements into Western Australia (WA) have been limited by the semi-arid Nullarbor Plain and more than 30 years of ongoing control work at the western edge of the main distribution of starlings (Figure 1, Woolnough et al. 2005). However, there have been a number of incursions into WA and these infestations have either been eradicated or are subjected to ongoing control (see Woolnough et al. 2005).

There are compelling economic arguments that it is cost-effective to control starlings in WA before they become widely established (Roberts and Cramer 2006). When an infestation of starlings was detected near the town of Munglinup in south-eastern WA in 2001 they were subjected to concerted control efforts. However, in February 2006, a report from a landholder resulted

FIGURE 1. Generalised distribution of starlings in south eastern Australia (shaded) adapted from Birds Australia atlas data (www.birdata.com.au), excluding low density records in north Queensland and Western Australia. The emergency response was situated at the boundary of the Ravensthorpe and Esperance Shires (local government boundaries).



in the confirmation of a new infestation at Jerdacuttup more than 30 km to the west of the Munglinup infestation. Immediately, an emergency response was initiated to define the western-most distribution of this new infestation using the principles of EAD response strategies. Here, it is demonstrated how the principles of EAD responses were used and how the underlying generic strategies can be adapted for biosecurity emergency responses, such as the detection and quantification of a new incursion of an invasive species.

Methods

EAD terminology

Part of adapting EAD principles is using the terminology, although some liberal interpretation may be required (e.g. 'infected' cf 'infested'). Definitions are widely available in EAD response in many manuals (see Animal Health Australia 2001, Gaynor and McAteer 2003, Anon 2006) but may vary slightly between jurisdictions.

Defining the CA

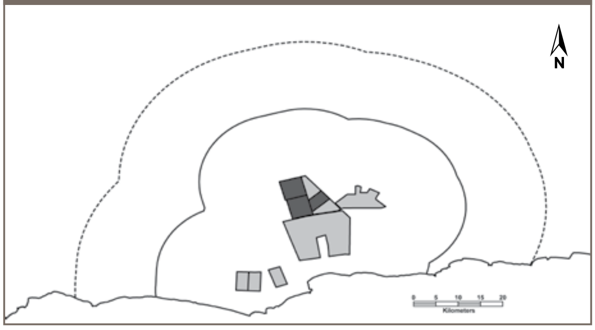
Like diseases, invasive species do not recognise land tenure as a boundary or barrier. Nevertheless, land tenure is often used as a management unit in EAD responses and the same pragmatic course was used in this exercise.

After starlings were first detected on a property at Jerdacuttup in the Ravensthorpe Shire in February 2006, follow-up surveillance detected starlings on two adjacent properties. Consequently, 3 IPs were defined and an additional 6 suspected infected premises (SPs) were identified through preliminary reconnaissance and intelligence from highly experienced starling control officers (Figure 2).

A two-zone strategy was implemented to define the CA in a similar manner to an EAD Protection Zone (PZ) and Surveillance Zone (SZ) strategy (see Gaynor and McAteer 2003). Unlike EAD manuals, this incident did not have any disease-specific distance measurements to define the area of each zone. Analogous EAD criteria were used to define zones. However, sound epidemiological principles and natural boundaries could be used to define each zone. The inner zone (equivalent to the PZ) was defined as the maximum span of short-term home ranges used by starlings centred about the IPs and SPs. This distance was conservatively set at 15 km, based on radio telemetry data from a starling infestation immediately to the east of the IPs (Woolnough et al. 2006, Woolnough et al. unpublished data). The outer zone (equivalent to the SZ) was defined as twice the maximum span of short-term home ranges used by starlings, or 30 km. This was based on a demographic assessment that it was unlikely (see Higgins et al. 2006), but not impossible, that the starlings from the IPs or SPs would move no further than the PZ and that any birds detected towards the edge of the PZ would move no further than the edge of the SZ. In this way, all likely encounters directly related to the IPs or SPs should be accounted for.

Using the buffer feature of a GIS (Geomedia V6.0) to create the PZ and SZ, area estimates of these two CA components were 2,250 km2 and 4,700 km2 respectively. This clearly represented a very large area in which to detect low density, cryptic birds. Consequently, the CA was delineated to the east by the local government boundary (Figure 3) and surveillance efforts were

FIGURE 2. Location of the three infected premises (IPs – dark shade) and six suspected infected premises (SIPs – light shade). The control area (CA) is compartmentalised by an inner buffer of 15 km (Protection Zone or PZ – solid line) and an outer buffer of 30 km (Surveillance Zone or SZ – dashed line), with the buffers set about the IPs and SIPs.



concentrated in the western three quarters of the CA. This focus on the western region of the CA was chosen as the most critical front for starlings in Western Australia (i.e. western most boundary), rather than for any definitive biological reason.

Habitat

Land use in the CA is primarily mixed farming, with cropping, grazing (sheep and cattle) and feedlots cattle (Woolnough et al. 2006). A common feature of the habitat of the CA is the many permanent and seasonal swamps surrounded by Saltwater Paperbarks (*Melaleuca cuticularis*) and/or Yate trees (*Eucalyptus occidentalis*). Other habitat characteristics of the CA include remnant tracts of native vegetation (dominated by *Banksia* spp. and *Eucalyptus* spp.), particularly along riparian strips, road-sides, property boundaries and fence lines, and introduced stands of Tasmanian blue gums (*E. globulus*) used for wind breaks or plantations.

Targeted areas

Starlings in south-western WA are often associated with swamp habitats, which they use for shelter and breeding. Surveillance used these habitats as focal points. However, within the CA there are more than 430 swamps. Because of time constraints similar to an EAD response, rather than assess each individual swamp for suitability, an assessment was made by aerial survey. Priority areas (PAs) to be targeted for surveillance were then selected on the basis of scores. Two observers flew east-west transects over the CA and independently scored each swamp on a three-point scale. Where the scores differed, the score of the most experienced observer was used. This observer had over 100 hours of aerial radio-tracking starlings in similar habitats, so was familiar with preferred starling habitat from the air. This is an important point, since interpretation of habitat from the air can be much different than from the ground.

Surveillance and detection

An emergency incident centre was established which was equivalent to a Local Disease Control Centre (LDCC; Animal Health Australia 2004). Key roles at the LDCC included an LDCC controller, a logistics manager, a mapping officer, a land holder liaison officer, a public relations officer and team leaders for the field surveillance teams. Many of the roles and responsibilities outlined in the Animal Health Australia (2004) manual were incorporated into the roles outlined above, with some participants taking on multiple roles. In all, 24 staff were engaged for the week-long emergency response, with additional staff involved prior to and after the response.

FIGURE 3. Because of the large area of the CA, surveillance efforts are restricted to the Ravensthorpe Shire to the west. The eastern edge of the CA is delineated by the Ravensthorpe-Esperance Shire boundary. Stippled area east of Shire boundary (Esperance Shire) was excluded from the final PZ and SZ. High priority target areas, identified by aerial surveys, are indicated in diagonal fill. Other features are described in the caption for Figure 2.

FIGURE 4. Results of the emergency response including existing and new IPs (dark shade), properties surveyed that were clear from infestations (no shade) and the SIPs (light shade). Other features are described in the captions for Figures 2 and B.

Surveillance was undertaken by three teams of four and one team of five observers (N = 17) experienced in observing birds and familiar with starlings. Surveillance was undertaken in two shifts per day (early morning and late afternoon) to maximise the opportunities at times when starlings were most active moving into and out of roost areas. For each surveillance session, teams were allocated to one of the 20 PAs (Figure 3), with surveillance concentrated on swamps and surrounding pastures. When starlings were detected, and confirmed by multiple observers, teams moved on to other swamps and priority areas. If starlings were not observed, a combination of observer judgement and pre-set criteria for the minimum observing time (3 hours by 2 observers per swamp) was used by the surveillance team leaders to determine that properties and/or swamps were not infested. Each team recorded details of time spent at each location, whether starlings were sighted, how many starlings were sighted and at what time. More specific details on observations of starling behaviour or suitability of a particular swamp for starlings were recorded separately for subsequent follow-up investigations. Results of each surveillance session were reported in a twice-daily debrief. The LDCC controller reallocated PAs based on information from each debrief. Central to this process was the rapid generation of detailed aerial photographs, superimposed with cadastral boundaries and ownership information, produced by the mapping officer.

Following this exercise, ongoing surveillance and control strategies were developed to clarify the western-most boundary of the new infestation.

Results

Aerial surveys

Four hundred and fifteen swamps were visually assessed from the air of which 158 were deemed suitable for starling habitation. These were allocated into 20 PAs for surveillance, with each targeted area covering multiple swamps (Figure 3).

Surveillance

Over 575 person-hours of surveillance were undertaken in the week-long emergency initiative, not including the > 850 person-hours in pre-deployment planning and preparation. This allowed for comprehensive surveillance of 30 properties selected within the CA. The owners/managers of these priority properties were contacted in person and briefed prior to teams conducting investigations. Of the 158 swamps targeted for surveillance from the 30 properties, 97 of these were investigated in detail.

In addition to the IPs, six additional properties were found to have infestations of starlings during the initial emergency response, including one of the SPs (Figure 4). Independent (time distinct) counts of starlings detected individual birds, as well as flocks of up to 60 birds.

Subsequent to this emergency response, surveillance of all potentially infested properties in the Ravensthorpe Shire (N = 64), until December 2006, found starlings on another 10 properties, bringing the total number of IPs to 20 (Figure 5). This represents a surveillance and control effort of more than 2250 person-hours, investigating 192 swamps, including all of the high priority swamps.

Discussion

The success of the emergency response in this exercise was largely due to adherence to the overarching principles contained within emergency response plans. Furthermore, this example demonstrates that the generic principles outlined in plans such as AUSVETPLAN, can readily be applied in other similar biosecurity emergencies. In this case, it was the rapid detection and quantification of a new incursion of an invasive species, the common starling in WA.

In Australia, the biosecurity sector has a number of emergency response plans that are sector-specific: PLANTPLAN for emergency plant pests, AUSVETPLAN for terrestrial animal disease management, AQUAVETPLAN for aquatic animal disease management, and CCIMPE for marine pests. These plans share similar fundamentals and constructs including organism control strategies, enterprise manuals, management manuals and operational documents (Murray and Koob, 2004). It is interesting to note, that apart from the Wild Animal Response Strategy (Animal Health Australia 2005) of AUSVETPLAN, vertebrate pests are largely overlooked in these biosecurity strategies. Evidence presented here suggests that the generic principles in these management manuals are sufficient to form the basis of real-life emergency response procedures in invasive species emergencies. Furthermore, there is perhaps no need to develop a different strategy for invasive species.

The concept of a generic set of policies, strategies, operational and tactical arrangements for all types of biosecurity incidents is being developed by the Emergency Risk Management Unit, Australian Government Department of Agriculture, Fisheries and Forestry (Peter Koob, personal communication). It is important that the relevance of invasive species (plants and animals) is considered when the preparedness and response strategies are agreed upon for each biosecurity sector.

The EAD management manuals are also suitable to develop appropriate training programs and scenario-based simulations (e.g. Saunders and Bryant 1988, Anon 2002, Koob 2004). In this scenario, training for one of the key roles was provided by participation in a field-based EAD exercise (Exercise WIldThing; Anon 2002). Field-based training provides unanticipated outcomes that require real-time responses and solutions. For example, Saunders and Bryant (1988) demonstrated that the compartmentalisation of the CA, though ecologically well-founded, was inadequate to anticipate the additional dispersal pressures created by persecution of the feral pig population, and that a level of flexibility in the management of the scenario was vital to achieve eradication of the disease from the feral pig population. Likewise, in this scenario, the LDCC needed to respond immediately to reports from the field to deploy teams in the most meaningful way to quantify the western front of the infestation. Even though desk-top exercises are very useful, particularly for refining high-end policy making and communication strategies (Koob 2004), nothing can replace the suite of challenges created during field-based testing of a simulated emergency response or indeed the lessons learnt from a real-life emergency response (Tarrant 2006).

Using the EAD analogy, the immediate rapid emergency response did not achieve complete containment. However, using the same strategic approach, the complete extent of the infestation was eventually defined. This demonstrates that the underlying principles were robust and applicable.

Additional challenges with starling control and eradication continue. Following the defining of the extent of the infestation, we could easily use the principles of emergency response to suggest that we

FIGURE 5. Results of ongoing surveillance in the CA until December 2006. Cross hatching represents properties where starlings have been detected following the initial emergency response, along with all properties surveyed without infestations (no shade). Other features are described in the captions for Figures 2, 3 and 4.

have entered a period of response and recovery within a preparedness, prevention, response and recovery (PPRR) framework. However, the length of time that this may take is presently unclear. Nonetheless, following an emergency management framework (PPRR or its derivatives; see Tarrant 2006) will lead to a better understanding of how this and future incursions of starlings need to be managed into the future. The principles of emergency management could also be considered for general management of invasive species. For example, a biosecurity emergency response strategy may provide policy and management support for setting priorities or allocating resources for invasive species within an increasingly resource-demanding sector. For this to occur, it is important that there is a multidisciplinary approach to biosecurity emergency management, including invasive species emergency management, and that there be a strong ethos of knowledge sharing, cooperation and the capacity to adapt within the sector.

Acknowledgements

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The workshop will be held at AEMI, Mt Macedon, Victoria. There is no cost for the workshop, meals, accommodation and transfer between the airport and Mt Macedon. Participants must pay for their own flights.

For information about how to nominate visit www.em.gov.au
or email: aemi@ag.gov.au or phone 03 5421 5100

NATIONAL SECURITY UPDATES

Excerpts from the Emergency Management in Australia website www.em.gov.au

JULY

2 JULY 2010

ALL-HAZARDS APPROACH TO DISASTER FUNDING

Attorney-General, Robert McClelland announced that the Australian Government will extend the Natural Disaster Relief and Recovery Arrangements (NDRRA) to include terrorist events as well as natural disasters.

SEPTEMBER

5 SEPTEMBER 2010

COMMONWEALTH ASSISTANCE FOR VICTORIAN STORM VICTIMS

Attorney-General, Robert McClelland, announced that the Commonwealth Government will provide financial assistance to Victorian communities affected by severe storms and flooding.

8 SEPTEMBER 2010

COMMONWEALTH ASSISTANCE FOR NEW SOUTH WALES STORM VICTIMS

Attorney-General, Robert McClelland, announced that the Commonwealth Government will provide financial assistance to New South Wales communities affected by recent storms and torrential rainfall.

14 SEPTEMBER 2010

FUNDING FOR LOCATION BASED EMERGENCY WARNINGS

The Australian Government announced that it will fund the upgrade of the national emergency warning system, *'Emergency Alert'*, to deliver warnings to mobile phones based on the location of the handset.

CALL FOR PAPERS

April 2011 edition of the Australian Journal of Emergency Management

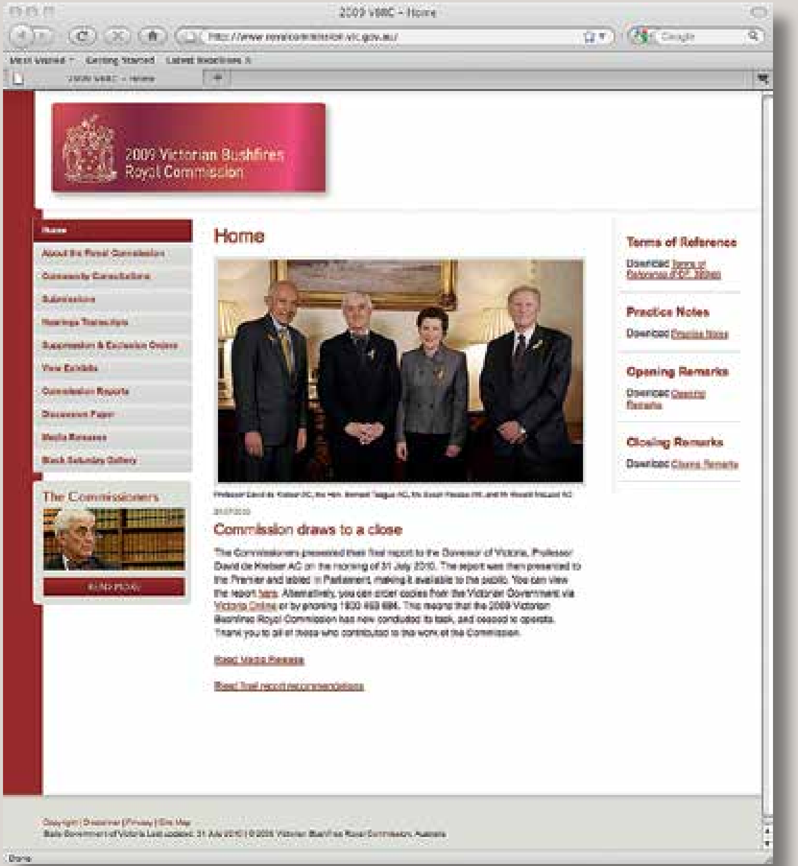
BUSHFIRE THEME

A special edition of AJEM, featuring a range of articles focussing on bushfire in the Australian context, will be produced in April 2011. This issue will have an emphasis on the social impacts of bushfire particularly in relation to the Victorian bushfires in February 2009.

We are currently calling for papers focussed around this theme to be included in this special edition. If you are interested in submitting an article for this edition your contribution must be received by the editorial team by 31 December 2010 and follow the Editorial Guidelines (www.em.gov.au).

Contact: Cate Moore cate.moore@ag.gov.au

INTERESTING WEBSITES:



2009 VICTORIAN BUSHFIRES ROYAL COMMISSION

http://www.royalcommission.vic.gov.au/

Produced by the State Government of Victoria, the 2009 Victorian Bushfires Royal Commission web site is a comprehensive portal containing a wide quantity of information on all aspects of the Royal Commission. The portal explains the role of the Royal Commission, details the Community Consultation process and the community sessions that were conducted as a part of the Commission, provides the public submissions received by the Commission and the hearing transcripts.

Visitors to the site can view the exhibits that were introduced as evidence during the Commission's hearings and can search for exhibits using free text search boxes. It also contains the interim and final reports that were delivered to the Governor of Victoria on 31 July, 2010 and discussion papers and media releases from the Commission over the duration of the Commission.

Other poignant additions to the site are images of the artistic works from the four exhibitions from the Black Saturday Gallery which was located in the foyer of the hearing rooms during the Commission. These exhibitions featured works by artists from Kinglake, Marysville, Buxton, Acheron and Healesville. The Gallery was an important part of the Commission's connection with the community. Not only did it add interest and colour to the public sitting and viewing area; it offered the opportunity for people to tell their stories and share their journeys through their art. Six images from the four exhibitions that were held are on the covers of the volumes of the Commission's interim and final reports.

Australian Government
Attorney-General's Department

Australian Emergency
Management Institute

Australian Emergency Management Institute

Providing education and training

Undertaking applied research

Conducting strategic activities

Promoting community awareness and resilience

A CENTRE OF EXCELLENCE FOR THE EMERGENCY MANAGEMENT SECTOR IN AUSTRALIA

Courses and Events

November & December 2010

- Emergency management for local government course
- Manage recovery functions and services course
- Coordinate resources within a multi-agency resource emergency response course
- Exercise management course
- Workshop: Education for uncertainty – preparing for the next national security crisis

Coming Soon

- Australian safer community awards
- Launch of the interactive disaster map
- ALIES conference
- Volunteer leadership program
- Business continuity management

For more information on these programs please visit www.em.gov.au

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