

Understanding the 2011 Grampians Natural Disaster, addressing the risk and resilience

Final Report

Prepared by:

Alison Ollerenshaw, Dr Peter Dahlhaus, Kelsey McDonald, Assoc Prof Jerry Courvisanos, Dr Michelle Graymore, Dr Helen Thompson, Dr Helen Sheil, Anthony Miner, Jennifer Corbett.

Centre for eCommerce and Communications, Federation University Australia

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Federation University Research Team
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Important Disclaimer

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Executive summary

In January 2011, an intense rainfall event in Western Victoria triggered over 200 landslides in the Grampians National Park and caused widespread regional flooding. This event had significant impacts on the environment and communities both in and surrounding the Park. The Northern Grampians Shire Council together with project partner organisations commissioned research into this event to better understand the impact of this natural disaster, with a specific focus on addressing risk and resilience. Co-funding for this project was secured via a grant from the Victorian Department of Justice (Natural Disaster Resilience Grant Scheme).

The overall aim of this study was to investigate the social, economic and environmental impacts of the 2011 landslides and floods in and around the Grampians National Park. Specific objectives included identifying the impacts of the natural disaster on communities within the region from a range of perspectives including residents, businesses, and from local and regional government and non-government agencies and providing recommendations on future emergency management for the region. This was achieved through a comprehensive post-assessment of the impacts of the 2011 events, and capturing information from across the community and from emergency services and infrastructure organisations involved in the response to, and recovery from, the Grampians natural disaster.

Although this research is focussed on the social, economic and environmental impacts of landslides, it quickly became apparent during the study that the community, including the local government and emergency service personnel, were unable to clearly distinguish the landslide impacts from those of the floods. Understandably, the two contemporaneous hazards were inextricably intertwined and it is impossible to determine the impacts of one from the other. Hence, the evaluation presented in this report inevitably includes the impacts of landslides and the simultaneous floods.

Research methods

A review of current national and international literature into the social, environmental and economic impacts for communities affected by natural disasters was undertaken. Current local, state and national strategies and policies were also reviewed and current best practice for emergency services and management for communities following disaster were identified.

Two online surveys were conducted with (a) individuals and residents and (b) businesses and community organisations to gauge the social, economic and environmental impacts of the 2011 events. Survey questions also examined the roles of emergency and recovery responses. A total of 20 individuals/residents and 17 businesses/community organisations completed the surveys. The data was then analysed to capture the impacts on the community during the emergency and the recovery.

Further, a total of 20 interviews across 15 agencies were conducted with representatives from emergency and recovery services organisations and community/health/tourism organisations. Interview transcripts were thematically analysed to gauge insights into the impact of the disaster at the time of the event and during recovery.

Parallel to this study, research was also conducted to determine the landslide distribution and processes of the January 2011 event. This research was completed by James Cameron, a Bachelor of Applied Science (Honours) student from Federation University Australia. Landslide distribution was analysed in relation to geology, geomorphology, vegetation and rainfall using Geographical Information System (GIS) techniques which further informed components of this research project.

Key findings

The key themes identified from the surveys and interviews include:

Preparedness and response to the Grampians Natural Disaster

Those interviewed from emergency and recovery services organisations consistently remarked on the magnitude of the January 2011 events as presenting numerous challenges to adequately respond. Comments received from the community closely mirrored this view with the nature and scale of the

events – both of the flooding and of the landslides – being wholly unexpected and therefore difficult to prepare for and respond to. Although unexpected for the residents and emergency response organisations, there is known to have been two similar landslide events in 1916 and 1934.

- *Catalysts for effective preparation and response to the Grampians Natural Disaster*
Three main facilitators were identified that assisted in creating effective preparation and response outcomes:
 - Past experience and local knowledge;
 - Communication and coordination;
 - The value of key community contacts and community ‘hubs’.
- *Challenges experienced in the preparation and response to the disaster event:* Seven major challenges were identified by the majority of participants during interviews about the emergency response during the floods and landslides. These are summarised below:
 - Blurring of agency roles during the response;
 - Concerns involved with pre-existing flood warning systems;
 - Issues with communication between agencies and between agencies and the community;
 - Difficulties presented by the complexities of the community response;
 - Issues relating to staff training and/or knowledge of natural disaster event management;
 - Concerns for short term tourism reductions to businesses at the time when recovery programs were being conducted by various agencies;
 - Very limited effort in recognising the ‘benefits’ – especially to visitors – gained following this event via short term recovery activities and longer-term legacy building opportunities.

Impacts of the Grampians Natural Disaster: Social, economic and environmental

The events of January 2011 directly and/or indirectly impacted on all the participants in this research, including agencies involved in the emergency response and recovery, business and community organisations and individuals/residents. While some participants reported varying levels of hardship and stress (socially and economically) both during the initial flooding and in the months following, it became apparent that for most participants, the magnitude of these impacts appeared to be largely dependent on the scale of damage to property and business and of their ‘experiences’ during and after the events in 2011.

- **Social impacts**

While it is important to acknowledge that the events of January 2011 did not lead to any loss of life or major injuries (a positive outcome which was acknowledged by some emergency services and infrastructure organisations staff) the reported impacts to health and wellbeing of those agency staff members involved in the response and recovery phases was an area of some concern.

Social impacts on infrastructure and emergency services organisations

For emergency and recovery staff the main impacts included fatigue, frustration, fear for self and family, stress, anxiety. This in part has been attributed to being assigned new roles and duties within their organisations in response to the disaster, a lack of training in landslide response, going above and beyond the call of duty, and some workplace OHS issues.

Social impacts on individuals and residents

More than half of all individuals/residents indicated little or no impact following the natural disaster event in the Grampians. However, some had suffered damage to buildings and fences, and many were impacted by the road closures. Similar to the emergency workers some people felt personal stress and anxiety, which may be an ongoing health issue for some in the community. There was also a positive impact on the respondents’ ability to cope with future disasters and on their relationships with friends and families.

Social impacts on businesses and community organisations.

Businesses in particular felt a large impact, with loss in customers and income and business due to the reduced number of tourists to the area for some time after the event due to road closures

and infrastructure repairs. Again, they also reported some personal stress and anxiety as a result of the event and the impact on their business.

The minimal social impact of this event suggests that the community is quite adaptable and resilient to natural disasters. For example, respondents appear to be well connected and supported in their community with 'the support of friends, family and community' being mentioned as important during the event.

- **Economic impacts**

Costs to emergency management and infrastructure organisations

Total construction costs of approximately \$140 million by all agencies, plus operating budgets stretched in order to place more resources in the Grampians, resulted in significant costs in agency relief and recovery programs. Adding a layer of complexity that makes addressing resilience even more problematic were intangible costs. Notably, these intangibles are management stress due to *ad hoc* governance, staff 'burn out' from long hours of work and agency officials dealing with legal obligations such as insurance and occupational health and safety. Further, there was no portfolio responsibility for landslides allocated to any agencies, unlike with bushfires.

Costs to individuals and residents

Impacts on individuals and residents in terms of their finances suggest minimal to moderate costs were incurred. In identifying the impact of costs during the recovery of the flood/landslide event, almost all respondents indicated that there was no, or very little, financial impact to them and one respondent even indicated that employment opportunities were created during the recovery. The intangible cost that frustrated residents, to the extent that local councils assumed responsibility, was insurance covering private property.

Costs to business and community organisations

In contrast to residents, the majority of businesses and community organisations responding were negatively or very negatively financially impacted. The financial costs incurred by these organisations and businesses primarily related to loss of income through reduced tourist activities. In describing the economic impacts at the time of the event and during recovery, businesses and organisations identified the greatest impact being the loss of earnings/no earnings, none or few 'sales', and loss of normal trading. However, all respondents reported no negative income issues two years after the event which suggests resilience in recovery to prior status. Also intangible costs were reported by businesses in terms of bureaucracy, confined movement and anxiety related health issues, which indicate non-market resilience problems.

Recovery phase outcomes

The approximate \$140 million construction work undertaken in the recovery phase produced employment and skill enhancement not available prior to the event. The output benefits from this work were modelled to multiply out to \$304 million, outweighing the tourism losses calculated by ten times. Yet only a small amount of this assisted the tourism sector economy, which was significantly, negatively impacted. Construction benefits were spread widely and were therefore less obvious to the immediate stakeholders. Also, it is important to note that once the recovery phase ended, so too did the short term jobs and output. Nevertheless it enabled the region to have some output gains immediately after the event that most certainly added to resilience. Finally, there is only limited evidence of the legacy of this emergency being recognised, honoured and commemorated. The exception was the work undertaken by the Northern Grampians Shire Council in showcasing recovery efforts to locals. However, this did not extend into the broader community. This indicates that there is a particular type of tourism opportunity that has not been taken advantage of, which may indicate a lack of dynamic resilience.

- **Environmental impacts**

The impacts on the natural environment were generally not documented at the time of the event, and very little information has been found on the subject. The extent of the landslides was mapped by VicRoads and Parks Victoria (or their consultants) immediately following the event, largely from aerial and satellite imagery. It is estimated that more than 200 landslides occurred throughout the Park as a result of the January 2011 rainfall event, causing major structural damage to private and public assets, including the environment. Anecdotal reports and the extensive photograph collections confirm that the scouring of riparian vegetation along the gullies was severe in places where fast-moving debris flows occurred. Cultural heritage sites were assessed after the event, including 67 Indigenous sites and at least six European sites. Most sites had escaped significant damage.

The Honours research project conducted in parallel with this project mapped and analysed a total of 176 landslides using the same imagery. The vast majority were on the steeper east facing scarp of the Serra-Wonderland/Mount Difficult Range and the Mount William Range, with only minor incidences on west facing slopes. Some of the debris from these landslides flowed into Lake Bellfield, which is the major source of water supply for many towns and farms in the Wimmera region. This has caused on-going water quality issues including high levels of turbidity, colour, and high concentrations of suspended chemical compounds attached to silt particles such as heavy metals (iron, manganese and aluminium). This meant that water remained unsuitable for drinking for a considerable period of time, causing ongoing issues for Grampians Wimmera Mallee Water (GMMWater) and their customers who rely on this water supply.

Resilience and recovery from the Grampians Natural Disaster

Recovery from the Grampians Natural Disaster remains ongoing, with some infrastructure repairs and future flooding and landslide preventative measures still to be completed. As organisations wind down and/or finalise their recovery activities from the 2011 disaster (and now, focus recovery efforts on the 2014 bushfires in the region), staff from emergency services and infrastructure organisations have reflected on the learnings from this disaster and have implemented new protocols, plans and procedures within their workplaces to better respond to future natural disaster events. These include:

- Improved agency-community communication and interaction;
- Improved inter-agency communication and coordination;
- Recognising the need for closure and a clear way forward;
- The importance of building resilient communities.

A dedicated-project website has been developed for this research project, entitled Grampians Natural Disaster Research (www.gndr.org.au). The website was initially established to provide the public with information about the project, timelines, project partners, and deliverables. During data collection, the website was used to provide public access to the online surveys. The website has recently been updated and now includes a sophisticated online spatial mapping resource capturing the landslide data relevant to this project. A knowledge management resource of documents, reports and literature pertaining to natural disasters that was accessed during the research has also been included on the website.

Recommendations

Research recommendations are based on an analysis of the findings and resultant discussion. They also consolidate and build on the large amount of work, including reports and planning documents, which the emergency response organisations have undertaken since the January 2011 event. A number of the recommendations echo those outlined in the Comrie (2011) report into the review of the 2010-11 flood warnings and response. The aim of these recommendations is to inform and enhance future response to emergency and recovery for the region in the areas of:

- Emergency response and recovery to landslides and natural disasters in the Grampians now and in the future (including the recent fires in the Grampians National Park in early 2014);

- Social, economic and environmental costs to the region of the landslide and the natural disaster event;
- Recovery processes still required;
- Building resilience in the Grampians communities;
- Building and strengthening relationships between communities and the emergency and recovery agencies.

Key recommendations include:

1. Emergency and recovery services organisations review their plans and procedures for future natural disasters (including the Emergency Management Manual Victoria) and finalise draft plans, using the findings of this study to maintain and enhance activities that worked well and review activities that did not.
2. Emergency and recovery services organisations regularly conduct reviews with all staff about the plans and procedures for responding to major natural disasters.
3. Emergency and recovery services organisations consider developing a work plan for staff outlining disaster management responses. The plan should include considerations for:
 - Staffing roles during a natural disaster including staff rotations and staff overtime;
 - Staff residing in the area of the disaster;
 - Supporting staff wellbeing during times of high stress. This may include additional provisions for counselling, debriefing and psychological support etc;
 - Ensuring occupational health and safety during an emergency.
4. That staff from emergency and recovery services organisations who are nominated to roles within their organisation's disaster management team are provided with appropriate disaster management training including landslide mitigation, response and recovery.
5. Emergency and recovery services organisations continue to build and strengthen their interagency partnerships to complement their response to major natural disasters for the future. This could include regular meetings and exchange of information including staff information (contact details and roles), organisational protocols and procedures during a natural disaster.
6. That each emergency and recovery service organisation reviews protocols for communication during a natural disaster and in recovery. This should include a review of protocols for communication with other key agencies at crucial time points before, during and after a natural disaster.
7. Emergency and recovery services should ensure their communication plans for future disasters include steps for clear and timely information that is disseminated to the community via a range of media including social media, radio, public meetings, etc. This could include developing a list of key community contacts to help distribute information; spatial mapping technologies (with limited public access) could be of valuable. The communication plan should outline steps to ensure anxiety in the community is reduced by strengthening relationships between the community and agencies before and during events, such as small group or one-on-one conversations about people's experiences with the disaster and empowering the community to provide local knowledge and feedback on how the recovery process should proceed.
8. In conjunction with key emergency and recovery agencies, ensure that external funding is sought to (a) develop better predictive models for disasters in the Grampians region and (b) continue to establish better weather and flood warning systems for the Grampians region.
9. Infrastructure organisations (particularly local councils) to increase the involvement of key members of the community in the preparation and planning for future disasters. This should include the involvement of community members and community leaders from key areas in the Grampians (particularly Halls Gap) in planning for a whole-of-community response for future natural disaster events.
10. Councils, in partnership with other agencies, to develop a register of people located in high risk areas to facilitate the early identification of people and places most likely to be affected by future landslides or other disasters and better enable a timely response to help the most vulnerable. Spatial mapping of this information (not for public access) may be valuable.
11. Affected communities continue to prepare and plan for all natural disasters, including major natural disasters, to reduce their vulnerability to future disaster events. Preparation should include public education programs about all natural disasters including landslides, development of individual emergency plans for residents and business owners similar to, but not confined to, bushfire preparation plans. This will need the support of emergency and recovery organisations.

12. To support local businesses within the Grampians region to undertake greater planning for major natural disasters to better protect local business and ensure the safety of staff and customers during future natural disasters.
13. Tourism and business associations work together to promote the region and encourage visitors in the recovery phase of future disasters once the area is safe for visitors, to reduce the impact of lower visitor numbers on businesses.
14. Agencies involved in areas of potential landslides need to be very aware, informative and inclusive in their dealings with the local community (both residents and business). This can be achieved through strengthening partnerships between public agencies and private businesses and residents. Such public-private partnerships can build inclusiveness prior to any disaster by providing better information for more effective complexity modelling, and also allow the community and businesses to be better involved in response and recovery during the disaster and its aftermath.
15. There needs to be strong post-emergency legacy opportunities created through the generation of this information and using new technologies (via websites) and other media outlets. This needs to recognise the strong relief efforts during the disaster, but even more importantly, recognise the vastly improved and more extensive infrastructure through the Park for residents, tourists and professionals who value ecological and economic resilience.
16. Stronger economic resilience comes from diversifying from existing businesses and community activities by broadening what tourism represents in the region and to bringing in different business activity such as knowledge-based industries that value the ecological environment (e.g. geospatial mapping).
17. Need to measure how intangible costs are measured and risk assessments are conducted in a coherent, coordinated manner that is accepted by all stakeholders in potential areas of flooding and landslides. Financial stresses in governmental arrangements and in insurance claims stem from the lack of appreciation of landslides as disasters that have cumulative effects and build from initial minor events to quite significant economic outcomes. A risk assessment and resilience building officer should be employed across the major stakeholders to co-ordinate this activity.
18. That the current Erosion Management Overlay (EMO) be extended to include statutory planning controls for the landslide susceptible regions of the municipality. The EMO should adopt the methods of the Australian Geomechanics Society National Landslide Risk Management Framework.
19. That longer-term research projects into the likelihood of future landslide events and the consequences of these events on the natural environment are undertaken. These projects should be considered as collaborative opportunities with land managers, government agencies, emergency services and research institutions.
20. That the community continues to celebrate and mark the final recovery efforts following the 2011 natural disaster event and that a final celebration of all recovery efforts is organised to reflect the end of the complete recovery period.
21. That health and community organisations providing services to communities that have been affected by the Grampians natural disaster continue to monitor and regularly review mental and physical health indicators for ongoing social impacts from this disaster.
22. Continue to build resilience in the Grampians region by the emergency and infrastructure organisations and the community working together to achieve the recommendations from the Victorian Floods Review (Comrie, 2011) and from this report.

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Introduction and background

Context for the study

The Grampian National Park is located approximately 220km west of Melbourne and covers a geographical range of 168,110 ha. The Park's significant landscape and natural heritage make it a popular tourist attraction for local, interstate and international visitors. Visitor numbers increase significantly throughout the year at peak times such as the Easter holiday period and during festivals and special events (Northern Grampians Shire Council; NGSC, 2011a).

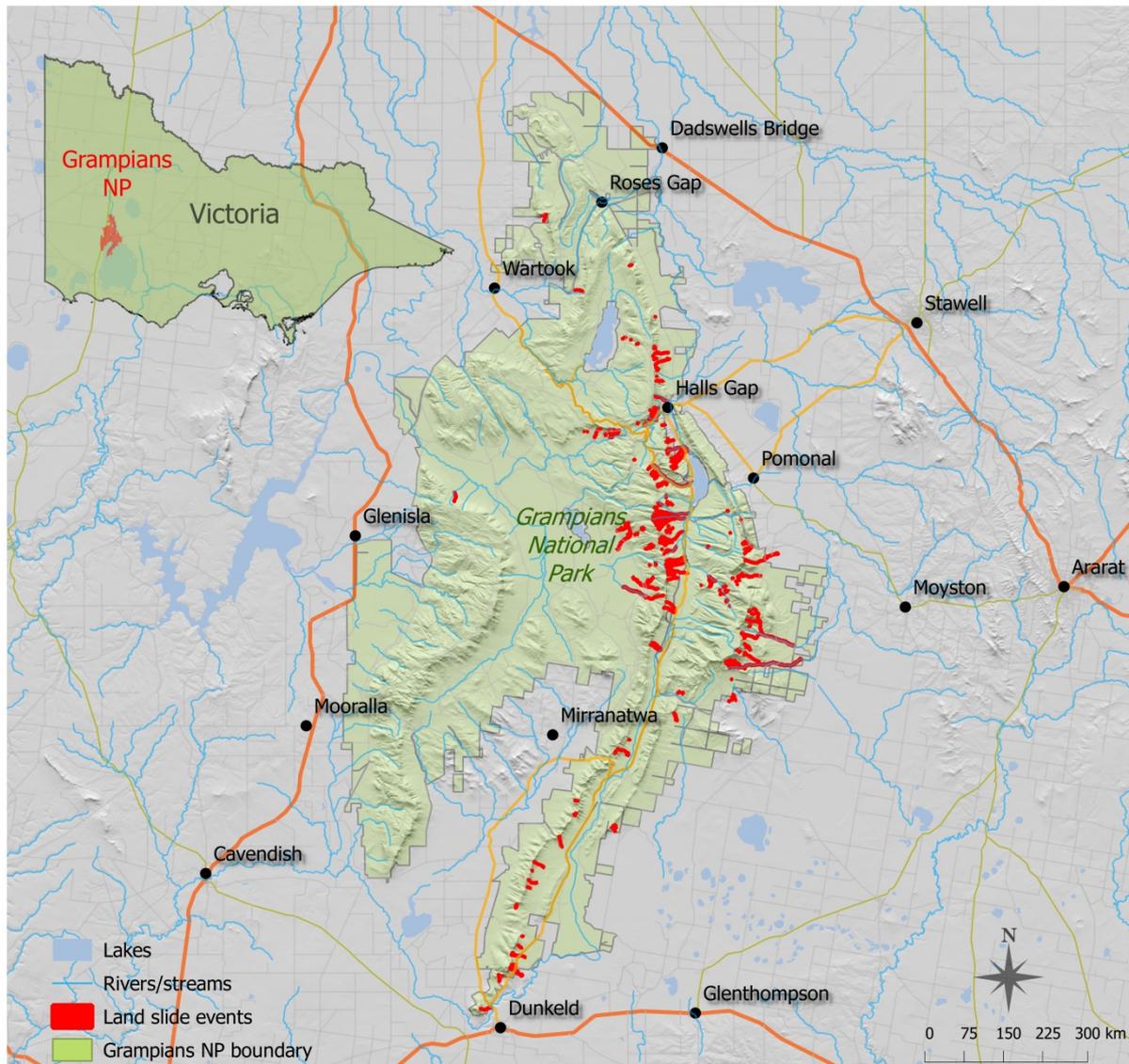
Four local government areas share their boundaries across the Grampians National Park, including Northern Grampians Shire, Southern Grampians Shire, Ararat Rural City and Horsham Rural City. The major townships in the Park include Halls Gap (population approximately 610) in the north-central area of the Park, and Dunkeld (population approximately 750) located at the Park's southern edge. There are a number of other smaller communities within the Park's boundaries and larger towns are located in relatively close proximity to the Park's boundaries, including Ararat, Stawell, Hamilton and Horsham. Within this defined area there are many stakeholders that are affected by any significant event in the Park, and include Parks Victoria, local councils, State and Federal Governments and their departments (e.g. Department of Environment and Primary Industries Victoria, DEPI; Tourism Victoria), water authorities (e.g. Grampians Wimmera Mallee Water; GMMWater), Catchment Management Authorities (e.g. Wimmera Catchment Management Authority; WCMA), State Emergency Services (SES), Victoria Police, business operators, local community organisations, and importantly, visitors to the Park.

In the occurrence of an emergency in Victoria, such as a natural disaster, emergency management is guided by the Emergency Management Manual Victoria (Department of Justice, 2013). This manual outlines the roles and responsibilities of emergency response organisations in response, relief and recovery from natural disasters, as well as other emergencies such as pandemics or disruption of water or electricity. When an emergency occurs the manual provides direction for which organisation should be the control organisation for the emergency, who the key support organisations should be, as well as who is responsible for individual services, support and repair/rebuilding during relief and recovery phases of the response. However, this manual does not include landslides, which means there is little guidance on which organisation should take control and what to do when one occurs. Thus, the control organisation for landslides becomes the Victorian Police as they are listed as the control organisation for 'other threats against person, property or environment' (Department of Justice, 2013, p. 7-4).

In January 2011, heavy rains across North-west Victoria were recorded. In parts of the Grampians region itself, around 300mm of rain fell between 12 and 15 January 2011. Extensive flooding was experienced across this broader region, not only in the Northern Grampians Shire, but also in many neighbouring local government areas including Hepburn, Pyrenees, Hindmarsh, Ararat, and Horsham. However the most extensive damage occurred across the Grampians National Park. The entire Northern Grampian Shire was affected by major flooding of rivers in the area (including Stoney Creek, which runs through the main township of Halls Gap) causing damage to private property, business, government and civic buildings as well as environmental damage to the Grampians National Park, road networks and services (including the water supply). Residents of and visitors to Halls Gap were advised to evacuate from the township at the time with some (approximately 120 mainly tourists and visitors) moving to the temporary emergency centre, established in Stawell.

In addition to the emergency presented by the floods, an unexpected event was triggered by the torrential rains: landslides. More than 200 landslides (NGSC, 2013) were recorded across the Park, with many extending up to 3km in length (Gray and Pech, 2011) - a map of the affected area is presented below. The majority of the landslides resulted in considerable debris flows, leading to extensive damage to roads, walking tracks and associated public infrastructure in the region. In the days, months and years since the event many roads were closed or inaccessible due to the damage. In addition, the water quality of Lake Bellfield, the Wimmera region's main water supply, had degraded

with the high sediment inflows making it unsuitable for drinking, causing ongoing issues for water treatment and supply in the region (Wallis and Graymore, 2012).



Above: Map of Grampians National Park and surrounding region, highlighting the location of the 2011 landslides.

Background to the event

Rainfall event

Parks Victoria in their 2010-2011 annual report noted that Victoria experienced eight severe storms between September 2010 and March 2011 that caused significant damage and flooding to 72 parks and reserves. The most severely affected parks were the Grampians, Wilsons Promontory, Mount Buffalo and the Alpine national parks, Lysterfield Park and the You Yangs Regional Park (Parks Victoria, 2011a).

Regionally, Halls Gap in the northern part of the Grampian Ranges recorded 294.4mm of rainfall in August 2010, the highest August rainfall on record. This was followed by 145.0mm for the month of December, which is in the top 5% range for December. Significant heavy and intense rainfall continued in 2011 with the presence of a tropical air mass and a low pressure system combining with a deep inland trough extending southwards into Victoria in early January. This resulted in heavy rainfall and the development of an intense thunderstorm which was centred on the Grampians. As a

result 135.0mm of rain fell on 12 January and 146.6mm fell on 14 January, resulting in a total fall of 281.8mm for the 72 hours from 12 to 14 January. The monthly total for January (297.0mm) was the highest on record.

According to the Halls Gap flood study, daily rainfall of 100mm is considered to be a 1 in 20 year to 1 in 50 year Average Recurrence Interval (ARI) rainfall event, whilst a daily event of 130mm is considered to be a 1 in 50 year to 1 in 100 year ARI event. Based on rainfall intensity-frequency-duration (IFD) curves for Halls Gap (Bureau of Meteorology, BoM, 2013), a total of 207mm over a 72 hour period is reflective of a 1 in 100 year ARI event. Hence a review of the Halls Gap rainfall records from 1876 to the present rank the January 2011 rainfall as the highest magnitude event within the record based on both a daily total and a cumulative 3 day total.

Using a different approach to the analysis of longer return period rainfall events given limited rainfall records (in Halls Gap, 135 years) provided by the CRC Forge rainfall analysis software, a total daily rainfall of 145mm (i.e. over a 24 hour period) constitutes a 1 in 100 year ARI event at Halls Gap whilst an event totalling 280mm in 72 hours is estimated to be in excess of 1 in 500 year ARI.

Irrespective of which approach or assessment is used it is evident that the daily total on 12 and 14 January are both of an order either equal to or exceeding a 1 in 100 year ARI event and the combined total over 72 hours is far in excess of a 1 in 100 year event and is probably more indicative of a 1 in 500 year ARI (notwithstanding the inherent assumptions based on a 135 year rainfall record).

Landslides

With landscapes saturated by the antecedent wet months, the December and January rain events triggered a number of landslides in the Grampians National Park (DSE, 2011; GHD, 2011; GHD and ASMG, 2011). Although little has been documented on the December landslides, those that resulted from the January events caused considerable damage. Three arterial roads – Grampians Road, Mt Victory Road and Silverband Road – were closed by landslide debris for several months. Dozens of smaller roads were covered in debris and there was damage to road pavements, culverts, drains and bridges (see Figures 1 - 3). Private property was damaged by large boulders, trees, debris and mud. Some houses were surrounded by debris (see Figure 4) and outbuildings, fences, gardens and fields damaged.



Figure 1: Mt Abrupt - Grampians Tourist Road (source: Parks Victoria, 2011b)



Figure 2: Mt Abrupt - Grampians Tourist Road (source: Parks Victoria, 2011b)



Figure 3: Northern Grampians Road (source Parks Victoria, 2011b)



Figure 4: Landslide debris surrounding private property near Halls Gap (source Parks Victoria, 2011b)

Digital aerial imagery was commissioned by VicRoads in conjunction with Parks Victoria soon after the events (acquisition date 27 January 2011) to allow a review of the impact of landslide sites and their interaction with stakeholder assets. Whilst the resolution was excellent (15cm pixel size), the coverage is restricted to the roads in the area, resulting in gaps in the coverage of imagery within the park. This imagery was also used by consultants (GHD, 2011) to identify landslides for Halls Gap but mapping was extended to include other areas depicted in the imagery. The landslides were clearly visible in the imagery as vegetation scars and areas of sediment deposition although it was noted that some clean-up of sediment had already been undertaken by the time the aerial photos were taken. A total of 193 features were initially mapped by the consultants in May 2011 and shown only as point sources.

In response to the landslide events, Parks Victoria commissioned a rapid assessment by the Department of Sustainability and Environment's (DSE) Bushfire Rapid Recovery Assessment Team (BRRAT). Debris flows were mapped over the entire Grampians National Park from RapidEye satellite imagery (5m pixel size) that was captured shortly after the event. Around 192 landslides were mapped, the longest being 2.4km.

Hence various estimates have been placed on the number of individual landslides that occurred as a result of the January 2011 event, but are likely to be in excess of 200 when the final analysis is completed.

Impacts of the event

As well as the landslides, the heavy rainfall resulted in floods that severely impacted on the Northern Grampians Shire region and surrounding municipalities. Around 95% of the Northern Grampians Shire was affected, including 11 townships and the agricultural, mining, tourism and meat production industries. Within the Shire, the floods impacted on 800 roads and 423 properties. Costs to repair works on roads has been estimated at \$19 million (NGSC, 2011b).

This event had a significant impact on the environment and on visitors, communities and residents in and adjacent to the Grampians National Park. The Park was closed on 14 January 2011, due to the landslides, fallen trees, flooding and debris which had impacted on roads and walking tracks. Eleven vehicle bridges were damaged and 21 pedestrian bridges. Sections of the Park were reopened shortly afterwards as repairs were completed and the Flood Recovery Program was completed on 30 June 2013. Direct National Park repair costs (to roads and walking paths in the Park) have varied in estimates: \$21.7M (DSE, 2011), \$19M (NGSC, 2011c) and \$7.5M (Parks Victoria, 2013).

As a result of the damage to public and private property and assets, Northern Grampians Shire implemented interim Landslide Guidelines to protect lives and properties. In the event of a 1 in 100 year rainfall, Halls Gap will be evacuated and all residents and visitors will be expected to leave for the period stated by the emergency services (NGSC, 2011c). These guidelines were tested in February 2011 when sections of the Halls Gap township were evacuated due to forecast heavy rain, although the rain did not eventuate. The Halls Gap community had, previous to this study, reported concern about the social and financial impact of the evacuations.

Justification for this project

A 'telling of the story' of the Grampians event, from the community and emergency and recovery services staff, enables the development of a more holistic and consolidated understanding of the full social, economic and environmental impacts of this event for the community and emergency and recovery services. Although many Council's in the region – especially Northern Grampians Shire – have taken considerable steps towards understanding this event and implemented planning in preparation for future events (i.e., Northern Grampians Shire Council have developed the Halls Gap Landslide Interim Guidelines; the Landslide Susceptibility Policy; and the Glenorchy Feasibility Study) there is still much to be learnt about the events of 2011. Developing an understanding of the social and economic impacts on affected communities and their perceptions of changes to their environment is particularly important.

To consider the broader impacts of the floods and landslides on the community, Northern Grampians Shire Council contracted Federation University Australia (formally the University of Ballarat) to undertake research titled *Understanding the 2011 Grampians Natural Disaster, addressing risk and resilience*. The overall aim of this research is to investigate the social, economic and environmental impacts of the landslide events in the Grampians National Park. It was decided that a multi-pronged approach to assessing these impacts was necessary and so insights were sought from those living and working in the towns and surrounding areas affected by the floods and landslides in the Grampians region. It was also important to capture information about these events during and after the floods and landslides from those employed within organisations involved in the emergency response and recovery efforts.

This report therefore documents the perceived social, economic and environmental impacts of the Grampians natural disaster by those living in the region and/or impacted by these events, including

local residents and business owners, community and tourism organisations. The report also examines the emergency response and recovery efforts of the January 2011 floods and landslides from the organisational perspective and to solicit perceptions of the emergency response at the time of the event and in recovery. An assessment of costs to the community and those organisations involved in the response and recovery is also provided.

Documentation and assessment of the January 2011 landslides is examined critically using a risk and resilience framework developed from a comprehensive literature review of the national and international natural disasters research. This framework challenges existing approaches that limit risk to the likelihood of economic losses from a hazardous event and resilience to returning economic activity to structures prior to disaster. The nature of landslides, as low short term events and relatively long and dispersed community effects, shapes this framework. The risks experienced by a vulnerable community need to be minimised or removed by understanding vulnerability and then building risk awareness and preparedness into future infrastructure and planning. Climate change intensifies the risks and requires greater flexibility to address such dynamic vulnerability. Looking at risk management in this more dynamic way, rather than merely in terms of costs and benefits, forms the basis for an effective disaster resilience strategy. Resilience needs to generate a persistent system that can absorb change and disturbance over what can be a long time as a result of landslides, while maintaining the basic integrity of the local ecosystem.

In addition to this project, a concurrent Honours research project has been completed by James Cameron, a Bachelor of Applied Science (Honours) student at Federation University Australia. James's research focused on mapping the landslides and undertaking an analysis of their spatial distribution in relation to other biophysical parameters, such as the geology, terrain, vegetation and rainfall distribution. The research contributes further understanding of the landslide processes in the Grampians as an adjunct to this study.

Research aims and objectives

The overall aim of this project is to document the social, economic and environmental impacts of the 2011 flood and landslide events on individuals, community organisations and representatives from government and non-government organisations (including emergency service organisations and infrastructure organisations closely involved with the disaster management response to the 2011 natural disaster in the Grampians region) and to analyse the data in response to future emergency services responses in the region. The research aims to:

- Determine the impact of the natural disaster on communities within the Grampians region (environmental, social and economic);
- Identify the social, economic and environmental impacts of the event from the perspective of local and regional government and non-government agencies (including GWMWater, WCMA, Tourism Victoria, SES, Victoria Police, DEPI, Parks Victoria) of the 2011 events;
- Gauge the environmental impact of the landslides in the Grampians in 2011, following an overview of the processes in the Grampians.

To achieve this, the following key questions will guide this research:

- What was the social impact (perceived and actual) of the 2011 event on communities in the Grampians?
- What were the short and long term impacts (environmental, social and economic) of this event on these communities?
- What was the actual impact (environmental, social and economic) on the communities as perceived by local and regional agencies (government)?
- How could disaster management processes reduce the social and economic impact of any natural disaster event in the future, for this region?

The study achieved this by conducting a comprehensive post-assessment of the impacts of the 2011 events on the community. This research may be used to:

- Guide disaster management and planning in the Grampians region which may help to minimise the impact of such events on communities in the future;

- Inform communities around the state and across Australia about the impacts of disaster and assist them to respond to natural disaster in the future;
- Contribute to the international knowledge base about landslide events and the social, economic and environmental impacts.

Scope of study

Although the focus of this research is specifically on the social, economic and environmental impacts of the 2011 landslides in and around the Grampians National Park, it became apparent from the outset of this study that the community, including the local government and emergency service personnel, were unable to clearly distinguish the landslide impacts from those of the floods. Understandably, the two contemporaneous hazards were inextricably intertwined therefore making it impossible to determine one impact from the other. Hence, the evaluation presented in this report inevitably includes the impacts of landslides and the simultaneous floods.

The research presented in the report relies heavily on the documents, data and images provided by the stakeholders and the anecdotal information gathered from the stakeholders and members of the wider community. Every effort has been made to collect all the known reports on the landslide and flood events within the bounds of the Grampians National Park and the areas adjacent to it that were affected by the landslides. That information is assumed to be correct and has not been independently evidentially verified by the authors.

Key organisations, community groups, businesses and residents were invited to participate in this research - which was widely promoted and publically advertised. The research aimed to gather a range of perspectives on this event from residents, businesses, local and regional government, non-government agencies and the community at large. While every effort was made to encourage participation in the study, it relies on voluntary participation and therefore the impacts of the events can only be assessed on the knowledge at hand.

Report structure

This report is structured as follows. The following chapter outlines the methods for data collection for the research. The subsequent chapters of this report examine the January 2011 Grampians natural disaster by setting out the findings from the examination of preparedness, subsequent responses and their social, economic and environmental impacts, both short and long term. This is followed by a discussion of these findings through analysis of the processes employed, comparing such outcomes with prior literature findings. The report concludes with a clear appreciation of the risk management and resilience building that needs to be developed. This enables a set of policy recommendations to be outlined for consideration by the local community and relevant authorities. References and appendices of research tools used to collect the data complete this report.

It should be noted that the review of current literature and best practice about the social impact and risk and resilience of natural disaster (focusing on landslides where possible) and an examination of the economic and environmental impacts of natural disasters (with specific focus on landslides) is included as Appendix A of this report. The literature review also examines current state and national guidelines in response to natural disasters and the best practice for responding to natural disasters (especially landslides) for emergency services and disaster management services. This knowledge base forms the framework of analysis that guides this research.

Research design and methods

A mixed methods approach was used to identify the impacts of the January 2011 flood and landslides from the experiences of individuals, community organisations, and representatives from emergency services and infrastructure organisations.

The methods were proposed in negotiation with Northern Grampians Shire and were outlined in the project proposal prepared by the research team at the Federation University Australia, in response to the Expression of Interest developed for this project by Northern Grampians Shire Council. Qualitative and quantitative research approaches were adopted to maximise the scope, breadth and depth of data collected and the range of insights on the Grampians Natural Disaster event – and recovery.

Research focus and questions

The research examined the impacts of the event from a range of perspectives including from infrastructure and emergency services organisations (regional government and non-government agencies) and the community, including individuals, residents and businesses. The key questions used to guide this research include:

Current literature and best practice

- What does national and international literature identify as the social, economic and environmental impacts of natural disaster (particularly flooding and concomitant landslides) on communities?
- What role does risk and resilience play within the context of communities – and in preparation and response to disaster?
- What are the current practices and guidelines for responding to natural disasters?
- What are the most appropriate practices for addressing risk and resilience when preparing for/managing the impacts of natural disaster for communities?

Community: Individual/residents/businesses

- What were the perceived social, economic and environmental impacts of this natural disaster on individuals (including residents and temporary residents) and businesses in affected areas, during the emergency and in recovery?
- What was their perception of the emergency response at the time of the event, and in recovery?
- From the community perspective, what elements of the response by organisations to the natural disaster worked well?
- From the community perspective, what elements of the emergency response to the natural disaster could be improved/modified to enhance responses to future emergencies?

Emergency services and infrastructure organisations

- What was the impact of floods and landslides from the organisational perspective?
- What role and contribution did organisations make during the emergency and in recovery, following the floods and landslides?
- What costs (direct/indirect) were associated with responding to this event?
- What was the level of preparedness by organisations to this event?
- What elements of the response by organisations worked well during the natural disaster – and in recovery, and how did such responses add resilience in the aftermath of the disaster?
- What elements of the emergency response to the natural disaster could be improved/modified to enhance responses to future emergencies (such as the recent 2014 fires in the Grampians National Park)?

Methods

A mixed methods approach was employed to capture and consolidate information about this event from key individuals and organisations from across affected communities and from government and non-government organisations involved with the disaster management response. Qualitative and quantitative data collection methods were used, including interviews and online surveys. Further details about each method are outlined below.

A project website dedicated to capturing information about the event was also established (www.gndr.org.au) in which the public could contribute to the research (via photos and stories of the event).

Literature review

A literature review was conducted using electronic searches of national and international databases. Current government policies and documents were sourced using Google search, or directly, by visiting websites of local government and state and national government departments.

To guide the literature search, priority was granted to literature that was published within the last ten years (older material was documented only where it was deemed particularly relevant and appropriate) and of a high quality and strong academic rigour. A priority search of the literature was conducted to identify research focusing on (i) landslides and (ii) natural disaster within the Australian context.

Given the vastness of the literature in the area of natural disaster (less so, landslides), the full literature review is included in Appendix A. A reference list of documents cited in the literature review is included to thus allow readers the opportunity to further explore the themes and current research identified.

Online surveys

Two surveys were developed to elicit data from 'community' participants for this study: one survey for residents and individuals, and another survey for completion by businesses and community organisations. Due to the wide geography of potential survey participants (across the Grampians National Park and beyond, but with special focus on Halls Gap and Dunkeld) surveys were prepared for online completion, using LimeSurvey. Online surveys were made available to the public via a dedicated project-website. An option for completing a hard copy survey was also available, upon request. The survey design drew upon the work of Fieldworx (2013), Blanchard et al. (1996), Jia et al. (2010) and Helton et al. (2011).

Project participants completing the survey were invited to share their insights into the social, environmental and economic impacts of the natural disaster. Questions gauged the social and community impact of the disaster in regards to health and wellbeing, social costs, perceptions of the services and management strategies during and after the event, and how the community could be better prepared for disaster in future. Economic and environmental insights were sought in response to questions about the personal/business financial costs associated with the disaster and the perceived changes to - and subsequent impacts from - the physical environment. Some demographic information was also sought from participants, including age range; location of business/residence; occupation; salary; household composition/business. Responses to questions included short answer, Likert scale and yes/no responses.

Methods for notifying residents, businesses owners and others of the research included distribution of a project flyer across key sites in affected communities (by researchers and others, including project partners), emails, formal letters to residents (facilitated by NGSC), media releases and a Council advertisement of activities through the local newspaper. The two surveys are included in Appendix B.

Interviews

An interview schedule was developed to elicit information about the events of January 2011 from organisations across the region that were affected by or involved with the January 2011 events – during the emergency and in recovery (including NGSC, GWMWater, WCMA, DEPI, Tourism Victoria, SES, Victoria Police and Parks Victoria). These consultations explored the impact of floods and landslides from the organisational-perspective, solicited perceptions of the emergency response at the time of the event and in recovery, together with an assessment of costs to the community and/or their organisation. Interviews were conducted either face-to-face or via telephone. Two people chose to provide written responses to the interview questions and submitted their feedback via email.

An interview schedule was also prepared for community organisations and local businesses. Participants were invited to share their insights about how they were affected or involved in the natural disaster events of 2011. The interview also explored the impact of floods and landslides from the organisational perspective, the direct/indirect costs on this event on the business/organisation, and solicited perceptions of the level of emergency response at the time of the event – and in recovery. This interview schedule contained similar information to that contained in the online survey for businesses/communities (described above). Interviews were conducted either face-to-face or via telephone. The interview schedule is also included in Appendix B.

Document analysis

Relevant documentation was supplied by project partners about the events of the January 2011 floods and landslides and/or organisational responses to these events. These documents have been reviewed in the context of this research and many (that have been previously circulated to the public) have been included as a resource for public access, available on the project website: www.gndr.org.au.

Mapping of the landslides was completed by VicRoads and Parks Victoria (or their consultants) at the time of the event, or immediately afterwards. The imagery used to produce those maps was made available to this study and used by the student undertaking the Honours student project concurrently with this study. The Honours thesis and derived mapping files (KML format) are also available on the website, as an additional resource.

Data analysis

Detailed hand written notes were taken by the researchers during each interview with participants. Thematic analysis of these notes was conducted for all interviews with initial themes and sub themes developed consistent with the conceptual framework driving this research: social, economic and environmental. To ensure greater reliability of the thematic review, three of the researchers independently prepared themes and structures and then cross referenced these themes against each other. These were then identified and listed accordingly:

- Social impacts of the Grampians Natural Disaster
- Reflections from participating Emergency Response Agencies:
 - Theme 1: Changes in roles and responsibilities within the organisation;
 - Theme 2: Going above and beyond the call of duty;
 - Theme 3: Workplace OHS issues.
- Reflections from the community:
 - Theme 1: Impacts for individuals was generally minor;
 - Theme 2: Damage to property and roads caused most concern;
 - Theme 3: Businesses and community organisations most impacted through loss of business and income and damage to buildings and property.
- Economic impacts of the Grampians Natural Disaster
 - Theme 1: Recovery phase;
 - Theme 2: Tourism industry;
 - Theme 3: Build economic resilience and minimise risk.
- Environmental impacts of the Grampians Natural Disaster
 - Theme 1: Impact to the built environment
 - Theme 2: Direct Impact
 - Theme 3: Changes to the environment as observed by the community

(Only insights consistently raised through interviews and surveys have been included in this report. Although many different discussion points were raised during data collection, it was impossible to capture and document all individual insights and perspectives. This report however has endeavoured

to document the insights that were repeatedly shared by the broader participant group and provide a point of verification for the information raised).

Data from the online surveys were loaded into an Excel spreadsheet and descriptive analysis was conducted; the LimeSurvey software also provided descriptive summaries (frequency distributions) of participant responses to quantitative questions. All qualitative responses to the survey (short answer responses) and all responses to interview questions were again thematically analysed by the researchers.

Limitations to the data: It should be noted that there may be some differences in response numbers to some survey questions as some participants did not respond to all questions. Although together both surveys have provided some solid public insights for this research, the response numbers are low reducing the generalisability of the results across the wider population. Therefore, general indications across each of the main themes are provided and caution should be used when generalising the participants' experiences to the wider population.

Overview of participation

The following results from the data collection are based on a total of 57 participants completing interviews ($n = 20$) and surveys ($n = 37$).

Interviews: Twenty staff representing fifteen organisations participated in interviews for this research (two participants provided written responses to the interview questions). Organisations include:

- Ararat Rural City Council
- Department of Environment and Primary Industries (DEPI)
- Grampians Community Health
- Grampians Tourism
- GMMWater
- Halls Gap Visitor Information Centre
- Horsham Rural City Council
- Northern Grampians Shire Council
- Parks Victoria
- SES
- Southern Grampians Shire Council
- Tourism Victoria
- VicRoads
- Victoria Police
- WCMA.

Surveys: Thirty-seven participants completed the surveys; 17 participants completed the business and community survey and a further 20 participants completed the individual/resident survey.

Results captured through all data collection methods are integrated into the findings. (As there were only a few survey responses from Dunkeld residents and businesses, all responses have been consolidated, unless a clear difference exists in response to questions. In such instances, these were identified separately).

Participant profile

The following section briefly summarises the profile of participants in this study.

Interviews: Twenty staff representing fifteen emergency services and infrastructure organisations participated in interviews; all staff were in middle to upper senior management roles and had been involved with the response and/or recovery (either in their present role, or previous roles) in the Grampians region during the natural disaster events of January 2011. All emergency services and infrastructure organisations interviewed (to be henceforth referred to as 'Emergency and Recovery Services Organisations') were involved with either the emergency and/or recovery response in the Grampians following the events of January 2011.

Individual/Resident Survey: Twenty participants completed the individual/resident survey. Most survey respondents ($n = 17$; 85%) lived in either the Northern Grampians Shire (total $n = 13$, comprising 9 residents from Halls Gap and 4 Stawell residents) or Southern Grampians Shire (total $n = 4$, comprising Dunkeld, Mirranatwa and Glenthompson residents). The remaining responses were received from residents in other regions ($n = 3$; comprising Ballarat and Ararat), as shown in Figure 5. The majority of survey participants ($n = 14$; 70%) are 'long term' residents having lived in their town or locality for 10 years or more (Figure 6).

Sixty per cent of respondents were aged 55 years or older; the remainder were aged between 25 and 54 years. Approximately one third of respondents were in paid employment ($n = 7$), another third of respondents were retired ($n = 6$) and the remainder nominated as either: semi-retired, farming, or business/shop owner. Seventy per cent of participants ($n = 14$) total household income of \$40,000-\$64,999 and above.

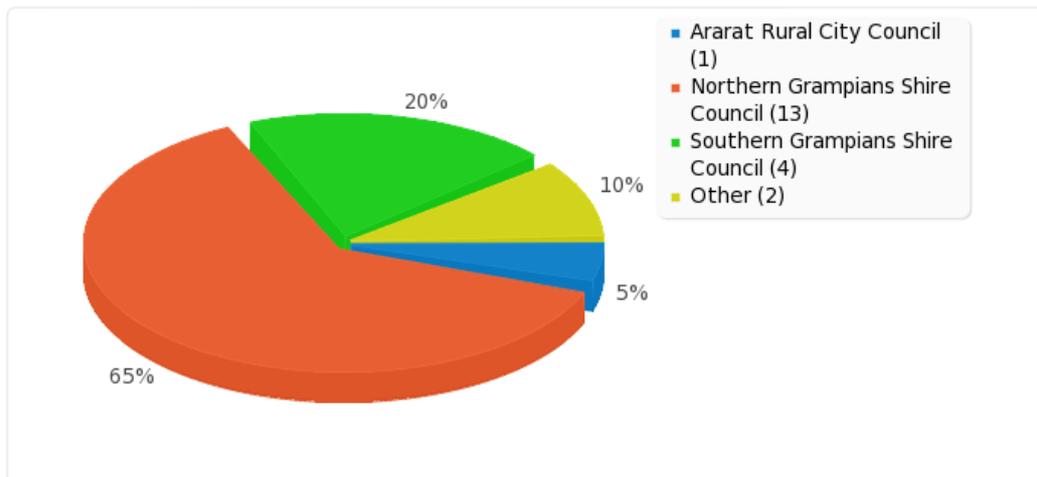


Figure 5. The Local Government Area in which individual/resident survey participants live ($n = 20$). (Note: the number in brackets in the legend refers to the number of people in each category).

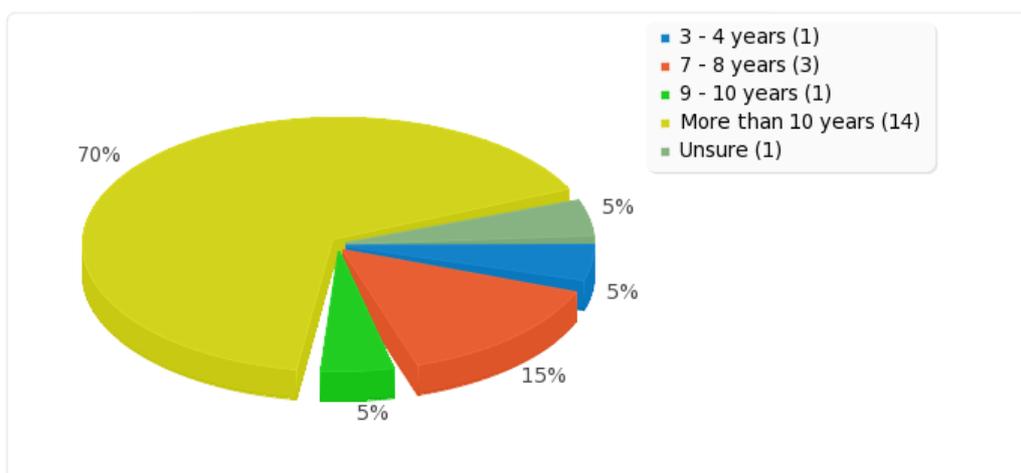


Figure 6. The duration that individual/resident survey participants have lived in their current residential region ($n = 20$). (Note: the number in brackets in the legend refers to the number of people in each category).

Business and Community Survey: Seventeen participants completed the business and community organisation survey. All but two respondents indicated that their business was located in either the Northern Grampians Shire (total $n = 12$, comprising 11 businesses from Halls Gap and 1 from Stawell) or in the Southern Grampians Shire (total $n = 3$, comprising Dunkeld and Mirranatwa); the remaining responses ($n = 2$) were received from people living outside the region. Just over half of all survey participants ($n = 9$; 53%) owned or were associated with a business that had been operating in the town for 10 years or more. A further 30% ($n = 5$) owned or were associated with a business in their region for between 6 and 10 years (Figure 7).

A range of businesses/organisations were represented by the survey, including accommodation services ($n = 6$), arts/culture ($n = 1$), hospitality ($n = 2$), tourism-related ($n = 3$); community organisation ($n = 1$), and other/not nominated ($n = 4$). The majority of respondents (65%; $n = 11$) were owners/directors of the business/organisation. The vast majority of businesses were 'micro' or 'small' businesses, as shown in Figure 8.

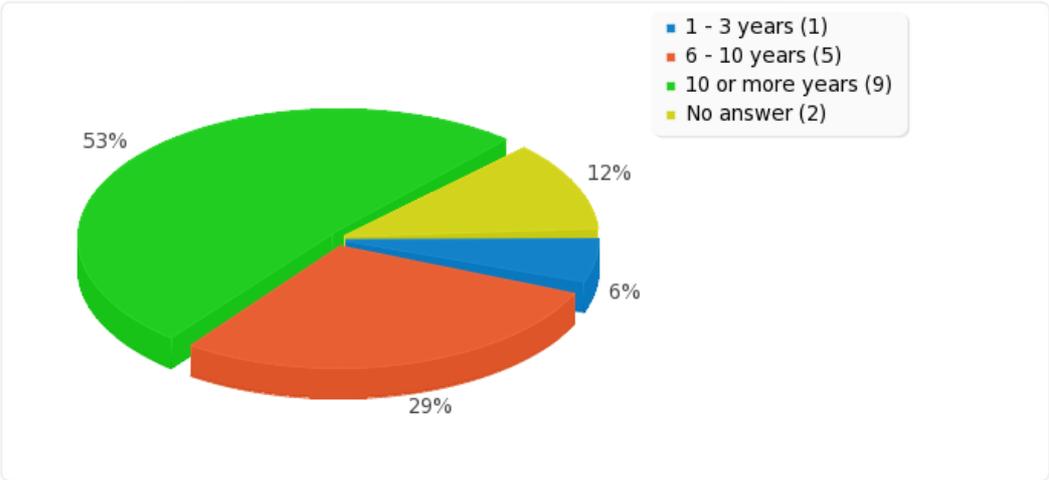


Figure 7. Duration of business operation in the region, as nominated by business and community survey participant ($n = 17$). (Note: the number in brackets in the legend refers to the number of people in each category).

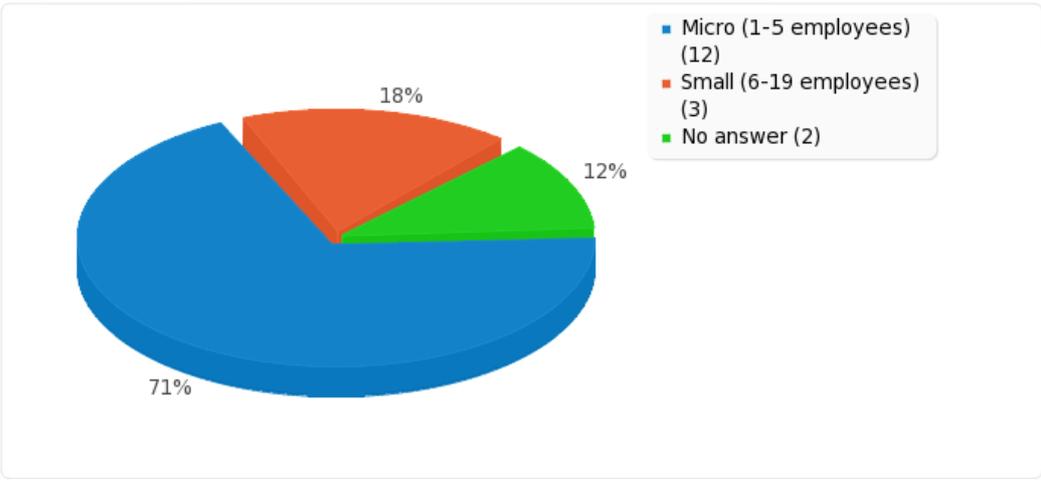


Figure 8. Size of business/organisation, as nominated by business and community survey participant ($n = 17$). (Note: the number in brackets in the legend refers to the number of people in each category).

Ethics

All research tools (surveys and interview questions; plain language information statements; consent forms) were submitted for approval to the Human Research Ethics Committee at Federation University Australia (formally the University of Ballarat). Ethics approval was granted for this project in July 2013 (Approval/project number: A13-095).

Findings

Overview: The January 2011 Grampians natural disaster affected communities in many different ways, but the general consensus amongst those organisations and individuals participating in this research was that it was an unprecedented event – an event like no other. Not only did the region experience the worst flooding in living memory, but an unexpected event for both community and emergency response organisations – landslides as a consequence of the flooding – occurred, impacting private properties and causing extensive damage to the environment and infrastructure across the Grampians National Park and surrounding communities. However, it has to be noted that there had been similar landslide events in 1916 and 1934 (as documented in newspapers of the time), they had been ‘forgotten’ by the current community and emergency organisations and thus, it became an unexpected consequence of the rainfall that occurred. The perception of landslides being a rare event in Victoria is demonstrated by the lack of landslides in the Emergency Management Manual Victoria (Department of Justice, 2013). Given the scale of this disaster, the social, economic and environmental impacts experienced by affected communities – and those responding to this emergency event – have been wide ranging and in some cases, have left an enduring legacy.

This chapter will examine the findings from the data collected from individuals (mostly residents) and businesses in affected areas, about the perceived impacts of this natural disaster. The intent of this research was to document the impacts of the landslides; however, it became evident when speaking to the emergency response organisations and community members, that the impacts of the floods and the landslides are not separate in the minds of these organisations or the community. Consequently, we have not made an attempt to separate the impacts of the floods and the landslides in the findings in this report; instead we refer to impacts of ‘the event’, which included flooding and landslides. Insights from agencies involved in the emergency recovery and response have also been captured. Following analysis of all participant responses, the data will be divided into three main areas of focus and these will also guide the structure of this chapter:

- *Preparedness and response to the Grampians Natural Disaster;*
- *Impacts of the Grampians Natural Disaster: Social, economic and environmental;*
- *Resilience and recovery from the Grampians Natural Disaster.*

Preparedness & response to the Grampians Natural Disaster: This was an event like no other

Level of preparedness: Reflections from participating emergency response agencies and the community

The Grampians and surrounding regions are prone to flash flooding; including Halls Gap, Glenorchy and Horsham (see for example Halls Gap Flood Study Report, 2008; Glenorchy Flood Study Report Year, 2006; Horsham Flood Study Report, 2003; Review of the 2010-11 Flood Warnings and Response, 2011). However the floods of January 2011, which have been assigned a ‘one in a 100-year event’, were exceptional, both in range and magnitude. Not only was this event extremely difficult to adequately prepare for, but the damage it caused created its own set of difficulties and challenges to service systems. Significant roads were blocked for extended periods of time and required ongoing repairs, critical services and infrastructure (water supplies, weirs and bridges) sustained major damage, alongside substantial damage to private property, businesses and government and civic buildings. Considerable environmental damage also occurred across the Grampians National Park. Some in the community, and especially business owners and residents, experienced considerable financial hardship due to the floodwaters destructive forces, particularly in regard to the perceived decline in tourists and visitors to the region following this event.

Those interviewed from emergency and recovery services organisations consistently remarked on the magnitude of the January 2011 events as presenting numerous challenges to adequately responding. This was despite each organisation having planned and prepared for natural disaster events and having knowledge about the region being prone to flooding. Even those organisations that had implemented their emergency response plans early and considered themselves ‘well prepared’ for

natural disasters (including floods) have, in hindsight, indicated that they were overwhelmed by the sheer scale of the event:

We are prepared 24 hours/7 days for these events but the size of the event was huge;

It was beyond a normal event. There was widespread damage throughout the Park;

We were prepared for natural disaster but the impact was unexpected and far reaching.

The extensive damage, prolonged recovery efforts, the intensity of the repair works and the extended length of time it has taken the region to recover from the initial incident was cited by many participants as evidence of the scale and impact of the event (*The scale of work was huge and it was intense from day 1 through to the end of August*).

This is further reinforced by the knowledge that the recovery program provided by some agencies and organisations remains ongoing, at least at the time the interviews for this project were conducted, in the latter half of 2013 (*We still have a flood recovery program that is still delivering but it is almost complete*).

In addition to the magnitude and subsequent impact of the flooding, emergency and recovery services organisations were confronted with an infrequent natural disaster event – landslides (evidence points to this being only the third landslide event in the last 100 years). The landslides were unexpected and proved to be an additional and significant event that complicated an already challenging natural disaster:

Landslides were new and as such it needed slightly different thinking;

We were aware of floods but we were not prepared for landslides;

There was a tonnage of rocks on some of the main and remote roads.

Staff from emergency and recovery services organisations commented that the scale of the events in January 2011 also caught many residents by surprise and that it was difficult for them to fully-grasp the scale of the disaster particularly in regard to the landslides and the associated length of time to recover key infrastructure:

People accepted that there was flooding and damage but it was more difficult to 'see' landslides and the lack of knowledge about the landslides made it difficult for the community to understand why the town was shut and why visitor numbers were restricted.

This caused some angst among local residents and business owners about the perceived delays in reopening roads and key infrastructure that sustained damage due to the landslides. It was not until the community could see first-hand (a bus tour to the landslide sites was organised for local community members by VicRoads) the destruction caused by the landslides that they could more fully understand the scale of the repairs required.

Despite the scale of the landslides across the region many of the survey participants in this study – residents, businesses and community organisations – focused their responses on the impact of the floods and much less on the landslides (with the exception of those that had been directly impacted). However it is clear from the comments received from the community – and which closely mirrors those made by staff from the emergency and recovery services organisations – that the nature and scale of both the floods and of the landslides were wholly unexpected:

We didn't expect flooding that way;

We had no idea there was going to be floods;

We never thought about a landslide in Halls Gap.

The unexpectedness of the events in January appears to account for the mixed reports of preparedness by residents, business owners and community organisations. As depicted in Figures 9 and 10, approximately one third of individuals/residents and business and community organisations considered themselves unprepared for the events in January 2011. Reasons for this response appear to relate, at least in part, to the nature and scale of the events. Consequently, many residents claimed that it was difficult to fully prepare:

It never occurred to me that we would face flooding of this magnitude;

It was difficult to predict such an event;

I saw no reason to be prepared – it's hard to see how we could be prepared.

Similarly, an examination of responses from businesses and community organisations reveals that they also felt the event was unprecedented thus making it difficult to prepare for such an event:

This was an unusual event that we have never seen before, and we could do nothing about the entry and exit to the town being blocked for so long;

It was a rare event with unknown consequences over time;

Hard to prepare for an event like this;

The floods came after a long period of drought...we had not encountered weather extremes such as this before.

Interestingly, two survey respondents were aware of the potential threats of flooding for the region. They attributed this knowledge to a long history and understanding of the region (*We had knowledge from a long family history in the area and knew what to expect*).

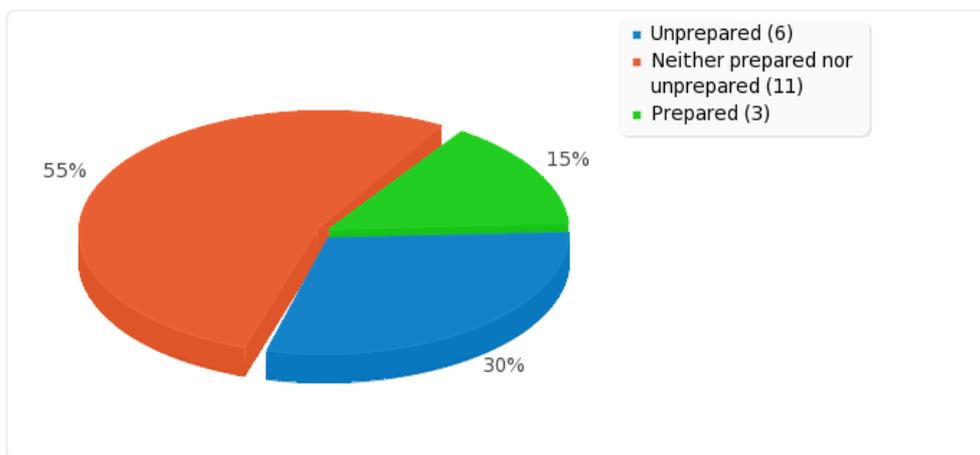


Figure 9. Estimate by individuals/residents of their preparedness prior to the Grampians Natural Disaster (n = 20). (Note: the number in brackets in the legend refers to the number of people in each category).

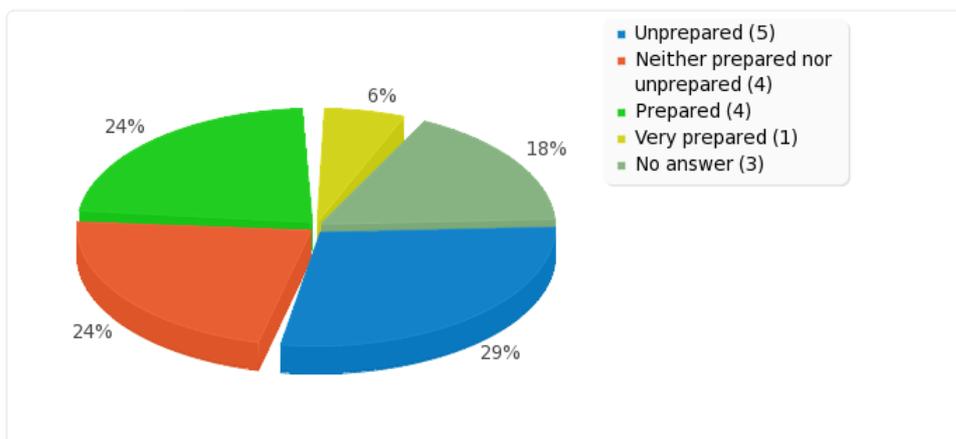


Figure 10. Estimate of businesses/organisations preparedness prior to the Grampians Natural Disaster (n = 17). (Note: the number in brackets in the legend refers to the number of people in each category).

Catalysts for effective preparation and response to the Grampians Natural Disaster: What worked well?

Staff from emergency and recovery services organisations described in detail the roles they performed during and in many instances, after the main flood and landslides event. Each organisation performed an essential and important role to ensure the safety of the community and the region both at the time of the event and during the long recovery phase. This support ranged from relaying information, gathering data and providing practical assistance during the initial flooding through to carrying out extensive repair work on key services and infrastructure during the months that followed. Each agency had organisational plans in place for such events and had undertaken preparations for expected heavy rain/flooding and had consulted with other key organisations as soon as warnings of heavy rains and potential floods were indicated to thus optimise their response to the event.

All staff assessed their organisation's response to the January 2011 natural disaster as appropriate. There was consensus that there were particular factors that facilitated organisational preparedness and response that had enabled a successful response to this event. All commented that the organisations they represent had escalated quickly to the emergency and responded appropriately after the event and in the months during the recovery. Upon reflection some key catalysts were identified as contributing to the effective response, including previous knowledge of disaster events, strong interagency communication, partnerships and strong connections with the community. These are explored in detail, below.

1. Past experience and local knowledge

Past experience with disaster and recovery responses was considered extremely valuable by those interviewed from the emergency and recovery services organisations. Many commented that their response during the 2011 floods was informed and enhanced by past learnings from other natural disasters in the area including bushfires, particularly the Mt Lubra bushfires of 2006. (This experience will have likely also informed the response during the recent fires in the Grampians National Park, in early 2014). This knowledge and previous experience was helpful at both an organisational and workforce/staff level, as highlighted below:

- **Organisational:** Some organisations had implemented processes that had worked successfully in the past with other disasters and were therefore better prepared with policies and procedures ready for activation at short notice. For example, one organisation drew widely upon successful methods of communication with residents and the broader community that had been used during the 2006 bushfires. It should be noted that a staff member from one of the participating organisations commented that their knowledge of natural disasters, broadly, was invaluable in assisting with the floods in 2011. However, they and their staff had not received any specific training in flood response and this lack of training had caused some challenges for them in searching for the appropriate information from which to respond.
- **Staff/workforce:** Staff that had been previously involved with a natural disaster response elsewhere in the region (either in their professional role, or personally), were identified as an 'asset' to the 2011 disaster and were considered by many to offer crucial insights and contribute more holistically to the event, and in some instances, enhance the organisational response. These staff members were also able to provide guidance and direction to other staff members in responding to the event because of their first-hand knowledge with previous disasters. In contrast, some participants commented that their response to the disaster may have been restricted by a lack of local knowledge and/or community connection or experience with natural disasters.

2. Communication and coordination

Generally, the inter-agency communication and coordination was considered to be effective. Although, as highlighted below, there were also some challenges with communication and confusion/blurring of agency roles at the time of the event. The workers involved with the immediate response focused much of their attention on supporting those communities affected, both emotionally and practically.

Many participants reflected that staff involved in the emergency response undertook work that was well outside their usual scope of activity and had responded 'above and beyond' the call of duty.

Participants also spoke of the strength of inter-agency partnerships, the goodwill of staff, and the solid response to service coordination that occurred during the emergency response. Many provided examples of where the coordination between services in response to the emergency and recovery was planned, considered, complementary and effective:

Northern Grampians Shire well and truly did what Council needed to do. They showed great dedication and effort over and above the call of duty. This positive feedback doesn't get put into the loop very often and it should;

Local government did an excellent job but I don't think they were integrated into the management role as well as they could be. They need to be more integral to the incident management role;

The level of cooperation between agencies was excellent in the early days of response. The people involved were well known to each other and reasonably rehearsed in the things they do.

Particular examples of the strong inter-agency coordination were mentioned and included (1) VicRoads and Parks Victoria; (2) Tourism Victoria and the SES; (3) Northern Grampians Shire Council and the SES; and (4) DEPI, CFA and the SES. This is evidence of the importance of agency partnerships and the need to ensure that these inter-agency relations continue to be strengthened into the future. Furthermore, these interagency relationships need to be strengthened between a wider range of agencies to ensure responses to disasters in the future continue to be effective.

3. The value of key community contacts and community hubs

Utilising and maintaining strong connections within the community was considered to be an important asset in responding quickly and effectively across the community. Some participants commented on how key community members were able to disseminate information to the wider community, including those unable to attend community meetings or who were otherwise not engaged in the inter-agency response and recovery itself. A range of different community 'events' were organised at the time of the disaster (and during recovery) that facilitated information sharing across the community (see for example the community activities integrated within the NGSC's Municipal Recovery Action Plan). Other hubs for information-sharing during the disaster were identified across the region, and in Halls Gap these included the Halls Gap General Store and the Tourism Information Centre.

The community's perceptions of the preparedness of the emergency and recovery services organisations during and after the event are presented in Table 1. These responses show that there was a lot of variation in perceptions of preparedness between residents, communities and business with some participants feeling they were unprepared/very unprepared and others feeling they were prepared or very prepared. However, a detailed examination of the comments suggest that overall people felt that the support they received from emergency services and infrastructure organisations at the time of the event was positive, with some identifying particular services as having provided good information, coordinated support and overall assistance:

We had immediate help from Parks Victoria and swift help from the Shire (NGSC);

The immediate response was adequate;

Volunteers came forward;

Information was good from Shire/Police/SES;

During the event, emergency services, Police, SES and the community came together to assist. In recovery, information meetings regularly took place;

I was impressed with the assistance given at all times;

The response from the local Council (NGSC) and Parks Victoria was very helpful;

I was amazed at how quickly sandbags etc. arrived and how the teams got to work.

Participants' perceptions of the services they had received during recovery were also largely positive. However some members of the community commented on the frustration they felt at the length of time to rebuild infrastructure (*It took 9 months to clear road – ridiculous*) and the warnings that kept tourists away (*Over time, too protective and stopped people coming; Informing public to stay away*).

Table 1. Survey results (individual/resident, n = 20; business and community organisations, n = 17) about the communities perceptions of the preparedness of disaster management services during the event, and in recovery.

Survey Results				
	Responses % (n)			
	Very unprepared to unprepared	Neither prepared nor unprepared	Very prepared to prepared	NA or no answer
Individual/resident survey				
During the Event	35% (n =7)	15% (n =3)	40% (n = 8)	10% (n =2)
During recovery	5% (n =1)	25% (n = 5)	45% (n =9)	25% (n =5)
Business and community survey				
During the event	23% (n =4)	24% (n =4)	24% (n =4)	29% (n =5)
During recovery	28% (n =5)	18% (n =3)	36% (n =6)	18% (n =3)

When individuals and residents were asked which emergency management strategies worked well during the event, most provided examples of services delivered by particular organisations, including local Council and the SES. The support provided within the community – and by the community – during the event was also widely acknowledged:

The community joined together and helped each other;

The local community was great.

During recovery, participants identified other activities that worked effectively to support the community during rebuilding. These included community meetings and events, the communication received (*Local Council kept tourism operators and businesses informed*), internet updates, road management and access.

Challenges experienced in the preparation and response to the disaster event

Representatives from emergency and recovery services organisations indicated that their preparedness to the events in January 2011 was appropriately responsive. However, the scale of response required to meet the magnitude of the events that unfolded in January 2011 presented a number of challenges.

Although most agencies indicated that they couldn't have prepared any better for the events of January 2011, the scale of the disaster compounded some of their usual roles as highlighted by the following quotes:

With an event like that we were reactive because we didn't have any evidence to drive us to particular conclusions about outcomes;

Yes there was miscommunication but this is the nature of a major emergency ... you're not going to get wonderfully packaged and correct information – it just doesn't happen that way;

I don't think that we or other services actually understand the nature of a major emergency.

Five major 'challenges' were identified by the majority of participants during interviews about the emergency response during the floods and landslides. These are summarised below:

1. Blurring of agency roles during the response

Several participants from the emergency and recovery services organisations commented that some overlap in roles had occurred between some services and agencies. For some participants, this blurring of roles led to some organisation's taking action on particular matters that were considered to be outside their level of responsibility:

Some agencies were stepping outside their remits and giving directives that directly impacted on our organisation;

Initially there was 'quite a bit of overlap' between the various services and agencies in regard to the type of work and support that was being carried out in the Halls Gap area.

Further illustration of the challenge of blurred agency roles was provided by staff members from one emergency and recovery services organisation who commented that another organisation had undertaken a role in the aftermath of the emergency event that led to an overlap in duties being performed by other organisations in the region. This also highlights the importance of having good communication between agencies.

Another representative of an emergency and recovery organisation had suggested that greater leadership in response to the floods was needed from organisations experienced in large storm events and flooding and with major disasters: *Some organisations don't have experience with big, longer-term floods or experience in many of the flood plains in the region.* It was suggested that other organisations with flood experience and knowledge could take a stronger leadership role.

2. Flood warning systems

Flood warning systems for Halls Gap at the time of the floods were largely reported to be insufficient. Staff from the emergency and recovery services organisations commented on the difficulties of accurately predicting floods for the Halls Gap region due to the limited number of rain gauges in the area. To counteract this at the time of the event, the extensive work conducted by the Wimmera CMA on flood studies and flood maps for the region were extensively utilised to provide the necessary information where there were gaps in knowledge. This information was considered by many to be extremely valuable in responding to the flooding event in the absence of more accurate flood warning systems:

There are parts of the system – the Wartook Valley Catchment – where there is no information about flooding. That was a black hole of information; same applied downstream of lakes Lonsdale and Mt Zero which feeds the MacKenzie River near Zumsteins – information from here about early flooding would be handy for planning.

Some staff from the emergency and recovery services organisations also commented that better scientific methods for predicting floods were needed for the region with one participant describing how, during the recovery phase, the BoM predicted heavy rainfall for the region in February 2011. Acting on this information, an evacuation of certain areas in and around Halls Gap was organised. The rains did not eventuate and as a consequence some emergency and recovery services organisations' staff thought that many residents 'lost faith' in the process and in the services involved. Greater modelling

of these events could enhance the accuracy of information given to the public and may avoid similar incidents in the future.

Note: Since the event in 2011 rain gauges have now been installed for the Halls Gap region by Council with funding from the State Government. Placement of rain gauges includes Reid's Lookout and Lake Bellfield. This provides more accurate information about rain and potential of floods in the area (*We can view and respond and provide more detail and advice about the size of the event from now on*).

3. Miscommunication and poor communication

There was evidence from those interviewed that there were some occurrences of miscommunication between agencies during the 2011 events. Examples of this occurred during the recovery phase where heavy rainfall was predicted for Halls Gap in February 2011. Conflicting messages were sent out from organisations about flood warnings and possible evacuations in the region that heightened confusion in the community. However inaccuracies in initial flood warnings may have contributed to this issue. One agency commented that they had not received sufficient information about the event from another organisation and felt unsupported in their role during the emergency: (*We were left to make our own decisions and gather our own information. There should have been better direction from this organisation*).

Another member of a recovery and emergency services organisation reflected that there was a lack of available public information about road access within the Grampians National Park. With several major and minor road closures and long delays in repairs due to the scale of damage to roads there appeared to be a lack of information available to both locals and tourists and as a consequence, *the region copped a lot of flak for not letting tourists know about lack of access to the Grampians National Park*.

Senior and experienced personnel from emergency response organisations indicated that a level of miscommunication was an understandable consequence given the scale of this emergency event, and may also have been compounded by the inaccuracy of flood warnings in the region. To highlight this, one participant commented that they had been repeatedly asked for critical information that they had previously circulated to all organisations on at least one previous occasion. This confusion may be a consequence of the anxiety that occurred as the disaster escalated. Another agency commented that it took some time to 'catch up' with the response, with regular weekly public information meetings only being established some two weeks after the initial flooding event.

Further issues regarding matters of communication came from a small number of community members who also commented that the communication they had received at the time of the event from the emergency response organisations was confusing and 'ad hoc':

Authorities were trying to do their best however it [the information] was quite confusing;

Follow up was ad-hoc, with not enough up-to-date information.

However, it should be noted that such sentiments were not reflective of the majority of community participants.

4. The complexities of the community response – expectations versus the reality; heightened angst by locals

Participants from the emergency and recovery services organisations spoke of the anxiety of those residents in the communities affected by the natural disaster and how this was sometimes directed towards staff involved with the response and recovery. A number of emergency and recovery services organisations' staff commented that the community's expectation about the event, and the response to recovery, was unrealistic. One emergency and recovery services organisation staff member commented personally on the public anger in Halls Gap with the 'closure' of the town immediately following the floods and landslides:

People accepted that there was flooding and damage but it was more difficult to 'see' landslides and the lack of knowledge about the landslides made it difficult for the community to understanding why the town was shut and why visitor numbers were restricted.

Similarly, another participant had also observed community angst in Halls Gap immediately following this event and where there was a heightened level of concern that tourism to the region was suffering as a consequence of the damages experienced by flooding and landslides. Another participant spoke of how a staff member had *waded through the floodwaters* in order to provide information and assistance to residential and business owners in Halls Gap only to be confronted with anger and frustration by those in the community affected by the flooding. Some commented that the community did not appreciate the demands placed on emergency services and the impact such demands may have had on the capacity of agencies to respond more promptly to the community.

One participant commented that there was some escalation in civil disobedience at the time of the event, with the participant having witnessed some members of the public remove road closure signs, threaten staff, and ignore travel advice. This is a reminder that during such events, members of the public do not always behave rationally and that this behaviour is a normal response to the turbulent and confusing events of major emergencies.

5. Workforce gaps: Lack of staff training and/or knowledge of natural disaster event management

Another concern during the emergency event was the small number of staff working within some organisations at the time of the event. This 'skeleton staffing' appeared to be primarily due to many staff members being on annual leave during the January/February summer school holiday period. As a consequence, some staff were placed in disaster emergency roles regardless of their experience or training in disaster management.

Importantly, some of the staff from organisations interviewed for this research have since responded to this challenge and have implemented staff protocols within their organisation to counteract such problems in the future, including a permanent roster of dedicated, on-call emergency response personnel to respond to future emergencies. For example, Northern Grampians Shire Council has developed and now implemented a new policy whereby there are three municipal emergency resource officers (MERO's) on rotating rosters. Other organisations have considered implementing similar protocols but they have not been finalised at the time of this study.

When the community was asked for suggestions about improving the natural disaster management strategies across three time points a range of responses was received, as summarised in Table 2. Many of their suggestions for change are closely linked to the challenges that the emergency response organisations had identified. These responses can be grouped into practical suggestions for improving (a) 'faulty' infrastructure (i.e. drains in Halls Gap); (b) weather alerts in the area; (c) planning by the community; (d) improving 'communication' and information sharing across all time points and between services and organisations; (e) more 'on the ground' emergency services support and personnel, and (f) improved liaison between key services about roles and responsibilities.

Table 2. Survey results/themes (individual/resident; business and community organisations) for improving disaster management services before and during a natural disaster and during recovery.

Survey results/themes	Prior to a natural disaster	During a natural disaster	During recovery
Survey participants			
Individual/resident	<ul style="list-style-type: none"> Halls Gap and drainage system; clean drains Real time weather stations and storm radars Better planning by the community Flood mitigation work to protect town 	<ul style="list-style-type: none"> Improved communication strategies (between all stakeholders) Warning systems More emergency services support: more police; crews ready to clear waterways 	<ul style="list-style-type: none"> More communication/ ongoing communication Prompt assistance; more workers
Business and community organisations	<ul style="list-style-type: none"> Preparation of individual emergency plans (similar to bushfires planning) Develop guidelines for locals and visitors Drainage/ water management Improved liaison between key infrastructure organisations (VicRoads, SES and Parks Victoria) and define roles/ responsibilities. 	<ul style="list-style-type: none"> More/ improved communication (including better mobile phone coverage) and information management 	<ul style="list-style-type: none"> Advice about communication and information to assist residents and tourist operators when cancelling bookings and refunding bookings Advertising campaigns to encourage tourists to return to the area Rebuilding damaged infrastructure more quickly More help – fewer meetings.

Impacts of the Grampians Natural Disaster: Social, economic and environmental

Social impacts

Overview of reported impacts

The events of January 2011 impacted on all participants in this research, including agencies involved in the emergency response and recovery, business and community organisations and individuals/residents directly and indirectly affected by the events of January 2011. While some participants reported varying levels of hardship and stress (socially and economically) both during the initial flooding and in the months following, it became apparent that for most participants, the magnitude of these impacts appeared to be largely dependent on the scale of damage to property and business and of their 'experiences' during and after the events in 2011.

While it is important to acknowledge that the events of January 2011 did not lead to any loss of life or major injuries (a positive outcome which was acknowledged by some staff from the emergency services and infrastructure organisations) the reported impacts to health and wellbeing of those agency staff members involved in the response and recovery phases was an area of some concern.

This together with insights into the social impacts (health and wellbeing) for all participants of this research is explored below.

Social impacts of the Grampians Natural Disaster – Reflections from participating emergency response agencies

Some staff from the emergency and recovery services organisations reflected on the pressures of providing response and recovery to this disaster. Impacts on the health and wellbeing of staff members were reported. Fatigue and the potential for worker 'burn out' from the long work hours were discussed:

Staff were working 24-hour rotating shifts in the Municipal Emergency Coordination Centre and when they should have been resting, they were trying to cover their normal workload.

The dramatic shifts between roles for some workers in response to the emergency and the intensity and prolonged nature of much of the long term disaster recovery work (for agencies involved in the extensive infrastructure repairs) were also raised.

Some of the main pressures placed on staff during the event (and in the aftermath) have been captured and summarised below:

- Changes in roles and responsibilities within the organisation: Staff from some emergency services and infrastructure organisations reported being assigned different duties and/or higher responsibilities during the response and recovery phases of this event. Some were working well outside the scope of their usual positions and were assigned these new roles having had little experience or training. One staff member commented about having to make decisions quickly and under pressure during the event (*We have to make decisions quickly and impact and consequences of these decisions can drag on after the event, with the community, and we have to 'wear it'*). Some raised concerns about this in relation to responding appropriately and effectively to the community's needs. Others were frustrated that they could not 'make everything better' while at the same time being fearful and concerned about their own safety, and that of their families, during this event. Some participants reported that their new roles and duties were not always undertaken voluntarily, but out of a necessity (and in some instances due to lack of other, available staff).

Other participants undertook 'dual roles' within their organisation and continued working in their usual role while also assuming additional duties to respond to their organisation's emergency and recovery efforts (*the events of 2011 stretched our capacity*). Staff interviewed indicated that they had contributed significantly to the recovery and response and continued to undertake duties associated with their 'normal' role, placing additional burdens on some staff members. One staff member suggested that instead of mobilising staff into recovery, a different response model could have been adopted: *Probably we should have set up a separate project team as even with this event occurring we still had to deliver our normal work.*

Since the events of January 2011, at least two organisations have implemented a range of health and wellbeing considerations for their workers as part of a holistic response to natural disaster. Another organisation had developed an internal crisis management staffing manual outlining roles and responsibilities within the organisation when a disaster event occurs. Prior to January 2011, one agency had already incorporated a model to address workforce considerations in response to natural disaster. This had been developed following past experience and was designed to mitigate the impacts upon workers during a natural disaster. Part of their strategy involved moving permanent staff into local disaster zones and backfilling their jobs with casual staff. This ensured that staff were not required to perform dual roles and that relief workers from outside the region did not work in the disaster zone. This same organisation had also implemented a range of other health and wellbeing measures for its workers to ensure their overall wellbeing when responding to such events.

- Going above and beyond the call of duty: Many participants commented on the exceptional commitment of staff in assisting the response and recovery efforts within their communities. Some had witnessed their colleagues and staff members going to extraordinary lengths to provide assistance and support to affected communities. Despite this, some workers were confronted 'in the field' by members of the community who were anxious, frightened and felt threatened by the events and had vented their concerns on these workers.
- Workplace OHS issues: Some participants mentioned isolated incidents within their organisation of staff compromising their own safety and that of their colleagues because of high levels of fatigue. This was exacerbated by some workers also volunteering to assist with flood relief after they finished work each day. Another concern was raised about the unsuitability of some equipment/vehicles used to respond to the emergency and of safety concerns associated with this. (*Note*: This concern has since been reviewed and vehicles and equipment have been modified to meet any future disasters).

Social impacts of the Grampians Natural Disaster – Reflections from the community

The social impacts of the Grampians Natural Disaster on individuals and residents were very different to those of the infrastructure and emergency services organisations – and of businesses and community organisations. More than half of all individuals/residents indicated little or no impact following the natural disaster event in the Grampians. This is illustrated in Figure 11 and captured by the following participant comments:

We weren't impacted at all;

We only experienced some minor silting of our driveway.

A fifth of individuals and residents who responded to the survey however reported a high or very high impact from the floods and/or landslides as a consequence of damage to property, including loss of land, fencing and outbuildings, along with 'stored items'. This is slightly higher than that found by Northern Grampians Shire where around 13% of houses suffered major damage (Northern Grampians Shire Council, 2013); however the difference here maybe due to differences in what is considered 'high impact' by participants compared to 'major impact' as defined by council staff. Many individuals/residents commented on the inaccessibility of the roads in the region caused by the landslides and floods. For some residents this impacted on their ability to travel within the region with travel routes, travel distances and travel times all affected:

We could not use the Grampians Tourist Road... but had to take a longer route via Moyston and Pomonal - minor inconvenience only;

We couldn't easily get to Dunkeld or Horsham;

The only disadvantage to me was the distance we had to travel, via a long detour, to Halls Gap, over one hour instead of 35 minutes.

In contrast, 65% of business/community organisations who responded to the survey reported a high to very high impact of the Grampians Natural Disaster on their business and/or organisation, as shown in Figure 12. (It should be noted that the more than half of all businesses and organisations reporting high to very high impact were from Halls Gap; $n = 8$). This was largely attributed to the loss of income, as highlighted in the following quotes:

Loss of guests and therefore no revenue for twelve long months, and beyond;

Business stopped....it relies on tourism.

For some businesses and organisations the road closures and infrastructure repairs after the events contributed to the loss of income:

A loss of income while infrastructure was being repaired;

I personally was trapped in Halls Gap for a number of days.... Our guests were also stuck in Halls Gap for a couple of days and had no water to their properties;

Our business was impacted – we were closed off from traffic both ways in the first few days and several months from traffic south towards Dunkeld.

Other impacts reported included business closures due to flood damage; and flooded and unsafe public spaces.

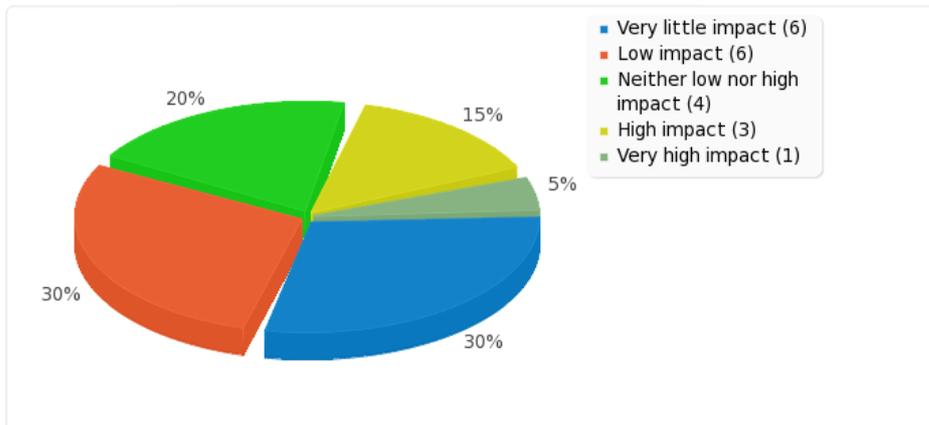


Figure 11. The level of impact reported to individuals/residents attributed to the Grampians natural disaster ($n = 20$). (Note: the number in brackets in the legend refers to the number of people in each category).

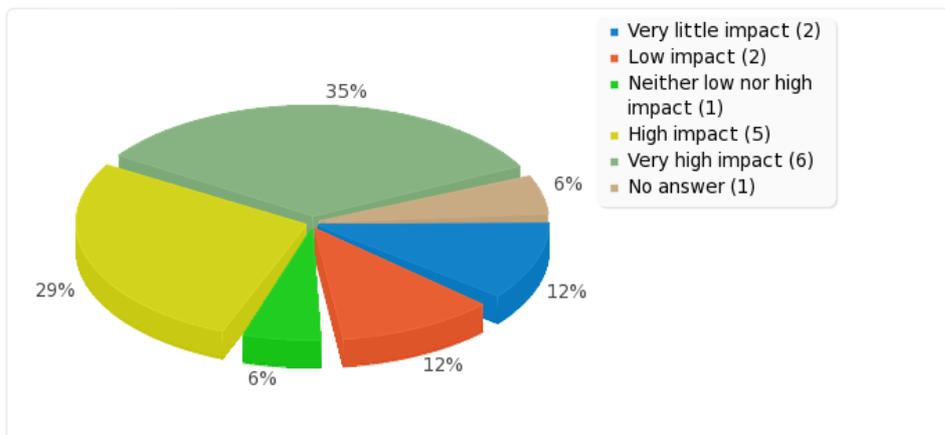


Figure 12. The level of impact reported to business and community organisations attributed to the Grampians natural disaster ($n = 17$). (Note: the number in brackets in the legend refers to the number of people in each category).

Injuries and threats

Reported injuries during and after the natural disaster event were minimal for all survey participants with only one reported injury (unspecified) during this event. A small number of individuals and residents experienced a direct threat to family and personal safety during the natural disaster, and this was associated with flood damage to property and the inaccessibility of roads; as well as road closures due to landslides.

Perceived threats to businesses and community organisations following the floods and landslides was high, with threats to property and possessions accounting for 70% ($n = 12$) of all responses, as shown in Figure 13. These threats were associated with business and property damage caused by flooding (and landslides) as highlighted with the following quotes by affected businesses and community organisations:

Property affected by flooding;

There was a threat of water flow and falling boulders;

Town cut off from south – no power, no sewage, water cut off.

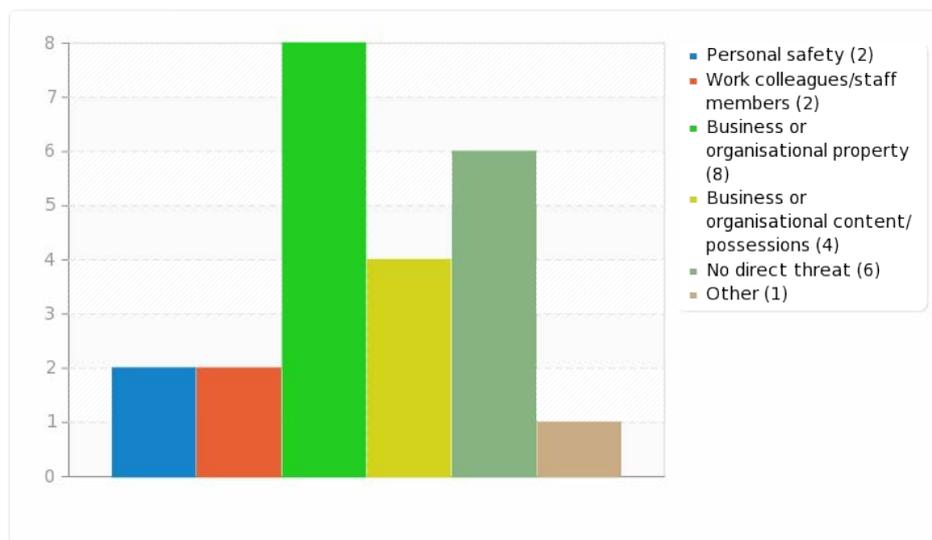


Figure 13. Perceived threats from the Grampians natural disaster by businesses and community organisations (n = 17). (Note: Each participant could respond to one or more of the response options; the number in brackets in the legend refers to the number of people in each category).

How people are coping and relationships with others

Individuals and residents were asked about the impact of the Grampians natural disaster on their health and wellbeing. The majority of these participants assessed the impacts on family health and their ability to cope with difficult circumstances as being 'neither positive nor negative', as summarised below:

- Impact on family health ('neither positive nor negative' response: 75%, n = 15);
- Ability to cope with difficult circumstances in life ('neither positive nor negative': 70%, n = 14; the remaining 6 participants indicated that their ability to cope with difficult life circumstances was 'positive' or 'very positive');

However, participants were divided about the impact on their ability to cope with another disaster, their relationships with family, friends and with others in the community, with around half feeling it had 'neither positive nor negative' effect and half feeling that it had a 'positive or very positive' effect, as show below:

- Coping with another disaster ('neither positive nor negative': 50%, n = 10; 50% of participants indicated that their ability to cope with another disaster was 'positive' or 'very positive');
- Relationship with family and friends ('neither positive nor negative': 45%, n = 9; 45% of participants indicated that their relationship with family and friends was 'positive' or 'very positive')
- Relationship with people in your community ('neither positive nor negative': 45%, n = 9;
- 55% of participants indicated that their relationship with people in their community was 'positive' or 'very positive')

Individuals/residents revealed that their ability to cope with natural disasters was aided by the help and support they received from family and friends and the community:

...with the help of our friends in the community, we coped satisfactorily;

Support from the community and Council;

Good to see people care for each other;

We saw how communities rally round.

Furthermore, one respondent commented that coping with the impact of the January 2011 events provided the *community with the skills to assist with future events*.

When asked to identify the social costs to themselves and their families during recovery, most individuals/residents indicated that there had been few or no 'social costs' and instead referred to the personal costs (property damage; inaccessible roads) and/or the region-wide impact of the event on loss of income to local businesses (*Huge social cost to the community in regards to lost income to local businesses*).

Potential/future considerations to the health of the community

A small number of people completing the surveys indicated that the events of 2011 had impacted on their mental health and caused *personal stress and health issues; anxiety*. Although mental health problems were not widely reported by participants in this research it does none-the-less present as an important consideration for the future health of the community. One non-government welfare agency commented as part of this research on the services it had provided in the region to respond to escalating mental health illnesses following the events of January 2011. It was suggested that there may be ongoing health issues for the community in coming years with the possibility of longer term impacts relating to ongoing health issues for those in community's affected by this (and other) natural disasters.

Economic impacts

Overview of reported impacts

As noted in the social impact section, many of the business and community organisations from the Grampians region who participated in this study were impacted by the event and the subsequent recovery phase much more than individuals and residents. Economic and financial issues suffered by businesses and community organisations resonated strongly in the views expressed in the survey, such that the economic impacts identified in this section are crucial to appreciating the financial risks of this event and understanding the need for building strong economic resilience. The analysis below recognises two sources to the financial risks exposed by the event. One is the complete dominance of tourism as the industry to which business activity is associated with. The other is the virtually complete reliance on public funding and infrastructure support to accomplish the necessary social and environmental recovery of the region that is essential for the tourism industry to again prosper. This is the dilemma noted by John Kenneth Galbraith (1958) in his book *The Affluent Society*; the private sector manages well under affluence, but needs public support when crises occur. Thus, economic resilience needs to build a strong private-public relationship that ensures future shocks have a strong inbuilt economic mechanism that is both reflexive and robust as described in Handmer and Hillman (2004).

The structure of this section on economic impacts is to first specify and contextualise the economic costs and economic achievements of the relief and recovery process. The data for this analysis has been provided through the surveys, transcripts of interviews and follow-up discussions with some of the interviewees; as well there is secondary data available from Grampians Tourism, Australian Bureau of Statistics and contemporary newspaper reports. Then the second section reflects holistically on this data analysis to derive three major themes that explicate the overall economic impact in terms of risk and resilience.

Costs to emergency management and infrastructure organisations

Despite the acknowledged, significant negative impacts on the tourism businesses in the Grampians, participant responses reveal that initial considerations immediately upon the flooding and then consequent landslides was for community safety. This was natural and proper; to protect our own kind in such emergencies. As a result, there was no consideration for the affected businesses. With the effort on community safety, as revealed in the interviews, there arose the need for regional government and non-government agencies to act as emergency agencies in response to the crisis. However, there was no portfolio responsibility for landslides allocated to any agencies, unlike with bushfires. Parks Victoria assumed governance, since they were 'on the ground' within the Grampians

National Park. The Victorian Police by default managed the co-ordination of interagency responses. Yet, when interviewed, representatives of both agencies who managed the emergency response were not able to specify costs or financing to their respective organisations in regards to these emergency and recovery activities. A Parks Victoria (2013) report does note that they spent 'over \$7.5 million since January 2011', although the financing of this bill is not stated. Both Parks and Police implied that it came out of existing operating budgets. This in itself is a financial risk that the Victorian public sector has to face, especially during times of avowed austerity by politicians in respect to the increasing public sector debt. Such financial risk severely limits economic resilience in the face of future emergencies.

Relief and recovery costs by agencies that contributed physical resources in the form of emergency repairs and reconstruction to infrastructure have been specified in interviews with agency representatives. The expenditure figures shown in brackets are approximate and noted in millions (M) of Australian dollars. Most significant were the local government authorities (LGAs), with Northern Grampians Shire (30), Southern Grampians Shire (15), Ararat Rural City (13.5), and Horsham Rural City (20). Based in the Wimmera region, there is Wimmera CMA (24) and GWM Water (10). Vic Roads (15) spent in the National Park (with Silverband Road alone costing 8), when a total of 60 was spent on flood recovery of roads in the Western Region (which extends west to the South Australian border and north to the NSW border).

The above expenditures in brackets (above) add up to a total of approximately \$130M. This was funded from multiple sources, but chiefly from the Natural Disaster Relief and Recovery Arrangements (NDRRA) in order to restore physical assets damaged or destroyed. NDRRA is the funding framework between Commonwealth, State and Territory governments in which the costs associated with response, relief and recovery are shared. Comrie (2011, p.207) notes that: *The NDRRA is a complex agreement and in Victoria is only understood by a small group of state government officials.* On the positive side of the ledger, NDRRA enables funding outside of normal operating budgets of LGAs, CMAs and state authorities; where the costs of relief and recovery are well outside the financial funding abilities of these authorities. On the negative side is the complexity of such arrangements that creates bureaucracy and uncertainty which extends recovery period and frustrates local communities that have been strengthened by the initial community safety effort to the disaster. Resilience requires a clearer and simpler approach to funding the costs of emergencies.

Further considerations are the intangible costs to the agencies during relief and recovery process. One already noted was the *ad hoc* governance issue which added stress to managing the process. Also noted by the interviewees were intangible costs that occurred both during the emergency and the reconstruction stages that resulted in fatigue of staff workers and volunteers involved. Such fatigue leads to 'burn out' from the long work hours and related health and wellbeing issues. These matters are covered in the social impacts section of this report. One final intangible cost specified by local government staff was the work that needed to be done regarding the legal obligations of the various agencies and organisations in natural disaster situations. As one manager stated: *Landslides aren't recognised in the Emergency Manual so there is no dedicated response.* These intangibles add a layer of complexity to addressing resilience.

Costs to individuals and residents

Impacts on household finances for individual/resident's following the event suggest minimal to moderate costs were incurred. For the majority of respondents (75%) the impact on household finances was 'neither negative nor positive'. For those that incurred costs associated with the event, these included costs to remove/repair damaged property and possessions (largely considered by the participants as 'minor' costs) including the removal and repair of property, fences, outbuildings and minor water pipe repairs. Extra petrol costs to drive longer distances due to road blockages also were mentioned. In estimating the impact of costs during the recovery from this event, almost all participants indicated that there was 'no/very little' financial impact to them, and one respondent even indicated that *'employment opportunities were created'* during the recovery. This last impact relates to the construction activity in repairing and reconstructing infrastructure that was itemised in the previous section as costs to various agencies. The employment creating opportunities for households in the region are positive, but temporary as these jobs only last for the period that recovery work is being

conducted. Most of this work was completed by late 2013, as signified by the re-opening of Zumsteins picnic ground on its (one-year delayed) centenary celebrated on Sunday 22 September 2013 (Webb, 2013). The positive economic achievements of this construction activity are specified below, after costs to organisations are discussed.

An intangible cost that frustrated residents to the extent that local councils assumed responsibility was insurance covering private property. It was noted that ‘government agencies were good at funding community infrastructure repairs but not in private property matters.’ Councils took the initiative to gain access for residents to funding for repairs. This is another example where the market is assumed to resolve these private sector issues, but where intervention is required when intangible costs are not handled by markets.

Costs to business and community organisations

In contrast to the minor costs incurred by residents, a large majority (70%) of businesses and community organisations were negatively/very negatively impacted, financially, during the actual event, as shown in Figure 14. (It should be noted that all but two respondents who reported a very negative or negative financial impact were from Halls Gap; $n = 10$). These are tangible direct costs that affected the physical nature of their establishments and losses from existing tourism operations at the initial stages of flooding and landslides that prevented travel in and out of Halls Gap in particular. One Halls Gap tourist hospitality operator quoted: *\$80,000 [to] replace water damaged floor coverings, sections of walls, fittings etc.* Also reported in the survey by participant owners of tourist accommodations were tangible indirect economic costs, notably costs for additional nights that visitors had to pay for staying while roads were closed. This was a small benefit to this particular tourist establishment, but a significantly negative effect on tourism for the region. Another indirect cost was the *Thought that the whole National Park was closed*, when much of the western part of the Park was unaffected or only with minor affects. Whether an event like this affects the region for the longer term depends on the resilience of the tourism industry in turning these negatives into an opportunity for building sustained tourism activities in the region. This will be analysed later.

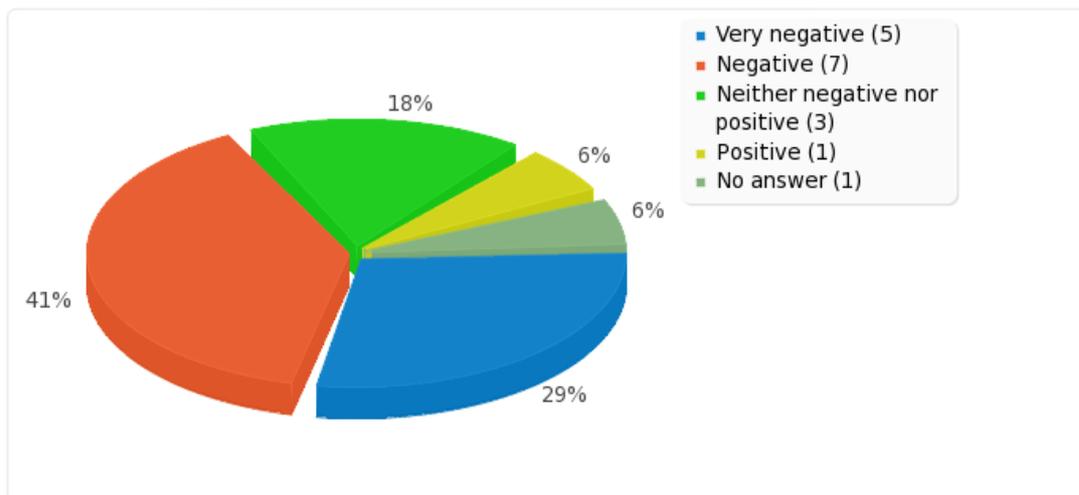


Figure 14. Overall impact of Grampians Natural Disaster on business and community organisation’s finances during the event ($n = 17$). (The number in brackets in the legend refers to the number of people in each category).

In Figure 15, 41% of organisations responding to the survey stated that the overall financial impact during the *recovery* period was very negative (6%) or negative (35%). This is much less than during the event, but still significant. The impacts were largely attributed to the loss of income through reduced tourism business activities with some participants claiming the loss in income was due to the

extensive road closures in the region during the recovery period which reduced the number of visitors to the region (*No tourists in the area for a minimum of 12 months...; Long term impact – 9 months until road reopened. Water impact continuing; Less bookings due to road closure and closing of walking tracks; Took a long time for tourists to come back, due to road closures*).

The financial costs identified in Figure 15 are tangible indirect costs and were incurred by business firms as it related to loss of income through reduced tourism activities (*'loss of income'; 'I had a noticeable decrease in income to my business'; 'impacted on the first quarter after disaster, then slowly recovered'*). In describing the economic impacts during recovery, businesses identified the greatest impact being the loss of earnings/no earnings, none or few 'sales', and loss of normal trading. Seven of the responding tourist related businesses estimated their costing as ranging between \$10,000 and \$80,000, in what they described as lost income. Some descriptions highlight the indirect costs by the following quotes:

Income down to nearly zero – minus \$10,000 at onset of event;

Cancellations and lack of bookings. Cost to business \$10,000 months until road re-opened;

Unprepared for 9 months of road closure! Insurance only covered road closure with no access;

Ongoing maintenance lost approximately \$45,000;

Insurance rates went up and up due to floods in general, even though we had none at our premises.

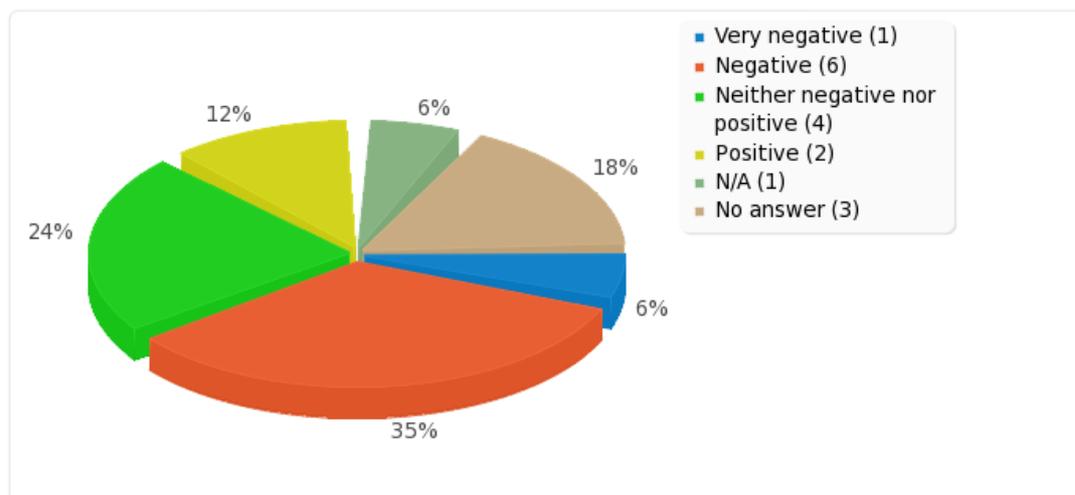


Figure 15. Overall impact of Grampians Natural Disaster on business and community organisation's finances during recovery (n = 17). (The number in brackets in the legend refers to the number of people in each category)

Reflecting on the financial concerns raised by the quotes above, the limited nature of 'like for like' insurance and the stress in accessing such funds, limits ability for resilience building. However, the one aspect of insurance that worked in favour of resilience was the new infrastructure inside the National Park. The very new park facilities, such as the re-opening of the Zumsteins picnic ground, do create a stronger and attractive park environment for visitors and locals alike. This park resilience building is juxtaposed with the more difficult environment around insurance claims and re-building facilities through the local council for businesses and the communities, as discussed in other parts of this report.

The financial direct and indirect costs to the tourism businesses in the immediate region have multiplier effects on diminishing the output in the region. This is because less local supplies are needed by the major tourist operators and less tourists travel through the region leading to lower demand for petrol sales, retail trade and other ancillary goods and services. This is the reason, in his Victorian Government review of flood warnings and responses, Comrie (2011, p.112) states that: *The Halls Gap landslips led to extended closure of the Grampians National Park which had a profound impact on local tourism.* Economic modelling using Compelling Economics consultants' REMPLAN model can provide some estimates on the extent of this 'profound impact'. Northern Grampians Shire was most affected by the event because Halls Gap is in its Shire. As a result, it's Director of Marketing and Community, Jim Nolan estimates that ten per cent of overnight stays were affected in the first year during the recovery works that were in progress. This estimate followed discussion with Northern Grampians Shire Council about the level of impact on tourism operators at Halls Gap, and based on anecdotal evidence it was determined that modelling the impact should be based on an estimate of 10 per cent of overnight stays.

Based on Grampians Tourism research data that shows year ended March 2011 had 1.8M overnight bed stays, which includes the period from the flooding on 13 January (Tourism Research Australia, 2013). Under normal conditions it is estimated that there would have been roughly 2M overnight bed stays. Ten per cent reduction for year ended March 2012 is 200 bed nights worth \$85 per bed night [based on \$83 per bed night in April 2010 (Tourism Research Australia, 2010) then adding Consumer Price Index (CPI) inflation increase of 1.025]. This results in a \$17M direct reduction in the Grampians tourism sector. Using REMPLAN modelling, two model simulations were conducted by Jim Nolan on behalf of the Northern Grampians Shire. Table 3 provides the model simulation for the overall reductions in output, employment, wages and value added throughout the Northern Grampians Shire. Table 4 conducts the same model simulation for the broader Grampians region, for which The Grampians National Park is the acknowledged focal point (Tourism Research Australia, 2010).

**Table 3. Northern Grampians Shire economic impact summary of tourism downturn
March 2011– March 2012**

Impact Summary	Direct Effect	Industrial Effect	Consumption Effect	Total Effect	Type 1 Multiplier	Type 2 Multiplier
Output (\$M)	-\$17.000	-\$4.596	-\$3.890	-\$25.486	1.270	1.499
Employment (Jobs)	-118	-18	-19	-155	1.153	1.314
Wages and Salaries (\$M)	-\$4.017	-\$1.110	-\$0.931	-\$6.058	1.276	1.508
Value-added (\$M)	-\$6.752	-\$1.835	-\$2.231	-\$10.818	1.272	1.602

Table 4. Broad Grampians Region (11 shires from Moorabool Shire west to the South Australian border) economic impact summary of tourism downturn March 2011 – March 2012

Impact Summary	Direct Effect	Industrial Effect	Consumption Effect	Total Effect	Type 1 Multiplier	Type 2 Multiplier
Output (\$M)	-\$17.000	-\$7.708	-\$5.780	-\$30.488	1.453	1.793
Employment (Jobs)	-134	-26	-25	-185	1.194	1.381
Wages and Salaries (\$M)	-\$4.387	-\$1.653	-\$1.353	-\$7.393	1.377	1.685
Value-added (\$M)	-\$7.020	-\$2.998	-\$3.102	-\$13.120	1.427	1.869

From these two modelling simulations, the total output reductions are between \$25.5M (Northern Grampians) to \$30.5M (Broad Grampians), with respectively job losses from 155 to 185, wage reductions from \$6 to \$7.4M, and value added reduction from \$10.8 to \$13.1M. With 70 per cent of all broad Grampians Region attractions existing within the Grampians National Park and the base being in Halls Gap (Tourism Research Australia, 2010), the economic impact is not only profound for tourism, but also for all parts of the Grampians economy.

Finally, noted by the respondents were intangible costs as a result of this event and its recovery phase. These identified costs are associated with non-market negative impacts on the tourist businesses that the Grampians region is very dependent on. In the survey, businesses identified such costs in terms excessive official procedures (*Bureaucracy prevails!*), confined movement (*Trapped in Halls Gap for a number of days and could not get back to my place of residence in Horsham*), and related health issues (*anxiety* and *confusion* due to landslide being an unfamiliar rare event). In fact, one of the agencies had a manager that was asked to talk to their staff and management about the 2011 event, mainly to allay their concerns that what had happened was 'not natural'. Yet this is to deny the geological past in which such landslide events occur and will increase in intensity with climate change. Denying such environmental history limits building strong resilience as identified in the literature review.

To summarise all the costs perceived to be incurred by businesses and community groups associated with the January 2011 floods and subsequent landslides, Table 5 sets out the number of organisations (out of 17 respondents) that were affected. Significant in this table is the relatively strong negative impact during the event on income compared to all other types of incurred costs, and such income costs prevailed during recovery. However, in terms of organisational resilience, it is heartening that all respondents report no negative income issues 'now'. Only three organisations continue to incur costs 'now', that is, in terms of property and contents.

Table 5. Survey results of incurred economic and financial costs by Business and Community Organisations (n = 17).

Type of incurred economic and financial costs:	During the event:	During recovery:	Now:	No costs incurred:	N/A:
Property and contents	3	4	3	7	2
Income	8	9	Nil	4	2
Savings	3	5	Nil	4	3
Ability to retain or employ new staff	5	5	Nil	4	6
Ability to retain or expand size and operations	3	5	Nil	4	5

Recovery phase outcomes

To address economic resilience, the analysis needs to extend beyond examining the costs of the flooding and landslides. Based on the risk and resilience framework (see Literature Review, Chapter 2), the recovery phase needs to build a local ecosystem that can persistently absorb change and disturbance from floods and landslides over a long time while maintaining the basic integrity of this system. There are two economic elements to this recovery phase. One is the immediate economic benefit arising from the construction work. The other is the long term economic benefits from altering the system so it is more resilient to future events of this nature.

Costs to the agencies involved in the recovery phase, created demand for jobs as well as goods and services which were concentrated in the first year after the event. Examining the immediate short term benefits can begin with Parks Victoria as the lead recovery agency on the ground within the National Park. Parks Victoria (2013) states five Parks Victoria employees took on recovery roles and were based in the Grampians. The Parks Victoria recovery program employed a total of 28 people throughout the two and half years of the recovery activity. A further three external project managers were employed, over 30 external contractors engaged and they also purchased good and services from over 100 suppliers. This extracted 'over \$7.5 million' expenditure (Parks Victoria, 2013). Together with the \$130M expenditure by all the other agencies itemised as costs to these agencies in the previous section, the total construction costs for the recovery phase amounted to around \$140M.

Using the same REPLAN modelling procedure (again conducted by Jim Nolan on behalf of the Northern Grampians Shire), the \$140M spending on construction work was inputted to calculate the positive economic impact on the Broad Grampians Region. The simplifying assumption is made that this total spending occurred in the year ending March 2012. Table 6 provides the results of this model run for the overall output, employment, wages and value added increases for this broader region. This positive economic impact counteracts the negative economic impact suffered from the 10% reduction in overnight tourism. In fact, the positive construction impact calculated is greater than the negative tourism impact over the same year and same region. Output loss of \$30.5M is ten times more than offset by recovery output of \$304M, whereas the employment, wages and value-added offset by a factor of around eight times. Two points can be made on these rough calculations. The first is that construction work is made up of labour and materials intensively sourced from the region and thus provides strong multiplier effects, as can be seen by multiplier type numbers that are more than 50 per cent larger than tourism multiplier effects. This provides strong economic resilience to the overall economy at a time when it suffered the most. The second point is that construction activity *cannot* directly offset tourism trade. From the survey it is clear that a small number of businesses particularly

in Halls Gap were able to offset potential losses by providing services (accommodation and food) to staff from organisations involved in response and recovery. However, this offset seems to have been of very limited positive impact on the primary tourism sector. From REMPLAN modelling, only a bit less than \$4M is contributed by construction to this primary tourism sector compared to the \$17M direct negative tourism impact identified for the same period in Table 4. Thus, the tourism sectors most impacted by the event were only compensated by a very small amount from the recovery economic activity.

Table 6. Broad Grampians Region (11 Shires from Moorabool Shire west to the South Australian border) economic impact summary of construction March 2011-March 2012.

Impact Summary	Direct Effect	Industrial Effect	Consumption Effect	Total Effect	Type 1 Multiplier	Type 2 Multiplier
Output (\$M)	\$140.000	\$120.276	\$43.568	\$303.844	1.859	2.170
Employment (Jobs)	245	373	189	807	2.522	3.294
Wages and Salaries (\$M)	\$19.218	\$26.315	\$10.197	\$55.730	2.369	2.900
Value-added (\$M)	\$37.707	\$45.859	\$23.385	\$106.951	2.216	2.836

Tourism in the Grampians also exhibited its own economic resilience by finding ways, at additional cost, to entice and keep tourists during the recovery phase. One operator commented on this as follows: *Additional cost incurred through providing guided walks for guests to compensate for some of the major natural attractions being inaccessible.* However, another tourism operator indicated a negative during this recovery phase: *The Halls Gap Visitors Centre was advising people to stay away. This was disclosed at a public meeting by a tourist.*

Examining the long term economic benefits from the recovery phase is crucial to see whether economic resilience has occurred through significant and positive altering of the system such that any future event is addressed more resourcefully. It is still too early to make a full evaluation of how effectively the region, and particularly the broad tourism industry, has been able to embrace the legacy of this devastation as an opportunity to make the region more economically strong. Evidence from the survey and interviews is mixed in this regard. Opportunities are being grasped as noted in these two comments by respondents: *The work done by the shire and the Recreation Reserve actually enhanced the garden. New paths, and help with a recovery project gave us a newly decorated gate; We now have trained staff, cleared property, emergency plans in place.*

David Roberts, Grampians National Park Ranger in Charge, expressed a strong resilience outcome in his final comment (using a vintage wine analogy) in the Parks Victoria (2013) report wrapping up the recovery phase:

It's not often you get to leave behind such a big legacy, however this Vintage will be remembered long into the future by the remains that are visible in the surrounding Landscape.

However, a strong vintage wine needs to be well publicised by the producing winery in order for knowledge of that vintage to be known. In respect to this *Grampians Park* vintage, a casual observation of the Parks Victoria website will not reveal any information on what the legacy of this January 2011 event has produced. In fact, the website seems to make a strong effort to ignore the event has even occurred, let alone remembering the event as a 'legacy' opportunity.

Reflections on major economic themes

From the data analysis above, three major economic themes emerge that essentially encapsulate the economic impacts of the event and provide the basis for the economic discussion and recommendations provided towards the end of this report.

Theme 1: Recovery phase

Approach to the recovery phase is crucial for addressing economic resilience. Mitigation actions (or strategies) during the recovery phase are essential as they are measures taken in advance of any future possible flooding and landslides that are aimed at decreasing or eliminating the impact of such events (Deloitte Access Economics, 2013, p. 5). It is estimated that every \$1 spent in mitigation strategies has the potential to save \$10 in future recovery costs (Deloitte Access Economics, 2013, p. 8). This is a powerful incentive to change practice and address resilience in a more economically effective manner. Parks Victoria, in all its recovery work has based their actions on this mitigation approach (DSE, 2011). This means that the Park's infrastructure is not returning to pre-disaster state, but to a new more effective level of resilience. Further, the recovery phase provided both a short term offset to tourism downturn, but also a longer term platform for the Park. This platform is dynamic in that it offers tourists a view of the legacy of such a momentous event and also the improvements that add increased interest in the Park's landscape.

Some lessons can also be learnt from the conduct of this recovery phase. Business respondents noted that community safety focus was obviously the crucial initial consideration. However, this limited any business-based focus with *minimal preparation for a specific flooding or landslip actual event, with the response post the event seemed to be modelled on the previously 'successful' bushfire recovery strategies*. Further, another business respondent was concerned when agencies were *telling us to get out of town, when we could stay and help mitigate some of the damage as soon as possible*. Yet, the generally strong positive response by businesses now (more than 2.5 years later) to how the situation currently exists, provides an indication that overall the recovery phase succeeded from an equilibrium (back to original state), but with some concerns about the dynamic resilience that has resulted.

Theme 2: Tourism industry

The negative financial and economic impact of the event on the tourism industry in the region is undeniable and significant, and the recovery phase could not offset many of these costs. Some business respondents suggested that other regions, including outlying townships in the periphery of the Grampians National Park, and towns to the west, such as Mt Gambier, may have benefitted from an increase in tourists who were avoiding the Grampians National Park when many thought (incorrectly) that the whole of the Park was closed and were instead looking for alternative tourist locations to visit. This limited the resilience of the tourism industry in the short term during the recovery phase. The very few tourism-based respondents indicating any negative economic impacts at the end of the recovery phase shows that the existing tourism industry in the region is resilient from the equilibrium perspective. This can be verified by tourism data that shows virtually no change in overnight stays and overnight visitor numbers in the Grampians for year ending September 2012 over the previous year (which included more than eight months of the event and major recovery works period). Then, for the year ending September 2013, there has been an 11% increase in overnight visitor stays, and 23 per cent increase in number of night stays (Grampians Tourism, 2013). This shows a strong rise in tourism for the period after most of the Park was restored. But, is this just a once-off bubble-effect brought on by re-opening of the Park after a period of deprivation?

For tourism in the Grampians to be dynamically resilient after the event, there needs to be a stronger commitment to altering the parameters that determined the nature of tourism prior to this event. There are some indications that this has been grasped, especially by Parks Victoria staff at Grampians National Park. However, the broader Parks Victoria organisation and the existing tourist operators are conducting their tourism marketing and sales as if the event did not happen. This is in stark contradistinction to individual tourists and residents who came together to celebrate the centenary (one year late) in the re-opening of Zumsteins picnic ground in September 2013 with acknowledgement of the past 100 years but also an exhilaration of what the reconstructed picnic grounds can offer post-disaster (Carracher, 2013).

Theme 3: Build economic resilience and minimise risk

In the context of a significant decline in the overnight domestic holiday travel industry in Australia since the early 2000s (Hooper and van Zyl, 2011), any major natural disaster to an iconic tourism site like the Grampians National Park in January 2011 creates major economic resilience issues. In a declining tourism market, the ability to regain lost market share is always a challenge. As reported above, the initial post-disaster overnight stay figures for the first full year since the Park was substantially re-opened, indicates resilience. First, there were the efforts of all the agencies in the recovery phase, and then there was the ability of the local tourism industry to rebound once the Park became fully operational again.

There are some issues in building economic resilience that arose during relief and recovery work that need to be recognised in order to minimise risk. One set of issues deal with the actual process of relief and recovery, the other is the nature and direction of this relief and recovery program and its consequences. On the actual process itself, the issues raised by respondents point to concerns on how the process can be better conducted in future events. The following comments are pertinent here:

Maintaining an awareness of implementing procedures in the face of further incidents;

Keeping tourism operators informed about the event, the consequences of the event, and what actions were being taken to remedy the drainage;

Impact on a community results in common bonds being formed between people who would otherwise be strangers to each other.

All these comments indicate the need for agencies to be very aware, informative and inclusive in their dealings with the local community (both residents and business) so that economic resilience can be built strongly and quickly following an event that threatens to destroy community and business.

On the nature and direction of the relief and recovery program there seems to be a tension between those who desire a return to what it was like prior to the event, as if the event did not occur, and those who embrace the change that this event has created. The equilibrium perspective has only a limited resilience building potential, as it attempts to 'turn back the clock' and ignore the event. Many existing tourism operators and Parks Victoria (as an organisation) tend to reflect this perspective. The dynamic perspective of resilience aims to build the disaster into a broader economic resilience, by recognising how the event changes and adds another dynamic natural ecosystem element to the ever changing ecology of the Park. The Grampians National Park staff, some residents, and managers with the Northern Grampians Shire tend to reflect this perspective. This dynamic perspective builds a stronger economic resilience by diversifying from existing businesses and community activities, by broadening what tourism represents in the region and to even bring in different business activity such as knowledge-based industries.

Environmental impacts

Key Findings

Immediately following the January 2011 rainfall event around 193 large landslides were mapped by VicRoads and Parks Victoria using high resolution aerial and satellite imagery. It is estimated that more than 200 landslides occurred causing major structural damage to private and public assets.

The 2013 Honours research project mapped and analysed a total of 176 large landslides using the same satellite imagery and aerial photography. The vast majority were on the steeper east facing scarp of the Serra-Wonderland-Mount Difficult Range and the Mount William Range, with only minor incidences on west facing slopes.

The landslides were triggered by the exceptionally heavy rainfall which fell during 12, 13 and 14 January 2011. The antecedent rainfall of the previous six months, well above the average monthly totals, was a contributing factor. Approximately 70% of the landslides were initiated in four geological units, with 25% initiated in the Silverband Formation, a geological unit mainly comprised of thinly laminated mudstone interbedded with fine-grained micaceous quartz sandstone. However, where

rainfall was in excess of 200mm, landslides occurred even in geological formations considered quite stable.

The landslides were initiated by either (a) rockfall high on the escarpment or (b) as a slide in the scree slope debris. Rockfalls were often at the head of natural gullies, creating self-propagating debris flows down the drainage lines. Slides occurred both as slumps in the scree slopes, and translational slides along the bedrock surface.

Approximately 90% of all landslides occurred on slopes greater than 22° and most were confined to the existing drainage lines. The type of movement transformed as the landslide progressed downslope, with a rockfall or slide transforming into debris flow that often behaved as a stream or Sturzstrom debris flow at the base of the slope. The flows moved very rapidly (3m/min) to extremely rapidly (5m/sec), and often the debris carried by the flows aggraded from boulders and trees to cobbles and gravel, and finally sand and mud, as it progressed downslope.

As previously stated, in terms of the built environment, the environmental impacts of the landslides have been recorded as:

- Three arterial roads - Grampians Road, Mt Victory Road and Silverband Road - were closed by landslide debris for several months (NGSC, 2011a; Parks Victoria, 2011; VicRoads, 2011; Parks Victoria, 2013). Impacts were on road pavements (in some instances parts of the road were swept away), bridge assets and drainage assets. VicRoads (2011) estimated the volume of debris to be in excess of 12,000m³, which presented a problem of debris disposal without further damaging the Park.
- Dozens of smaller roads had debris on roadways and damage to road pavements, culverts, drains and bridges (Figure 16). The more widespread floods impacted on 800 roads in the Northern Grampians Shire alone (NGSC, 2011a).
- Public and private property was damaged by large boulders, trees, debris and mud. Some houses were surrounded by debris and outbuildings, fences, gardens and fields damaged. The floods impacted on 423 properties in the Northern Grampians Shire (NGSC, 2011). At Halls Gap 50 metres of water main was washed out, affecting the urban water supply, requiring a substitute supply to be trucked in (GWMWater, 2011a). A sewerage line was also washed out in the same location. In some locations power and communication services were temporarily cut during the event. Stormwater infrastructure was overwhelmed and in some places, blocked by debris. Public parks and open spaces (and the associated infrastructure, street furniture, etc.) were damaged (Figure 17).
- Within the Grampians National Park buildings, roads, 68 walking tracks, fences, 11 vehicle bridges and 21 pedestrian bridges were damaged (Parks Victoria 2011; Parks Victoria 2013). The release of around 13,100KL of water from Lake Wartook on the MacKenzie River over the five days of the event (up to 3,500ML/d) severely impacted on visitor sites and walking track infrastructure. More than 548km of roads and tracks were rebuilt, repaired and improved, including the replacement of 2 bridges and 11 creek crossings.
- Urban and agricultural water supplies were impacted, mainly by changes to turbidity, colour, salinity, iron and manganese levels in Lake Bellfield, a water storage constructed on Fyans Creek (GWMWater, 2011b; Wallis and Graymore, 2012). The cause of the changes are complex, with the floods, landslides and antecedent bushfires all implicated. The number of towns serviced by GWMWater receiving non-drinking water rose significantly as a direct result of the January 2011 rainfall event, with 47 towns now serviced with non-drinking water (GWMWater, 2013). Regionally, the floods and landslides damaged the water supply and wastewater infrastructure by debris build-up and blockages, erosion around water pipelines and infrastructure, and channels breached by overtopping (GWMWater, 2011c). The estimated repair costs were \$2.2M.

The impacts on the natural environment were generally not documented at the time of the event, and very little information has been found on the subject. However, anecdotal reports and the photograph collections confirm that the scouring of riparian vegetation along the gullies was severe in places where fast-moving debris flows occurred (Figure 18). Cultural heritage sites were assessed after the event, including 67 indigenous sites and at least 6 European sites (Parks Victoria, 2013). Most sites had escaped significant damage.



Figure 16: Pavement and culvert damage, Silverband Road (source: VicRoads)



Figure 17: Impact on Zumsteins picnic ground (source: VicRoads)

Post event flora and fauna monitoring is continuing as academic research projects to provide information on the ability of species to recover from future events. The research includes small mammal refuge studies, and aquatic fauna (Parks Victoria, 2013).

The disruption of pest plant and animal control programs was initially flagged as a threat (DSE, 2011). Following the event, surveys of Chytrid Fungus and Cinnamon Fungus have been completed (Parks Victoria, 2013).



Figure 18: Scour and damage to the riparian environment (Source: VicRoads)

Direct impacts

Discussions with key emergency and recovery services organisations involved with assessing the direct impacts to the environment following the January 2011 events summarised these as:

- heavy rain in the catchment of Lake Bellfield;
- flooding; flooding levels were above the gauge reading at Lake Lonsdale;
- water supplies affected (i.e., Upper Fyans Creek caused erosion and silt deposits and interfered with the water systems);
- landslides and debris flow contributed to a significant deterioration in water quality at Lake Bellfield.

This led to the water in Lake Bellfield being unsuitable for drinking, and thus, those who rely on this as their water supply were no longer able to drink this water (Wallis and Graymore, 2012). The sediment load from these floods contributed to a large increase in turbidity, colour, iron and manganese concentrations, all of which well exceeded Australian Drinking Water Guidelines (ADWG) and caused the lake to look noticeably 'muddy' (see Figure 19). Over the last 2.5 years the water quality has improved; however, turbidity, colour and iron concentrations still exceed ADWG (see Table 7). Since the January 2011 event, GWMWater have investigated different treatment types including mixing with other water sources, different coagulates and other treatment options to improve the water quality to drinking water standards. Still, when this report was written, residents in the Wimmera region are not able to drink the water supplied to them from Lake Bellfield.



Figure 19. Change in Lake Bellfield turbidity - pre-flood (on left) and post-flood (on right) (Source: Briggs, 2011)

Table 7. Water quality data (average across the depth of the lake) for Lake Bellfield at offtake between January 2011 and July 2013 (Source: GWMWater)

Date	Turbidity (NTU)	Colour (HU)	Iron (mg/L)	Manganese (mg/L)
AWDG	<5	<15	0.3	0.1
5/01/11	2	50	0.5	0.018
25/01/11	168	106	5.62	0.068
15/03/11	235	129	3.91	0.186
20/05/11*	86	138	1.94	0.100
17/06/11	81	123	2.24	0.048
20/01/12	38	90	2.06	0.024
07/06/12	22	87	1.61	0.018
25/07/13	9.5	62	1.05	0.014

*The lake turned over and mixed just before this sampling resulting in the change in water quality observed.

Some of the strongest insights about the impacts to the environment however come directly from those living and working within the Grampians National Park. Between 65% and 75% of all survey respondents from residents and individuals who had observed changes in the environment during the event, in recovery and now. In commenting about these changes, participants demonstrated that they were informed and showed a distinct passion of the local environment and thus, they had observed many changes in it, since January 2011 including:

- Alteration to the physical terrain within Grampians National Park:
 - extensive landslides and damage; visible scarring of the mountains from the landslides ('very obtrusive on Mt Abrupt');
 - mountain ranges have changed shape – they are lower and more eroded; ripped gullies;
 - altered waterways throughout the Grampians National Park with rivers washed away; changes to waterflow; and creek beds relocated.
- Changes to the flora including large destruction to flora; trees felled or died due to trauma; loss of understory natural flora; invasion of weeds; lack of river bank ferns.

A fifth of all survey respondents commented on improvements to the Grampians National Park's infrastructure, especially to walking tracks, since the events of 2011. Some attributed this to the high standards and 'excellent rebuilding' provided by Parks Victoria and Council. Others commented on changes to the environment that have now contributed to other, positive environmental outcomes, including 'stronger lakes and stronger flora growth'; regrowth of bush and 'beautiful' lookouts.

In identifying how the environmental changes had impacted on individuals/residents and their families, some reported that it had caused them 'stress' and that it was upsetting to see the damage to the environment across the region. Others indicated that they were impacted by the track and road closures which had limited their access to the Grampians National Park. When asked to identify and estimate the costs incurred by changes to the physical environment during the Grampians Natural

Disaster by individuals/residents, three respondents indicated that it had cost them 'days of wages' and 'lost income'.

Businesses and community organisations were asked whether changes to the physical or natural environment following the Grampians natural disaster event had impacted on their business/organisation at the time, during recovery and now. They indicated that the greatest impact of changes to the physical and natural environmental on businesses and organisations occurred at the time of the event and in recovery – a small number of residents indicated that the impact is ongoing. For a small number of participants, the overall impacts related to the loss of income, modifications to programs and locations for business operations. Another participant commented that as a result of the rubble being cleared from a culvert, the direction of the water had caused erosion and new environmental impacts. When asked to identify and estimate the costs incurred by businesses and community organisations as a consequent of changes to the physical environment, only three respondents provided costings that ranged between \$3,000 and \$10,000 and related to repair work to a car park and a loss of \$10,000 in income.

Ongoing long term impacts

When asked to estimate the longer-term costs associated with the changes to the physical environment during recovery from the event, four businesses and community organisations responded. Two commented on the loss of income (one estimated the direct costs to be \$30,000), another commented on the loss of tourism associated with the extensive road repairs (*roads taking far too long to open*) and another commented on the repairs to landslide sites (*the low side of landslide sites – unsafe due to inappropriate works*). When individuals/residents were asked to identify and estimate the costs incurred by changes to the physical environment during recovery after the natural disaster most indicated that there were no costs - only minimal inconvenience (although one business owner and resident indicated that it was many months after the disaster event before tourist activities and events were organised - no costs however were offered).

Five business and community organisations commented on costs incurred to the physical environment at the present time. One respondent indicated that the financial costs were still ongoing (*ongoing extra wages*). Others indicated that business is returning (*returning to normal; income has returned to business*). Individuals and residents indicated that there were now no costs incurred by the changes in physical environment. For details on the impact of these costs on residents and businesses, see prior section.

When asked whether the physical and natural environment impacts on individuals/residents and business and community organisations had been resolved, the majority of respondents (>70%) indicated that it had. For businesses and community organisations, the resolution of the environmental impacts had occurred with the reopening of the Grampians National Park and the completion of road repairs (road reopening between Dunkeld and Halls Gap). Similarly, individuals and residents acknowledged that 'resolution' had occurred with the reopening of roads and of the Grampians National Park – and with public accessibility of walking tracks.

For businesses and organisations where resolution had not occurred, the reasons given were longer-term investigations or insufficient investigation on specific matters and where parts of the Grampians National Park were yet to reopen to the public.

The impact on the biophysical environment has not yet been well recorded or studied. One of the aspects that have been poorly addressed is what impact the landslides have had on further destabilising the upper cliffs and scree slopes of the Grampians Ranges. Some rapid assessments have been completed for emergency response (DSE, 2011), emergency planning controls (GHD & ASMG, 2011), and road restoration (GHD, 2011), but these have tended to address small areas for a specific purpose. The question of whether the January 2011 landslide event has increased or decreased the likelihood of landslide events does not seem to have been examined.

Resilience and recovery from the Grampians Natural Disaster: Considerations for future planning

Recovery from the Grampians Natural Disaster remains ongoing, with some infrastructure repairs and future flooding and landslide preventative measures still to be completed (at the time of data collection, in the second half of 2013). As organisations wind down and/or finalise their recovery activities, staff from emergency services and infrastructure organisations have reflected on the learnings from this disaster and have developed and implemented new protocols, plans and procedures within their workplace to better respond to future natural disaster events. These include:

- Critical reflection and improvement of procedures and policies;
- Improved agency-community communication and interaction;
- Improved inter-agency communication and coordination;
- A collaborative recovery process;
- Recognising the need for closure and a clear way forward for those affected by the disaster;
- The importance of building resilient communities.

These are outlined below and represent the steps being undertaken to build their organisations' and community's resilience for future disaster responses.

Critical reflection and improvement of procedures and policies

Since the 2011 event, many organisations have individually and collectively reflected on the emergency response and recovery procedures and policies to improve on them for future events. Some examples from the interviews include:

- One organisation documented their role in the recovery from the 2006 bushfires, including a list of work they undertook and how it involved all staff. The organisational 'process' provided support when the fires started and into recovery. Key learning for sustainability such as staff roles and duties; staffing stress; the need to consider a wide range of issues relating to the complexities of disaster for victims.
- Staff rotations: balancing overtime and special consideration for staff that reside in the area; a different work model, which includes a 'separate project team; a mix of contractors and organisational staff for recovery;
- Moving 'regular [known to locals] workers' into local zones and backfilling jobs – not bringing outside workers into the disaster zone;
- Another organisation had established an internal crisis management staffing manual that outlines who does what within the organisation, to be implemented for future disasters.

Improved agency-community communication and interaction

Representatives from some emergency services and infrastructure organisations reflected on their communication strategies with the community at the time of the response and in recovery. Some agencies had implemented strategies used with other natural disaster events that were successful. Other organisations had implemented new plans and strategies to assist with future natural disasters and to respond to the recovery needs of the community, including through revised communication protocols. This is exemplified with public meetings to inform the community about the recovery processes, invitations to the community to attend openings of new infrastructure (such as the opening of roads), and the celebration of key outcomes and milestones associated with the recovery efforts - targeted specifically at locals and not tourists. For instance, the Northern Grampians Shire Council organised an 'end of the floods' weekend in October 2011 which was held as a community event with BBQ, live music, etc. Over 300 people attended this event.

Despite the efforts of emergency services and infrastructure organisations, some of the comments made by residents and businesses in the survey suggest that the public communication was sometimes limited in scope and intention as highlighted by the following comments:

(Prefer to have) community consultation rather than lectures;

No notice from locals, Shire on water flow, inundation-erosion issues. No consultation Shire Engineers;

Information flow was strong however perhaps a greater willingness to listen to community opinion in relation to the scheduling, prioritising of repair work would have served the business community better;

Over the years developments have been allowed that didn't recognise natural watercourses.

Improved inter-agency coordination and communication

Some agencies reported that as a direct result of the 2011 emergency they had improved their protocols and procedures for emergency responses for the future: *How we would respond in a future event would be quite different...rather than responding as an autonomous organisation we would confine ourselves to acting within the emergency management centre response.*

Some organisations discussed impacts regarding agency roles and that in future they would ensure that clearer levels of communication are received:

For future events, (our) staff would rely on information from only one source (the SES).

Once initial information gathering had occurred we would step back and let the other emergency services take over.

Recovery process

During the recovery process, it was decided by a number of the emergency services and infrastructure organisations that there was a need to change the approach to repairs to reduce the impact of future natural disasters in the region. For example for Parks Victoria, who were faced with extensive repairs for the third time in recent years (following the 2006 and 2009 fires), decided to improve the infrastructure to increase its resilience. Although this took time to achieve it has increased resilience for future events and resulted in optimism and strengthened relationships with community members. This approach is also evident in repairs carried out by the Northern Grampians Shire, VicRoads and GWMWater. These efforts have been noticed by the community, as demonstrated by the following quotes:

Wonderful to see how well Parks Vic and the Shire have done the recovery work (public land);

The restoration works to roads, bridges, embankments and many other structural areas has been first class and took a long time to materialise and this is understandable. Hopefully Hall's Gap and environs is in a better place now to withstand a similar event;

The work done by the Shire and Recreation Reserve actually enhanced the garden;

With massive input from Vic Roads and National Parks to get damage fixed and reopen to the public.

Recognising the need for 'closure' and a clear way forward

Some participants spoke of the need for an end point to the recovery phase and an opportunity to 'move on' from events of January 2011. For others, this already appears to have occurred. One resident for example declined to participate in this research as he/she felt that the community had 'moved on' (*We've moved on – what will this research contribute?*). On two occasions, business owners/residents in the region commented that the floods and landslides event in 2011 was less prominent in some people's minds now that they have had to focus their attention on other threats from natural disaster, specifically bushfires.

The Importance of Building Resilient Communities

Some participants, including those from the emergency and recovery services organisations, as well as members of the community, commented on the importance of individual resilience – and of the need to build community-wide resilience. Some suggested that the natural disaster in the Grampians region in 2011 actually enhanced people's levels of 'individual' resilience (*People knew what to expect*

and how they would feel based upon previous experiences and they knew what help they needed and where to find help).

This is also evidenced by 41% of individuals/residents who responded to the survey feeling that they were more able to cope with a future disaster suggesting their resilience had increased due to their experience with this event. Also one participant reported that in Halls Gap fewer members of the community had moved away from the region after the events of 2011 in comparison to previous natural disasters in the area. Furthermore, it was suggested that the community's past experience with natural disaster may have strengthened their individual resilience to respond and cope with the floods and landslides of 2011 and in doing so they were committed to remaining in the area.

Although it appears that the community is resilient to natural disasters to some extent, the need to continue to strengthen the community's 'collective' resilience for future disasters was mentioned as an area requiring greater attention. There was a sense from talking with those from emergency and recovery services organisations and those who worked closely with the community during the 2011 events that resilience is essential but actions for implementing this, for future disasters, have not yet been fully achieved:

It's all about making the community more resilient;

We need to establish a resilient tourism business that is prepared and can respond to a crisis and any event.

When asked to identify how communities – collectively – could become better prepared for a natural disaster in the future a range of suggestions were provided from individuals/residents, business and community organisations. These included suggestions for communities to strengthen their leadership and responsibility during natural disasters. The majority of responses fell within one of three broad themes as highlighted below (and accompanied by participant quotes):

- Community leadership, community ownership, and community responsibility before, during and after the event:

We need somebody in the township to assume immediate command once an event occurs;

The community needs to take responsibility in understanding and planning for these events;

The linkages exist it's the inclination for the community to utilise them;

Community ownership of the local risks. Community resilience.

- Communication:

Public briefings for disaster planning (similar to the yearly meetings organised for bushfire preparedness);

Communication via email alerts;

Improve community understanding about which areas are at a higher risk for similar events;

Register of 'vulnerable residents' (for Police and SES); a current database of 'whole of community' to ensure transient population members are recorded;

Less reliance on radio as one method of communication;

Ensuring accuracy of information provided by all emergency services and infrastructure organisations.

- Collaboration between community and agencies in planning, preparation, response and recovery:

Help communities to be more prepared so that businesses and individuals can have their own plans and be aware of risks and options available to respond appropriately;

For everyone to have a plan like we do for fire;

Maintaining an awareness of procedures to implement in the face of future incidents;

Volunteers and local people worked well together. Regular community meetings, Shire Engineer told us flood overlay. Meetings with engineers took local information on flood levels;

Immediately set up disaster committee ... and community convened and administered by Shire Officer and driven by Senior CFA, Park, SES and Tourism Association;

VicRoads provided the community with first-hand knowledge/experience via bus trip to landslide areas. Highlighted the extent of damage to the areas and enabled the community to examine the extent of damage and took the pressure off organisations to repair damage within unrealistic timeframes.

Discussion and Recommendations

Overview

The focus of this study has been to understand the social, economic and environmental impacts on the community (residents; business and community organisations) and the emergency and recovery services organisations during and since the Grampians Natural Disaster in January 2011. Insights about the extent of this disaster and the damage incurred from the floods and landslides have been documented to some degree in the reports prepared by key organisations instrumental in the response and recovery of this event (see for example: Northern Grampians Shire Council: Municipal Recovery Action Plan and associated documents prepared for the landslides since 2011). However, unlike many of these documents, this study has sought to capture insights from members of the community and emergency and recovery services organisations about their perceptions of the event: their preparedness, the impacts it had (social, economic and environmental) and the service response and recovery following this natural disaster event.

This report provides new understandings about the impact the landslides had on the environment, as well as the social and economic impacts on the affected communities in the Grampians region. Up until now, the impact of landslides on the community – and the emergency response to this – has not, at least in the Australian context been well documented, with little information on the impacts beyond deaths, injuries and property damage (Leiba, 2013). In addition to providing further insights into the social and economic impacts of this event this report also provides a review of the emergency response and recovery from the workforce perspective provided by staff in these organisations who were involved in the response and recovery. Perceptions from the community about the service response have also been included.

This section of the report discusses the key findings and what these mean for:

- Emergency response and recovery from landslides and natural disasters in the Grampians now and in the future;
- Social and economic and environmental costs to the region of the landslides and the natural disaster event;
- Recovery processes still required;
- Building resilience in the Grampians communities.

Recommendations on how to reduce the impacts of future natural disasters, such as this event, are provided including areas that will improve preparedness, community resilience, response and recovery for natural disaster in the region for the future.

Emergency response and recovery to landslides and natural disasters in the Grampians now and in the future

Overall, the response and recovery services were seen to be adequate by the residents, businesses, community organisations and emergency and recovery and infrastructure organisations. For example some in the community found the response swift and helpful with particular agencies forming a strong part of their positive response. However, others did not feel the response was adequate suggesting that the services were caught off-guard by the unexpected magnitude of the events. These participants felt confused by the services provided and frustrated at the length of time for rebuilding in recovery stage (i.e. roads and tourist access). Although some of this frustration is most likely due to a lack of understanding of the extent of the impact the landslides had on roads and other infrastructure in the Park.

Most of the emergency and recovery organisations felt they were well prepared, however, the landslides caught everyone 'off guard', particularly the breadth and magnitude of this disaster. This meant that nearly half of the residents, business and community organisations were not prepared for such an unexpected event. Having 'survived' this event has had a positive impact on how people feel about future events, with many saying they felt this event had a positive impact on their ability to cope with future disasters. This will be discussed further below. Thus, the nature of this event, floods

followed by landslides, over a wide area, meant that there were a number of challenges for emergency response and recovery organisations. Floods were the primary focus in response, with emergency workers primary focus on ensuring community safety, while the landslides were secondary as the impacts of landslides on the health and safety of the wider community was more removed (except for those property owners where the landslide encroached on their land).

The challenges for emergency response and recovery organisations as identified in this research include:

- lack of clear roles for each agency;
- lack of real time weather information or good flood warning systems;
- provision of accurate information to community;
- loss in (some) interagency communication;
- workforce issues including under staffing issues due to the time of year the event occurred and lack of training or knowledge of natural disaster management;
- the sheer breadth and magnitude of the event;
- unrealistic community expectations.

Some of these challenges appear to have contributed to a heightened level of angst in the community towards the emergency and recovery organisations. One particular issue uncovered in this research, was the fact the community did not fully understand the magnitude of the impact the landslides and the extensive damage it had on local infrastructure, particularly roads. However, the emergency and recovery organisations staff rectified this issue by taking community members on a bus trip to show them the extent of the damage. This will have contributed to increased knowledge in the community about the impact landslides can have on the Grampians region.

However, some of these challenges may have been caused, in part, the lack of reference to landslides in the Emergency Management Manual Victoria. This meant that there was little guidance as to which emergency response organisation should be the control organisation in the event of a landslide. This in combination with a lack of training and awareness about landslides within emergency response organisations may have contributed to the lack of clear roles for these organisations during the response to the 2011 event.

In fact one of the positives to come from this disaster was the lessons learnt about how to prepare for and deal with future disasters. Most staff from the emergency services and recovery organisations indicated that their involvement and experience during the floods and landslides of 2011 has greatly added to their knowledge for future disaster events and as one participant commented: *We learnt what we could do better next time*. Further, the present research has identified a range of factors – comprising both from the experiences of the community and the emergency and recovery services staff – that will increase the preparedness and response to natural disaster by the community and emergency and recovery services organisations in the future as summarised in the Figure 20. Importantly it must be noted that many of these ‘lessons’ have been, or are currently being addressed, by many of the organisations interviewed. Each has made considerable effort to learn from this event and to better develop preparations for and responses to future natural disasters.

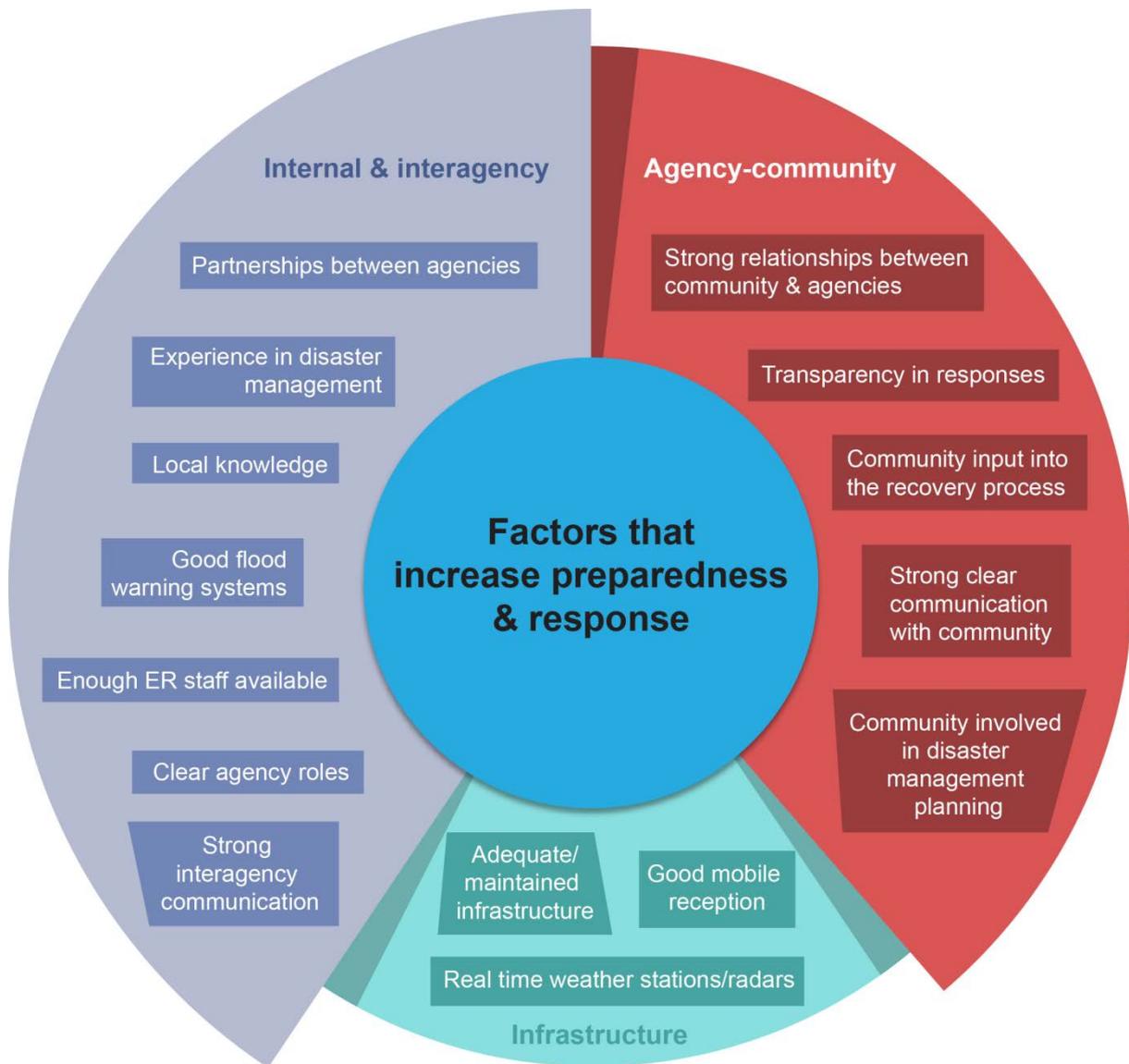


Figure 20: The factors identified that increase preparedness and response (Note. ER = infrastructure and emergency response organisations' staff).

As shown above, the factors that will increase the preparedness and response to natural disaster by the community and emergency and recovery services organisations in the future include internal and interagency responses and relationships, agency-community relationships and interactions and adequate and well-maintained infrastructure. Some of these factors were noted as strengths by some agencies, including the contribution of past experience with disaster management, having local knowledge, and examples of good interagency communication and coordination. Other factors identified include increasing strong relationships between community and agencies, community input into the planning and recovery process, including the development of individual emergency plans for residents and businesses. These factors align with those identified by others in the literature on emergency management, such as Comrie (2011), *National Strategy for Disaster Resilience* (2012), Cutter et al. (2008) and Ainuddein and Routray (2012) (see Literature Review Chapter 1).

Another important finding of this study is that emergency and recovery services staff were heavily impacted by their involvement in the response to this event. Many talked about their own and others experience of fatigue, burn out, frustration and fear for self or family particularly during the response to this event. Other staff raised concerns about occupational health and safety issues that may have been caused by both fatigue and lack of adequate equipment. In addition they identified a number of factors that caused these issues (see Figure 21). These factors have the potential to impact on the health and wellbeing of emergency and recovery staff. Consequently, knowing what these factors are

can help emergency and response organisations to review and/or redefine their staffing policies, and other related disaster management policies, to reduce the impact of these factors when responding to future natural disasters.

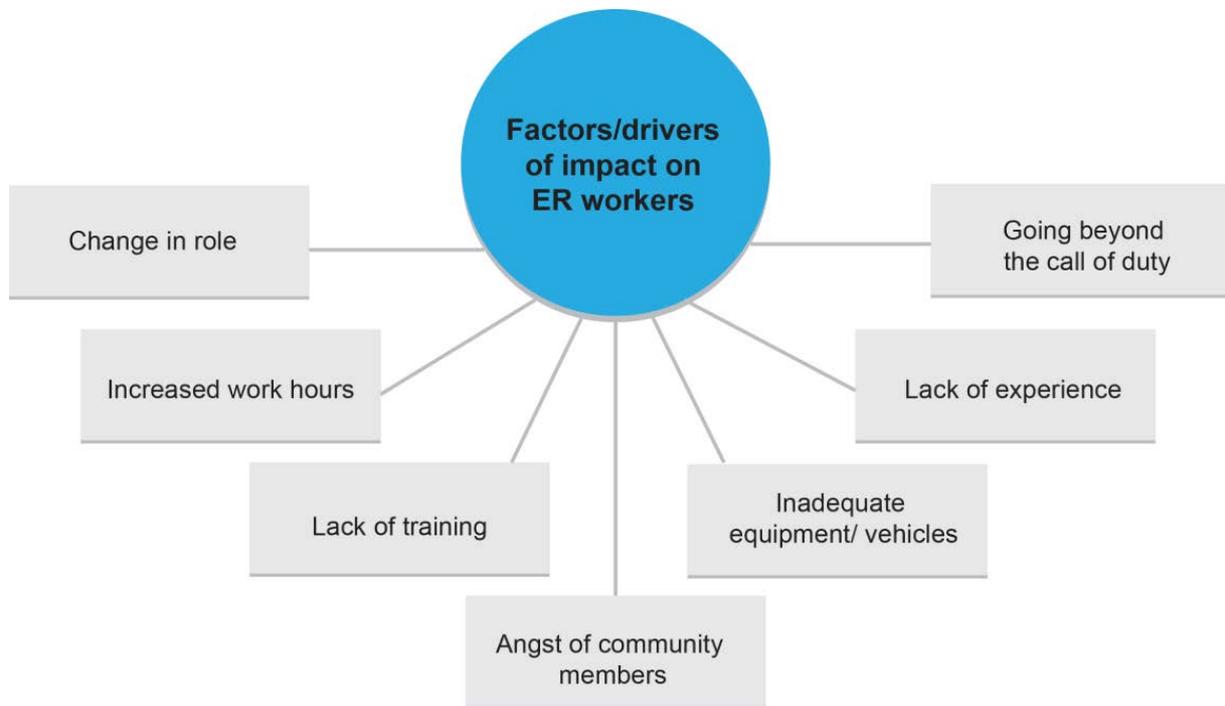


Figure 21: The factors that have the potential to impact on the health and wellbeing of emergency and recovery staff (Note. ER = infrastructure and emergency response organisations' staff)

Although most agencies indicated that they could not have prepared any better for the events of January 2011 given the scale of the disaster many organisations have, importantly, reviewed their response to this major natural disaster and drawn widely from their learnings. For many organisations, the events of January 2011 provided the impetus, and knowledge, to develop and/or update a range of documents (ranging in scope from organisational resources and measures, policies and procedures, audits and studies) or implement new systems for future prevention, preparedness and response to natural disaster events. These initiatives were identified by many of the participating agencies as being vitally important so that learnings from this major natural disaster event are not lost. Examples of these initiatives include:

- The development of local flood guides; the provision of technical advice about what would trigger another flood event (SES);
- Installation of new telemetry measures and rain gauges to improve flood warnings for the Halls Gap region;
- Northern Grampians Shire Council have developed various documents pertaining to landslides (see for example the Halls Gap Landslide Interim Guidelines; Landslide Susceptibility Policy and Map). Northern Grampians Shire Council also reported undertaking a further three projects to inform planning for future disasters including a project to improve warning systems for landslides, increasing preparedness and contingency planning for landslides. The second project is an erosion-mapping overlay as a planning tool and the final study involves an assessment of the feasibility of raising houses to reduce the impact of future disasters such as flooding in Glenorchy;
- Tourism Victoria has recently developed a Crisis Essentials booklet to assist tourism businesses with crisis management (http://www.tourism.vic.gov.au/images/stories/Documents/IndustryResources/crisis_essentials.pdf);
- DEPI are currently preparing a Flood Zone repository for flood mapping and identification of potential damage from floods and heavy rains. This will be a comprehensive resource;

- A range of research projects investigating different aspects of the 2011 event is currently underway or has recently been completed (i.e., Lake Bellfield water quality see Wallis and Graymore, 2012).

In response to these research findings the following recommendations are presented to help maintain and enhance future response to emergency and recovery for the region. Some of these recommendations echo those of Comrie (2011) providing further weight for the need to take up these recommendations, and those of Comrie, to reduce impacts of future natural disasters and to help build resilience into our communities and infrastructure.

Recommendations

Recommendation 1: Emergency and recovery services organisations review their plans and procedures (including the Emergency Management Manual Victoria) for future natural disasters, and finalise draft plans, using the findings of this study, in particular, to maintain and enhance activities that worked well and review activities that did not.

Recommendation 2: Emergency and recovery services organisations regularly conduct reviews with all staff about the plans and procedures for responding to ‘major’ natural disasters.

Recommendation 3: Emergency and recovery services organisations consider developing a work plan for staff outlining disaster management responses. The plan should include considerations for:

- Staffing roles during a natural disaster including staff rotations and staff overtime.
- Staff residing in the area of the disaster;
- Supporting staff wellbeing during times of high stress (This may include additional provisions for counselling, debriefing and psychological support etc.);
- Ensuring occupational health and safety during an emergency.

Recommendation 4: That staff from emergency and recovery services organisations nominated to roles within their organisation’s disaster management team are provided with appropriate disaster management training, including landslide mitigation, response and recovery.

Recommendation 5: Emergency and recovery services organisations continue to build and strengthen their interagency partnerships to complement their response for major natural disasters for the future. This could include regular meetings and exchange of information including staff information (contact details; role), organisational protocols and procedures during a natural disaster.

Recommendation 6: That each emergency and recovery service organisation reviews protocols for ‘communication’ during a natural disaster and in recovery. This should include a review of protocols for communication with other key agencies at key time points before, during and after a natural disaster.

Recommendation 7: Emergency and recovery services organisations should ensure their communication plans for future disasters include steps for clear and timely information that is disseminated to the community via a range of media including social media, radio, public meetings, etc. This could include developing a list of key community contacts to help distribute information; spatial mapping technologies (with limited public access) could be of valuable. The communication plan should outline steps to ensure angst in the community is reduced by strengthening relationships between community and agencies before and during events, such as small group or one-on-one conversations about people’s experiences with the disaster and empowering community to provide local knowledge and feedback on how the recovery process should proceed.

Recommendation 8: In conjunction with key emergency and recovery agencies, that external funding is sought to (a) develop better predictive models for disaster in the Grampians region and (b) continue to establish better weather and flood warning systems for the Grampians region.

Recommendation 9: Infrastructure organisations (particularly local Councils) increase the involvement of key members of the community in the preparation and planning for future disasters. This should include the involvement of community members and community leaders from key areas in the Grampians (particularly Halls Gap) in planning for a whole-of-community response for future natural disaster events (see below, community resilience).

Recommendation 10: Councils in partnership with other agencies develop a register of vulnerable people located in high risk areas for future disasters to enable them to quickly identify people and places most likely to be affected by future landslides or other disasters and enable a quick response to help those most vulnerable. Spatial mapping of this information (not for public access) may be valuable.

Social and economic and environmental costs to the region of the landslide event

Social

The Grampians natural disaster in 2011 appeared to have a variable social impact on both staff from emergency and recovery services organisations, and on the community. The social impacts for emergency and recovery staff included fatigue, frustration, fear for self and family, stress, anxiety, some of which was also attributed to being assigned new roles and duties within their organisations in response to the disaster.

The main social impacts for residents, business and community organisations are outlined in Figure 22. Although the social impacts identified by residents were largely minimal there were some residents who felt a threat to themselves, their family or friends at the time of the disaster; others reported the loss of property, land, fencing, outbuildings and possessions; and some reported extended travel times and costs due to road blockages. There were also reports of elevated mental health issues related to anxiety, loss of wages, damage to property and possession, and also some impacts from the environmental damage and loss with the Grampians National Park.

Many community participants indicated that they had not been sufficiently prepared for the events of January 2011. Although some preparation for natural disasters had occurred (and in some cases were closely linked to bush fire plans) a number of participants had indicated that the magnitude and impact of this major natural disaster had meant that they were not fully prepared.

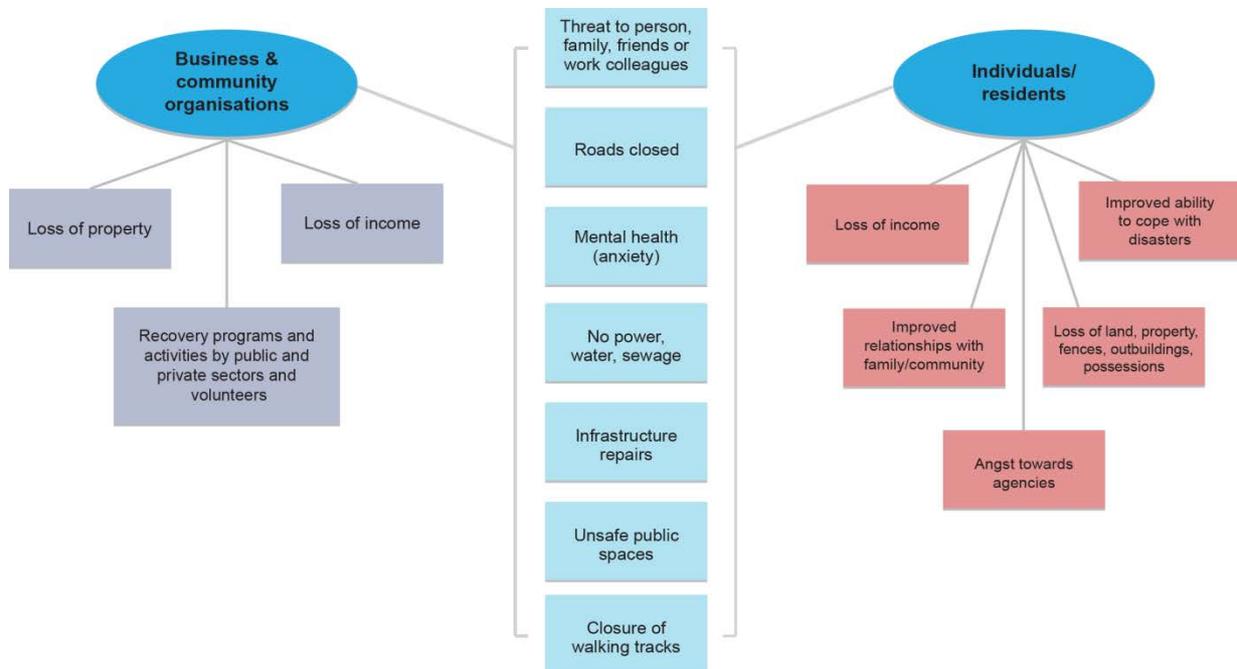


Figure 22: The main social and economic impacts of the 2011 Grampians natural disaster

However, the limited number of surveys completed and the time since the disaster (three years) may mean that the social impacts identified here are not the full extent of what occurred. Time makes it hard for people to fully recall negative experiences, and thus there may have been some underreporting or we may have missed those who were most heavily impacted by the event who may

have moved away from the region. So the results have to be used only as indication of the level of social impact rather than a definitive list of the social impacts felt by this community.

As mentioned above, mental health appears to be an issue for some community members and emergency workers with some respondents indicating elevated stress and anxiety related to the broader natural disaster events. This was supported by insights from staff at non-government agencies observing greater numbers of clients seeking psychological support. This finding is consistent with the literature that natural disaster can impact on mental health, including post-traumatic stress disorder, increased domestic violence, suicide (Gordon, 2013; Hazeleger, 2013), depression, anger, helplessness and a sense of a lack of control (Proudly, 2013; Lindell and Prater, 2003). Further, these mental health issues may persist long after the event and recovery-periods have officially concluded (Lindell and Prater, 2003).

There were also some positive social impacts from this event, with people reporting that the disaster had a positive impact on their ability to cope with future disasters and on their relationships with friends, family and community. These findings are consistent with those in the literature. Research suggests that those that have lived through a natural disaster can change people's risk perception, and increase hazard intrusiveness (i.e. the disaster is in thoughts and discussions regularly) which can lead people to adopt measures at home to reduce their vulnerability to future disasters (Lindell and Prater, 2003). In terms of indications of resilience in the community, respondents stated that the support of friends, family and family and community being was important during the event, suggested that at least the respondents were well connected and supported by others in the community. Further, people helping each other out during the recovery phase of the a disaster is common (e.g. Tierney et al., 2001; Mileti et al., 1975; Drabek,1986; Siegel et al., 1999; Lindell and Prater, 2003; Eyre, 2004). This is attributed to the notion that helping empowers people and may reduce feelings of being a 'victim' and can facilitate recovery from the event (Eyre, 2004).

Recommendation 11: Affected communities continue to prepare and plan for all natural disasters, including major natural disasters, to reduce their vulnerability to future disasters. Preparation should include public education programs about all natural disasters including landslides, development of individual emergency plans for residents and business owners similar to, but not confined to bushfire plans. This will need the support of emergency and recovery organisations.

Recommendation 12: To support local businesses within the Grampians region to undertake greater planning for major natural disasters to better protect local business and ensure the safety of staff and customers during future natural disasters.

Recommendation 13: Tourism and business associations to work together to promote the region and encourage visitors in the recovery phase of future disasters once the area (or parts of the area) is safe for visitors, to reduce the impact of reduced visitor numbers on businesses.

Economic

The Grampians natural disaster in 2011 appeared to have a significant economic impact on both emergency and recovery services agencies, and on business and community organisations. The economic impacts for emergency and recovery agencies were related to the expenditure on physical resources in the form of emergency repairs and reconstruction to infrastructure. This expenditure had both a negative and positive impact. On the negative side most of this expenditure was public funds that needed to be sourced (or financed) in an economic period of public budget austerity policies. Such funds, if met under operational budgets would place greater pressure on relevant agencies. Where funds were obtained through special funding, there was the complex process of negotiating special finance arrangements across three levels of government. Finally, there was also insurance-based financing, which required much bureaucratic manoeuvring. This is because there is no provision for landslides under the current insurance system. On the positive side, from the construction-based work, emerged employment and supply needs that led to strong multiplier effects on output in the region, while innovative tourism and community volunteer activities provided a broadening of the economic base for the Grampians after the recovery programs ended.

The main economic impacts for residents, business and community organisations are outlined from the centre to the left side of Figure 22. After the significant negative impacts in loss of property and

income during relief and recovery, all respondents reported no negative income issues 'now'. This indicates resilience in recovery to prior status due to the strong recovery programs by public agencies with their construction work, businesses developing alternative tourism activities, and individuals volunteering in relief and recovery activities. However, intangible costs were reported by businesses in terms of bureaucracy, confined movement and anxiety related health issues, which indicate non-market resilience problems (see centre green column in Figure 22).

All respondents observed environmental changes following the landslides, like modifications to terrain, altered flora and waterways. For businesses this affected tourism and subsequent income for individuals and residents, as access to the Park was initially reduced and then altered, leading to disappointment from tourists and operators over the changes and their relation to the existing physical structures. This reflects the inevitable equilibrium perspective to resilience by existing stakeholders accustomed to the Park as it was prior to the disaster. From this perspective, these stakeholders see only the current disruptions and consequent costs and value such losses very highly. Thus, ongoing costs to the events of 2011 in terms of financial debt and inconvenience were emphasised. The positives from this perspective were seen as the Park and its roads were progressively opened, and as the public were able to access the Park. These stakeholders recognise resilience as recovering the Park to pre-disaster state, yet some features of the Park will probably never recover. This perspective is described in the literature as a risk reduction form of resilience and is associated by studies such as Kjekstad and Highland (2009) in general, Osuchowski and Roberts (2011) in specific context of the Wollongong region landslides, and the Bureau of Transport Economics (2001) for measuring costs of Australian natural disasters.

There is, however, a recognition by some participants in the study of the dynamic resilience perspective as championed by ecologist Holling (1973) and analysed from a regional economic approach by Simmie and Martin (2010). Some stakeholders that are very close to the environmental impacts of such disasters as these landslides, like the Parks Victoria staff at the Grampians Park and Northern Grampians Shire, see the need to embrace the devastation as an opportunity to make the region more resilient to future shocks. This requires changing the parameters operating on a daily basis in the Park. To this effect, some respondents and interviewees commented positively on the improvements to the Park's infrastructure since the landslides in January 2011 and some alternative tourist activities developed by a few tourist operators. Other respondents also recognised the role that construction work played in creating employment and building skills that were different to tourist-related employment.

In the previous section of this report, the economic impacts were identified, first by economic losses that were significantly of concern to all stakeholders. Economic costs were calculated through modelling the negative multiplier impacts on the tourist industry, but eventually, such costs dissipated as the Park resumed its prior state with all roads opening and facilities re-established. From this modelling, the total output reductions are between \$25.5M (Northern Grampians) to \$30.5M (Broad Grampians), with respectively job losses from 155 to 185. The costs were generated essentially from the loss of tourism demand, but with a strong rebound with a 23 per cent increase in number of night stays for the year ending September 2013. This shows effective short term equilibrium resilience for tourism to be able to bounce back as tourists were keen to see an area foregone over the past year or more.

Then, the positive economic effects of building dynamic resilience were examined. First in the \$140M spending on construction work which was a financial issue for funding purposes, but the output benefits from this work was modelled to multiply out to \$304M, far outweighing the tourism losses calculated by ten times. What is a concern is that this output increase had a very small (\$4M) multiplier impact on the primary tourism sector of accommodation and food, compared to the \$17M direct negative impact on this sector. The construction benefits are spread more widely, and thus less observed and recognised directly by the immediate stakeholders. The second point to note is that these recovery construction works are a once-off shot to the system and completely dissipate at the end of the recovery phase. Capacity to take advantage of such construction works and have built infrastructure and innovative activities that establish long term benefits makes for a more economically dynamic region into the future and thus helping the region be better placed to handle any future disasters. It is too early to give a definitive response to this aspect of building resilience, but there is

strong commitment to such action by both the Park staff and the major local council covering the Park. The problem is that most of the stakeholders further way from the Park or linked to established tourist businesses, are less aware or appreciative of the long term dynamic resilience aspects.

The remaining issue relates to the whole process of costing landslides and its specific use in the Grampians for this event. As noted in the literature review, the post-emergency focus in costing devalues the impact of landslides which are initially relatively low in impact, but build cumulatively as multiple linked events and their multiplier effects work themselves out, especially in the context of the tourist industry, as noted in Osuchowski and Roberts (2011). Thus, the economic cost disaster models are inappropriate for landslide costs, this includes lack of data and research on landslides and their effects – particularly in Regional Australia which tends to have many more of such events. The added element of climate change exacerbates the problem with no effective modelling. The level of uncertainty around the cumulative effects of landslides and the increasing variability of such events under climate change makes post-emergency equilibrium-based economic modelling very problematic for the type of event analysed in this report (Handmer and Hillman, 2004).

Better quantification of landslide costs is essential to develop informed policy and practice. This requires complex adaptive systems methods to be applied that take into account uncertainty and build more reliable economic modelling (Richardson et al., 2011). This has not been adopted in Australian disaster studies to date. The economic impacts, both negative and positive, calculated in the economic impacts section of this report is a first tentative step to such modelling. To develop this approach further requires an evidence base with historically lengthy records that chart levels of vulnerability at different sites throughout the region. For this approach, locally-based data that can be used to understand the level of vulnerability of different sites by placing specific assumptions of threshold levels of vulnerability for such sites, based on vulnerability literature and local knowledge. Data currently collected by different agencies that are linked to the Grampians National Park and its partners will enable this analysis. Such modelling will assist with the financial concerns raised in the report, notably insurance coverage and negotiating cross-government level financial arrangements.

Recommendation 14: Agencies involved in areas of potential landslide need to be very aware, informative and inclusive in their dealings with the local community (both residents and business). Thus, there needs to be a stronger partnership between public agencies and private businesses and residents. Such public-private partnerships can build inclusiveness prior to any disaster by providing better information for more effective complexity modelling, and also allow the community and businesses to be involved more in response and recovery during the disaster and its aftermath.

Recommendation 15: There needs to be strong post-emergency legacy opportunities created through the generation of this information and using new technologies (via websites) and other media outlets. This needs to recognise the strong relief efforts during the disaster, but even more importantly, recognise the vastly improved and more extensive infrastructure through the Park for residents, tourists and professionals who value ecological and economic resilience.

Recommendation 16: Stronger economic resilience comes from diversifying from existing businesses and community activities by broadening what tourism represents in the region and to even bringing in different business activity such as knowledge-based industries that value the ecological environment (e.g. geospatial mapping).

Recommendation 17: Need to measure how intangible costs and risk assessments in a coherent approach that is accepted by all stakeholders in potential areas of flooding and landslides. Financial stresses in governmental arrangements and in insurance claims stem from the lack of appreciation of landslides as disasters that have cumulative effects and build from initial minor events to quite significant economic outcomes. A risk assessment and resilience building officer should be employed across the major stakeholders to co-ordinate this activity.

Environmental

Without doubt, the impact on the built environment – roads, footpaths, bridges, structures, water services, and associated infrastructure – was both severe and costly. The severing of arterial roads for most of the year disrupted the local communities and visitor numbers declined. Some residents suffered emotional, physical and economic losses from the damage impacted by the landslides on

their built assets. For a few residents these issues remain unresolved (as have been largely discussed elsewhere in this report).

Landslides are episodic events that account for around 17% of mortalities in global natural disasters (Kjekstad and Highland 2009). They are a combination of preparatory factors (e.g. steep slopes), causal factors (e.g. undercutting the slope) and triggering factors (e.g. heavy or prolonged rainfall) (Popescu, 2001). Predicting landslide occurrence requires recognition of all three factors, but is notoriously difficult. The fact that the landslides of the January 2011 rainfall events did not cause personal injury or trap park visitors between the landslides was noted by Neil Comrie in his Review of the 2010-2011 Flood Warnings and Response for the Victorian Parliament (Comrie, 2011). In his analysis, Comrie attributes this to:

- the advice received from the Bureau of Meteorology (BoM) in the lead up to the event;
- the responsiveness of staff to recognise the consequences of such rainfall predictions across the landscape;
- the subsequent evacuations of camp grounds, day use areas and the dissemination of information, prior to the worst of the conditions hitting the Grampians region.

Comrie (2011) also notes that at the time of the landslides, they (landslides) were not identified as 'incidents' in the Emergency Management Manual and accordingly no control agency was nominated, defaulting to the police.

The response during the event and after the event was also rapid and appropriate. To their credit, the Halls Gap Community Safety Committee responded quickly with interim guidelines to address the risk of landslide damage from future extreme rainfall events (HGCS, 2011). This was followed by the implementation of a Landslide Susceptibility Policy by the Northern Grampians Shire Council in June 2011 (NGSC, 2011d).

Landslide risk management of the assets in the built environment has a very strong foundation in Australia through the development of the AGS LRM framework (Leventhal, 2007), as discussed in the literature review. The framework is intended to guide Australian governments at national, state and local levels to promote appropriate use of land and landscapes. At the state and local level this is achieved through the Victorian Planning Provisions (VPP) and the municipal Planning Schemes (DTPLI, 2013a). In the absence of a specific landslide overlay, the statutory planning tool used is the Erosion Management Overlay (EMO), which the Shire has in place, but only for control of soil erosion in a relatively small area west of St Arnaud (DTPLI, 2013b). The intent to update the EMO to include the areas susceptible to landslides as defined by the AGS LRM framework is stated in the Northern Grampians Shire Council Landslide Susceptibility Policy (NGSC, 2011d). Implementing these statutory controls will provide appropriate LRM for new developments in the built environment.

In terms of the natural environment, the obvious impact is in the form of vegetation removal, habitat destruction, creation of linear 'bare earth' barriers, destruction of stream beds and their associated ecosystems, increased turbidity of waterways and deposition of earth sediment and debris. The social and economic impact of the environmental destruction has been described by the survey respondents and those interviewed since. All had observed these obvious changes to their environment. For businesses this had affected tourism and subsequent income, and for individuals and residents it altered and reduced access to the Park, with many disappointed by the destructive changes and damage to the physical structures. Some commented positively about improvements to the Park's infrastructure since 2011, and to road access. For a few respondents, the inconvenience and financial costs of the physical and natural environment impacts of the landslide events are on-going, but for the majority, they are now resolved.

However, the measuring or assessing the actual impact on the natural environment seems to have received little attention. A few academic studies and surveys were mentioned (Parks Victoria 2013), mainly focused on the ability of fauna species to recover and monitoring pest plant invasions. Assessing how this 2011 landslide event has changed the likelihood for future landslide events is an obvious knowledge gap. In particular the potential instability of the slopes, the potential for on-going erosion and sediment release, the potential for future impacts on water supply from Lake Bellfield, and the implications for the potential longer-term ecological changes to the riparian zones from future events seem to be obvious areas for more research. Extreme weather events are predicted to be

more frequent (DSE, 2008; CSIRO, 2012), which in turn is likely to trigger more frequent debris flows (e.g. Guzzetti et al., 2008; Allen et al., 2011).

Recommendation 18: That the current Erosion Management Overlay (EMO) be extended to include statutory planning controls for the landslide susceptible regions of the municipality. The EMO should adopt the methods of the Australian Geomechanics Society National Landslide Risk Management framework.

Recommendation 19: That longer-term research projects into the likelihood of future landslide events and the consequences of these events on the natural environment are undertaken. These projects should be considered as collaborative opportunities with land managers, government agencies, emergency services and research institutions.

Recovery processes still required

Recovery for some organisations is still ongoing however insights from key staff interviewed for this research indicates that most major infrastructure projects initiated following the January 2011 disaster are now largely complete. This is exemplified by the reopening of major roads (for example the road between Dunkeld and Halls Gap) and the completion of local infrastructure and rebuilding projects (sporting grounds and club; community facilities such as halls; and the reopening of Zumsteins) across affected towns in the region.

During the recovery, many agencies have provided substantial support and improved infrastructure to businesses and organisations to ensure that communities can resume their usual activities. Two related examples of this were provided about the support received from infrastructure organisations to assist with repairs to private and public resources and which were considered to be 'beyond' what would have normally been included within the repairs following disaster. These community members were supportive in their praise of the extent of the recovery efforts that went beyond expectation.

Celebrating the key stages of recovery from this natural disaster event is important in marking the completion of significant repair milestones, and in marking new beginnings while noting the legacy of the past disaster. Examples of recognising achievements in the recovery stages from this natural disaster have occurred, including the Northern Grampians Shire Council's 'end of the floods' weekend in October 2011 and of the community-wide invitations to the opening of new roads. Additional evidence of this is also repeatedly captured through meeting and Council minutes from affected Shires, where particular recovery efforts following this disaster have been show cased at these public meetings.

Another consideration to the broader recovery efforts following this natural disaster recovery is the potential for long term mental health illness within the affected communities. Anxiety and associated stressors relating to this event have been recounted in this research. Monitoring longer-term health impacts for those most affected by the floods and landslides in January 2011 is also a recommendation from this study, as highlighted below.

On a final note, the extensive impact of the landslides in the Grampians National Park in January 2011 appears to have had a profound effect and longer-term impact on the environment. Substantial repairs to the Park have enabled visitors – and residents – to return and explore the Park. Such infrastructure repairs are considered by many local residents to be an improvement to the old infrastructure. None-the-less the Park continues to exhibit the scars – especially from the landslides – that have become the hallmark of the natural disaster of January 2011. In some instances the environmental impacts to the region will continue for many years and may never resemble their former terrain. Examples of this include the damage to mountains, and of altered creek paths, so too Lake Bellfield which continues to experience a deterioration in water quality, with the silt and associated debris following the landslides.

These scars provide opportunities for community education, using simple information signs or interpretative signs to inform the public visitors of landscape processes and their impacts. Similar examples may be borrowed from overseas parks (e.g. Government of Alberta, 2012; USNPS, 2013) and combined with safety information (e.g. GA, 2013). By marking the place in the landscape with information signs, the hazard is identified, providing both duty of care for the land manager and ensuring that the information is not forgotten in the passage of time.

Recommendation 20: That the community continues to celebrate and mark the final recovery efforts following the 2011 natural disaster event and that a final celebration of all recovery efforts is organised to reflect the end of the complete recovery period.

Recommendation 21: That health and community organisations providing services to communities that have been affected by the Grampians natural disaster continue to monitor and regularly review mental and physical health indicators for ongoing social impacts from this disaster.

Building Resilience in the Grampians Community

Current resilience of the community, business and organisations in Grampians

This study has demonstrated that the Grampians community has some resilience to natural disasters, contributed to by experience with past natural disasters in the region, the community support networks, the planning and preparedness of the emergency response and infrastructure organisations, and the established collaborations and partnerships between agencies. Evidence of resilience in the community during the event and recovery includes the minimal social impacts on the community, the support felt by community members from friends and family, the minimal numbers of people who have moved away, the successful working of collaborations and partnerships between emergency response and infrastructure organisations and the flexibility in response demonstrated by some organisations.

From an emergency services and organisational perspective Grampians Natural Disaster reflects solid inter-agency collaboration and preparation to respond to the event was reasonably high. Staff drew on experiences from natural disasters in other regions and from the bushfires in the Grampians in 2006. For agencies, reflecting on past practice has provided a valuable foundation to extend the scope of the response – particularly with the community – during this natural disaster. This has, and continues to build agency resilience and community resilience as the learnings from past disasters help improve the planning, preparations, response and recovery. Another aspect of agency resilience is the level of co-operation and flexibility shown during the response and recovery of this disaster. For example, issues such as landslides on private land which were not covered by insurance placed unrealistic demands on private property owners. In some situations the Shire was able to assist these landholders through administrative changes.

However, the 2011 event also revealed some vulnerability in the community to natural disasters. These include, the lack of accurate flood warning systems, gaps in collaborations between emergency response and recovery agencies, gaps in available equipment, reduced staff numbers available to respond in some organisations, lack of clear roles and responsibilities of agencies during such an event, lack of good communication between agencies and between agencies and community, and the lack of empowerment of community through the planning and preparation phases. These vulnerabilities influenced the level of impacts on the community and on the effectiveness of the response and recovery process.

For example, the lack of clear agency roles led to some doubling of efforts, while poor communications between agencies caused some issues during the response and recovery (such as not receiving sufficient information about the event from another organisation). In addition, the unprecedented size of the event and the lack of involvement of the community in the planning, preparation and response phases, led to the community having unrealistic expectations of the recovery process and this developed some angst between community and agencies. The top-down nature of the response and recovery, including evacuation procedures, road access, weather conditions, water provision, and future planning changes left some in the community feeling that there needed to be greater involvement in the decision making from the community with more two-way conversations between agencies and community. Further, since this event there has been a shift in disaster policy focus with the National Strategy for Disaster Resilience (Commonwealth of Australia, 2012) to a focus on building resilience to natural disasters rather than response and recovery. This Strategy points out that this requires a shared responsibility between agencies, business and community, an shared understanding of the risks, partnerships between agencies and community, and empowering communities to do their own emergency planning and preparation. To do this requires

communities and agencies to work together to build knowledge, skills and capacity to plan and prepare for future natural disasters.

This disaster also demonstrated the vulnerability of the businesses in the Grampians to natural disasters that result in large reductions in visitor numbers to the region. This had a large impact on the business income and the anxiety levels of business operators. This is because many operators are reliant on tourists for their income. Therefore, agencies need to work closely with local businesses to help develop emergency plans to build their resilience in the face of future disasters similar to this one. Further to such emergency plans; agencies, community and businesses need to work together to examine potential areas of dynamic resilience. This could include exchanging data and discussing in community meetings crucial issues of visitors and visitation, events, infrastructure plans and innovative activities. From such data and debate, there should be extension and diversification of the region's activities to provide wider opportunities for regional development and also offer a stronger economic base to any pre-planning for future ecological shocks.

Moves to build community resilience since the event by the emergency and infrastructure organisations

The Victorian Floods Review (Comrie, 2011) concluded that the most effective means to make our communities safer is to build their resilience to natural disasters. This is because the more a community can develop resilience prior to any emergency, the fewer the impacts of the disaster and the greater the speed of recovery. The Victorian Floods Review recommended that this could be done by ensuring that local knowledge was considered as a critical component of emergency management, involving communities in the development and ownership of community resilience plans based on an 'all hazards' approach, encouraging communities to form resilience committees to administer community resilience plans and to consult with these committees in the preparation, planning, response and recovery phases of emergency management (Comrie, 2011 p.12). As a result of this review and the events in 2011, community resilience is becoming a focus of the emergency and infrastructure organisations in the Grampians, as reflected in the key documents prepared since the event and by the emphasis on community meetings and celebrations since the event occurred.

In the Grampians since the disaster, many organisations have started to invest in building community and business resilience so that communities are prepared for, able to cope with and adapt to future natural disasters. For example Northern Grampians has put a lot of effort into future responses to disaster and landslide through many community meetings, community celebrations, and other measures to involve community in the planning and preparations for future events. This demonstrates a shift towards a more collaborative approach to emergency management that will enhance the resilience of the community and provides a good foundation for a continuing focus on building community resilience.

However, building community resilience is not just about the community members, it also requires the building of resilience in emergency and infrastructure agencies and in businesses. So the focus of resilience building must not focus just on the community. In the Grampians since the 2011 event, there have also been efforts to increase the resilience of the emergency and infrastructure organisations and in the infrastructure itself. After reflection on the experience of this disaster, there have been a number of moves made to improve practice for future events. This has included reviewing and improving emergency management plans and procedures, development of improved communication strategies between agencies and with the community, further development and strengthening of collaborations and partnerships between agencies, implementation of improved flood warning systems and flood mapping, and moves to work more collaboratively with community. For example, the continuation of the Municipal Recovery Committee, which includes Northern Grampians Shire Council, Grampians Community Health, Department of Health, Parks Victoria, DEPI, GMMWater and VicRoads, has strengthened collaborations between agencies and helped improve communication strategies between agencies. Further, as this was the third natural disaster in the region it was decided that where infrastructure had to be repaired that more resilient infrastructure design was used to reduce the impacts on infrastructure in future disasters.

Continuing to enhance the resilience of the Grampians region

There are a number of areas that need further efforts to build the resilience of the Grampians region to natural disasters by both the community and the emergency and infrastructure organisations. A resilient community (community members, business and agencies) is one that is flexible and willing and able to adapt to changes, is well connected, has the skills, knowledge, capacity and adequate resources to respond to natural disasters, has effective and inclusive processes to help plan, prepare, respond and recover from disasters, with clear roles and responsibilities and lines of communication and information sharing (see Figure 23). Thus, to ensure the Grampians community is resilient to future disasters attention needs to be paid to the following areas (see Figure 23), many of which have already been highlighted in the Victorian Floods Review and the National Strategy for Disaster Resilience:

- further develop collaborations with the community in all phases of emergency management to ensure local knowledge is considered, to build emergency management knowledge and skills in the community and give community ownership of and responsibility for emergency management;
- development of community resilience plans and community resilience committees;
- development of individual and business emergency or resilience plans with regular planning meetings;
- further development of flood warning systems;
- continued strengthening of collaborations between agencies and with community;
- clarification of roles and responsibilities in emergency management;
- incorporation of flood and landslide mapping into planning schemes to prevent future development in high risk areas;
- raise flood and landslide risk awareness in the community;
- continue improving communication strategies for community to include a range of media including social media and to develop a communication tree (starting with a list of key community members) within the community to ensure everyone is well informed;
- continue with the Municipal Recovery Committee to continue strengthening collaborations between agencies, but look to widen this to other councils in the region;
- ensure all staff and volunteers have appropriate emergency management training;
- develop a vulnerable people register;
- develop a volunteer register;
- continue to build the resilience of infrastructure through mitigation strategies and renewal programs;
- build emergency management knowledge and skills in the community and empower community members to better enable them to respond and cope with future disasters.

Vulnerability	Resilience
Lack of flexibility	Flexible with a high adaptive capacity
Isolated community members	Connected community
Few networks in the community	Well networked
Few resources	Well resourced
Little capacity, knowledge or skills	High levels of capacity, knowledge and skills
No clear roles or responsibilities	Clear roles and responsibilities
Few or weak partnerships or collaborations between and within the community and agencies	Strong partnerships/collaborations between and within the community and agencies
Top down emergency planning, response and recovery	Community involved in planning, response and recovery
No clear processes for social learning	Clear processes that enable social learning
Poor understanding of risk	High level of risk awareness
Unprepared	Prepared
Inadequate/unmaintained infrastructure	Adequate, well maintained infrastructure

Figure 23. The characteristics of resilience and vulnerability (created by Graymore, 2013).

By developing a collaborative approach (such as those advocated by Cutter et al., 2008 and Shiel, 2013) with the community on planning, preparing, responding to, and recovery from natural disasters will provide the community with enhanced knowledge and skills on emergency management, risk awareness and preparedness and gives them ownership of emergency management. This greater community ownership enables emergency management teams to focus their resources and energy on issues too large to be tackled alone by community members. Also, by taking a collaborative approach this establishes a co-operative culture and local community ownership in partnership with agencies (Sheil, 2013). It also strengthens the relationships and communications between agencies and the community, enabling them to establish agreed ways of working together and clarifying roles during the response and recovery. By empowering the community and including them in the planning, community stress and anxiety during an event will be reduced and it will also help reduce community angst as they will have more realistic expectations of the recovery process. It will also reduce confusion under traumatic conditions with improved outcomes for community and emergency workers.

An example of what can be done to build resilience in the community by agencies by building knowledge, preparedness, networks, collaboration and community ownership has been around fire preparation. The Fire Ready program which includes workshops, information and community planning meetings, enables community members to be better informed and prepared to act in the response to bushfires, building their resilience to bushfires. Further, the Fireguard program (see website www.cfa.vic.gov.au/plan-prepare/community-fireguard) builds networks within the community with local fire fighters building knowledge and skills, strengthening relationships and effectively enhances the community's resilience to bushfires. Another example of this is the Weather Ready program being run by the City of Port Phillip (<http://www.enviroehub.com.au/weather-ready>). A similar approach is needed that covers all hazards rather than focusing on just on potential natural disaster.

Recommendation

The Municipal Recovery Committee membership involving senior staff of the Northern Grampians Shire, Grampians Community Health, Department of Human Services, Parks, Department Primary

Industries, Department Sustainability and Environment, Grampians Mallee Water and VicRoads are in key positions to implement an investment in local knowledge and strengthening community resilience.

Recommendation 22: Continue to build resilience in the Grampians region by the emergency and infrastructure organisations and the community working together to achieve the recommendations from the Victorian Floods Review (Comrie, 2011) and from this report.

Conclusion

There were a range of impacts from the flood and landslides in 2011 in the Grampians National Park, including loss of property, loss of income, increase in the ability to cope with future disasters, anxiety and stress, community angst towards emergency and recovery workers, loss of roads and walking paths, reduced access to the Park, loss of amenity of the park, loss of tree, riparian vegetation and understory flora and alteration of waterways. However, the emergency and recovery organisations felt they were well prepared for a disaster. Yet they, and many in the communities, were caught off guard by the magnitude of this event. This led many in the community to feel the response was inadequate, and caused angst in the community towards the emergency and recovery organisation staff. Thus, there are some learnings from this event that not only will help improve the response in this region to future disasters and thus, reduce the impacts of these, they also help emergency and recovery organisations and communities in other regions better prepare for such events.

However, this study also provided indications that the community in the Grampians region is quite adaptable and resilient to natural disasters. This was demonstrated by the small number of ongoing health issues – and anecdotal evidence suggesting that only minimal numbers of people have moved away from the region as a result of the 2011 natural disaster. Additionally, the reported improvement in the ability to cope with future disasters and improved relations between family, friends and community, as well as the number of partnerships and collaborations between the emergency and recovery agencies. This may have been as a result of past natural disasters in the region, such as the 2006 bushfires. Although it has to be noted that there is also some indication that businesses in the region need to increase their resilience as they were the hardest hit in the community with many not prepared for such an event of the impact it had on their businesses. Improved business and community resilience is essential considering the likelihood that natural disasters similar to this event are likely to increase in frequency in the future due to the impact of climate change on rainfall patterns causing more frequent high intensity rainfall. Thus, one way to help reduce the impact of future unprecedented natural disasters on the Grampians communities is to support and enhance the community's resilience, including that of the local businesses. This can be done by:

- Building and strengthening relationships between communities and the emergency and recovery agencies;
- Include community in the emergency planning process for the region, and help build ownership of the plan in the community;
- Set clear roles for emergency and recovery agencies;
- Develop a list of key community members to develop leadership in the community and help in communication to the wider community in future disaster responses;
- Assist community members including businesses develop household/business emergency plans;
- Develop/review communications plans to strengthen inter-agency communication and agency-community communication;
- Continue to develop better flood warning systems;
- Implement flood mitigation measures to reduce impacts of future flood events;
- Develop staffing policies for emergency response and recovery that protect the health and wellbeing of staff;
- Establish a register of vulnerable people and develop plans to ensure these people are safe and taken care of;
- Stronger communications between all stakeholders to allow for more inclusive data collection, to be co-ordinated by Parks Victoria staff at the Grampians;
- Build a strong post-emergency 'legacy' on the landslides and other disasters in the Grampians Park to recognise and commemorate the history of disasters in a way that unites all stakeholders.
- Diversify from existing businesses and community activities, by broadening what tourism represents, and also include related areas in ecological resilience based on knowledge-based information technology expertise like geospatial mapping;
- Appoint a risk assessment and resilience building officer who is co-shared by councils, Parks Victoria, SES and DEPI. Such an officer could assist in measuring intangible costs and assessing risks that could be communicated to all stakeholders.

For other regions susceptible to landslides, this study has shown that the impacts of floods and associated landslides can be wide ranging, particularly for communities whose economy is heavily reliant on tourism. Once the roads are cut and the time to rebuild them becomes extensive, the impact on businesses can be large, leading to the loss of business and income causing high levels of stress and anxiety. Thus, there is a real need for similar communities that are at risk of landslides to build resilience into their economy and businesses and ensure everyone has developed emergency plans for future disasters. Further, this report has shown the importance of community involvement in emergency planning to build relationships between community and emergency and recovery agencies, ensure it is informed by local knowledge, build community ownership and build knowledge of emergency response and recovery, and develop realistic expectations of the response in the community. All of this helps to enhance the resilience of the community to future disasters.

One area that is key to the relative success of the response to the Grampians 2011 event, and that probably helped reduce the long term impacts was the partnerships and collaborations between emergency and recovery agencies. This enabled them to respond quickly and work closely together, most of the time, during the event. However, this also highlighted the importance of having clearly defined agency roles and clear lines of communication between agencies, to ensure that there was no duplication of efforts or misinformation going out to the community.

However, it is not just the communication between agencies that is essential to a smooth recovery and reduced impacts to community, there also needs to be good clear communication between community and agencies. To ensure the essential information gets out to the wider community, there needs to be clear lines of communication, such as the use of key community members to help disseminate information more widely, as well as the use of mixed media and forums to ensure the information reaches everyone. This could include the use of social media, group discussions where feedback from the community are used to inform the recovery process, public meetings, radio, etc. There also needs to be accurate information provided, to help build and enhance trust between the community and agencies. This requires good flood warning systems and modelling to produce accurate and timely information. The other lesson learnt with communication to community here, is the need to have the means to describe the full extent of the disaster to affected communities to help them understand the time it will take to fully recover and regain access to all services and infrastructure. In this case, since the extent of the disaster was large, this required agencies to take community members on a bus trip to show them the extent of the damage.

Thus, this report highlights the need to build community resilience – across residents, businesses, regular visitors, community organisations, and agencies – to reduce impacts of future natural disasters (including the recent 2014 bushfires in the region), which means there needs to be a collaborative approach to emergency planning that not only includes the development and strengthening of relationships between agencies but also includes the same for community-agency relationships. In this way communities and agencies can work together to build their resilience to future natural disasters.

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Appendix A

Understanding 2011 Grampians Natural Disaster, addressing the risk and resilience

Literature Review

Prepared by:

Alison Ollerenshaw, Dr Peter Dahlhaus, Kelsey McDonald, Assoc Prof Jerry Courvisanos, Dr Michelle Graymore, Dr Helen Thompson, Dr Helen Sheil, Anthony Miner, Jennifer Corbett.

Centre for eCommerce and Communications, Federation University Australia

Date: 31/03/2014

Executive Summary

The Northern Grampians Shire Council contracted the Centre for eCommerce and Communications (CeCC) at Federation University Australia to undertake research into *Understanding the 2011 Grampians Natural Disaster, addressing Risk and Resilience*.

The overall objective of this project is to investigate the social, economic and environmental impacts of the landslide events in the Grampians National Park, located in Western Victoria. Particular reference is attributed to the events of January 2011 where flooding in the Grampians National Park precipitated over 200 landslides. This event had a significant impact on the environment and communities surrounding the Park.

The proposed research will document the outcomes of events from key individuals, community and agency personnel to inform the social, economic and environmental impact following the 2011 landslide event and will integrate these into a consolidated inventory.

This component of the research provides a review of current national and international literature on the social, environmental and economic impacts for communities affected by natural disasters. This review will include identification of best practice for emergency services and management for communities. Relevant local, regional, state and national strategies and policies have also been examined.

The key findings from the literature review across each of the key areas are summarised as following:

1. There has been little in-depth research into the social impacts of landslides, particularly in regard to the functioning of the community. However, the literature on the social impacts of natural disasters more broadly reveals that there is a wide range of social impacts that occur over a long period of time, at least for some in the community.
2. Case studies that make use of self-reported impact surveys and interviews provide the most in-depth information that can be used to direct policy and planning for future natural disasters.

3. There is an issue of inappropriate cost models for determining landslide costs, with accompanying lack of data and research. Better quantification of landslide costs is essential to develop informed policy and practice.
4. Landslides can be caused by an accumulation of small, multiple linked events occurring over a longer timeframe. To better understand this cumulative aspect, complex adaptive methods that take a dynamic perspective of economic and community reliance need to be developed; these have not been adopted in Australian disaster studies.
5. Of major implication for the community and local government is the nature of eligibility criteria for relief funding, which excludes most landslide related events.
6. Impacts of landslide events on the built environment are dramatic, as are the impacts on the natural environment, but impacts on the latter have not been well documented in the published literature.
7. Landslides impact assets across multiple land management tenures and required multi-jurisdictional cooperation to resolve immediate risks.
8. Current literature for emergency management best practice in Australia and from overseas has been largely focused on community support and resilience during response and recovery to emergencies and disasters. What is known is that greater consideration of, and better planning for psycho-social support following disaster and building resilience can greatly enhance community safety. Furthermore, open consultation and communication with communities can greatly enhance the ability of communities to survive and recover from future disasters.

The full outcomes of this literature review are outlined in the following chapters.

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Overview of the Literature Review

Understanding the 2011 Grampians Natural Disaster, addressing Risk and Resilience project comprises various inter-related stages, including a review of current literature.

This literature review provides a broad overview of current research focusing on the social, economic and environmental impacts of landslide and/or natural disaster (particularly flooding, which is a precondition to landslides). An exploration of risk and resilience has also been undertaken. The inclusion of literature for this review will be guided by widely accepted definitions relevant to the overall research project (as outlined below).

To guide this literature review some parameters have been set to maximise the collection and presentation of the most current and relevant documents. Literature and documents outside these parameters will be included in the review only if they are deemed central to the discussion and seminal in the national and international learnings.

Since records began in Australia in the mid-1800s, more than a hundred landslide events, many the result of natural phenomena, have been recorded. Detailed reports of landslide events across Australia expose the widespread damage and destruction caused by such events, including substantial environmental degradation and damage to infrastructure and services including roads, railways, pipelines, agricultural regions and communication networks (Geoscience Australia, 2012).

In Australia, thousands of landslides have been mapped including earth slides, rock falls and debris flows. A landslide can be triggered by either a natural or human made event and can range from a single rock fall to a massive debris flow. The extent of the landslide can be localised and impact on a small area or it can impact on much larger areas (Geoscience Australia, 2012).

Natural disasters present a serious and significant threat to life and livelihood and to the built and natural environments. Natural disasters, including floods and landslides, pose significant danger and disruption.

The following literature review chapter summarises current research and documents about the social, economic and environmental impacts of landslides, and more broadly, natural disaster (in the absence of specific literature on landslides). Literature has been included that informs the broader natural disasters research and contributes to a fuller understanding of the Grampians Landslide Event of 2011. Full references for all documents cited have been included to allow readers the opportunity to further explore the themes and current research in each of the key areas beyond that presented in this report.

Search Parameters

The identification and review of literature was conducted using electronic searches of national and international databases (including EBSCO, Host Online Citations; Informit; JSTOR; Sage Reference Online; Social Science Research Resources Network; Springer Link; Taylor and Francis Online), and Google Scholar. Current government policies and documents were sourced using webhosted search engines and online library databases, or directly, by searching websites of local government, and state and national government departments.

Priority was granted to research and literature published within the last ten years (older material was included only where it was identified as being particularly relevant and appropriate) and of a high quality and representing a good standard of academic rigour (i.e., peer reviewed scholarly articles; manuscripts from educational institutions etc.). A priority search of the literature was conducted to identify research with a focus on landslides and natural disasters, in Australia.

Definitions

For the purposes of this literature review and reflecting the scope of this research and the various terms that are used throughout (and sometimes interchangeably) the following definitions have been provided. In some instances, selected definitions from key sources have been included where there is more than one widely acknowledged definition.

Natural disaster

The definition for natural disaster was outlined in the report to the Council of Australian Governments entitled *Natural Disasters in Australia* (2002) and has been widely adopted in subsequent government publications and reports. This definition states that:

A natural disaster is a serious disruption to a community or region caused by the impact of a naturally occurring rapid onset event that threatens or causes death, injury or damage to property or the environment and which requires significant and coordinated multi-agency and community response. Such serious disruptions can be caused by any one, or a combination, of the following natural hazards: bushfire; earthquake; flood; storm; cyclone; storm surge; landslide; tsunami; meteorite strike; or tornado (p. 4).

Landslide

Landslides and landslide risk management are comprehensively described in the National Landslide Risk Management (LRM) Framework for Australia published by the Australian Geomechanics Society (AGS) (Leventhal, 2007). The framework comprises a set of documents that were developed in response to the Coroner's report on the 1997 Thredbo Landslide, which killed 18 people and remains Australia's most devastating landslide (Hand, 2000; AGS, 2007).

The AGS LRM guideline (2007) defines a landslide as 'the movement of a mass of rock, debris or earth (soil) down a slope' (p.14); this conforms to the global definition. Landslides are most commonly categorised by the type of material and movement (Varnes et al., 1978; Cruden et al., 1996; Walker et al., 2007). Material may be rock, soil, earth or debris; and movement may be falls, topples, slides, spreads, flows or complexes of these, resulting in types such as rock fall, debris flows, etc.

(The AGS LRM framework and guidelines can be accessed at: <http://australiangeomechanics.org/resources/downloads/#dlLRM2007>).

Risk

The AGS LRM (2007) adopts the terms for risk management, as documented in the Australian/New Zealand Standard - Risk Management, Principles and Guidelines (Standards Australia, 2009). The standard, which has been adopted as the International Standard, defines risk as the 'effect of uncertainty on objectives' (p.1), adding that it is often expressed as the combination of the likelihood of the occurrence of an event with the consequences of the event (including changes in circumstances).

In compliance with the Australian Standard, the AGS LRM framework (2007) and guidelines outline the procedures for landslide risk analysis and contributes to landslide risk assessment. The analysis and assessment are then used to inform landslide risk management strategies. The key components of risk analysis include an analysis of the landslide hazard and the consequence, which together result in the risk estimation (Leventhal, 2007).

Hazard

The Australian Risk Management Guidelines (Standards Australia, 2004) simply define Hazard as 'a source of potential harm' (p.2). Landslide hazard analysis comprises two components: landslide characterisation and an analysis of landslide frequency. The AGS LRM (2007) guideline for landslide susceptibility, hazard and risk zoning for land use planning (AGS, 2007) define hazard as:

A condition with the potential for causing an undesirable consequence. The description of landslide hazard should include the location, volume (or area), classification and velocity of the potential landslides and any resultant detached material and the probability of their occurrence within a given period of time. Landslide hazard includes landslides which have their source in the area or may have their source outside the area but may travel on to or regress into the area (p.14).

Hazard can be informed by an inventory of landslide location, classification, volume, activity and date of occurrence, together with an assessment of the susceptibility of an area to landslides.

Consequence

Consequence is defined as the 'outcome of an event affecting objectives' (Standards Australia, 2009, p.2) and under the AGS LRM (2007) the outcomes or potential outcomes arising from the occurrence of a landslide are expressed qualitatively or quantitatively, in terms of loss, disadvantage or gain, damage, injury or loss of life. The analysis of consequence must examine the elements at risk, the temporal spatial probability, evaluation of the consequence to property and the evaluation of consequence to persons.

Consequence analysis is a complex and time-consuming process that must examine all the potential scenarios for the occurrence of the landslide event (types, volumes, movements, directions, etc.), the vulnerability of the elements or persons at risk (types of structure, conditions of the structures, health of the persons, etc.) and the economic, social and environmental values of the elements at risk (Walker et al., 2007).

Resilience

The term 'resilience' first originated from the materials sciences and environmental disciplines but is now used broadly across different disciplines, from psychology to economics and biology, to describe species, materials, communities, individuals, households and organisations (McAslan, 2010a). Despite its broad application it has been argued that the term 'resilience' when applied exclusively to human beings shares common characteristics that include:

- the ability to absorb and subsequently recover from an abnormal event;
- being prepared to face threats and events that are abnormal in their timing, scale or form;
- the willingness and ability to adapt to changing and sometimes threatening environment;
- a commitment to survival;
- a willingness of communities and organisations to support a common cause or shared value (McAslan, 2010b).

These characteristics are captured in the psychological literature. The American Psychological Association (2013) defines resilience as 'the process of adapting well in the face of adversity, trauma, tragedy, threats or significant sources of stress — such as family and relationship problems, serious health problems or workplace and financial stressors. It means "bouncing back" from difficult experiences' (p.1).

Similarly, in Australia's National Strategy for Disaster Resilience (2011) prepared by the National Emergency Management Committee an examination of the characteristics of disaster resilient communities, organisations and communities was adopted. Four key characteristics were identified, specifically:

- Functioning well under stress;
- Successful adaptation;
- Self-reliance; and,
- Social capacity (National Emergency Management Committee, 2011).

Community resilience is also fostered through the shared support systems that include community 'structures' or links such as families, networks, neighbourhoods, social cohesion, mutual interest and mutual self-help groups (National Emergency Management Committee, 2011).

An exploration of the meaning of resilience for the purposes of promoting discussion and examining its influence on disaster management policy has been prepared by Prosser and Peters (2010).

Structure of Literature Chapters

This literature review will be structured as follows. The first chapter is dedicated to a review of current literature of the social impact of natural disaster and the role of community resilience (focusing on landslides). This chapter also examines the influence of emergency response management on social impacts and provides an overview of the method used to understand social impacts following natural disaster (and where possible, specific to landslides).

Subsequent chapters of this review will examine the economic and environmental impacts of natural disasters and will include an exploration of what these comprise and how they impact on individuals and communities. The final chapter will broadly examine current best practice guidelines around natural disaster for emergency services and disaster management services.

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Chapter 1: Social Impact of Natural Disasters on Communities

Overview

Natural disasters can cause widespread social disruption and can impact on the quality of life of residents and disrupt the social fabric of the community (Gordon, 2004). The common impacts on communities include death and injuries, mental health and physical illnesses, loss of homes, jobs, income and services, damaged infrastructure, and changes in relationships with authorities and others in the community. These impacts can be either as a direct result of the natural disaster, as is the case for loss of homes, services, infrastructure, injuries and death, or indirectly through the stress and anxiety that the event and the ongoing disruption to 'life as normal' can cause.

In Australia, landslides have damaged buildings, roads, railways, pipelines and communication lines, as well as caused death, injury, stress and displacement of people located in the area where the landslide occurred (Geoscience Australia, 2007). However, there is a lack of in-depth knowledge of the social impacts of landslides-specifically, as little data has been collected, with the exception of deaths, injuries and property damage (Leiba, 2013; Michael-Lieba, 1999; Michael-Lieba et al., 1997). For example, in Australia between 1842 and December 2011 there have been approximately 114 known landslide events¹ resulting in at least 138 fatalities, 174 injuries, 370 buildings damaged or destroyed leaving many people without homes and workplaces, and considerable damage has been done to roads (i.e. 300 landslides between 2000-2011), railways and bridges (Leiba, 2013) impacting on the ability of people to move around in the affected areas.

The impacts of one landslide in Australia have been studied in-depth. This landslide occurred in Wollongong and caused a range of impacts including:

...stress, psychological trauma, loss of homes, loss of savings, loss of trade of tourist based businesses, increased commuter time, cost and inconvenience associated with temporary relocation, loss in social and recreational activities, litigation costs, reduced real estate values at risk of landslides, loss of tax revenues on properties devalued as a result of landslides, loss of tourist revenues as a result of damage to land or facilities or interruption of transportation systems (Osuchowski and Roberts, 2011, p. 41).

Beyond this study, little has been documented on the social impacts of landslides, particularly on the more intangible social impacts. Thus, this chapter provides an overview of the social impacts of natural disasters, followed by some insight into the influence of emergency response on social impacts and the methods for measuring social impacts to inform the development of survey questions for the Grampians Natural Disaster project.

Social impacts of natural disasters

The impacts on community emerge from the very onset of a threat of natural disaster and can continue until years after the immediate threats have disappeared. However, it is difficult to document the scale of impacts as many psychological symptoms, for example, can take time to manifest and the link between social impacts on an individual's capacity to 'function normally' is still being explored (Proudly, 2013). Yet it is important to monitor these social impacts through time, as the types of

¹ A landslide event may involve one or many individual landslides. For example the Grampians Landslide Event of January 2011 resulted in at least 200 individual landslides.

impacts change at different stages of recovery and can have significant effects on the long-term functioning of some people, households, businesses and communities (Lindell and Prater, 2003).

The range of social impacts from natural disasters identified in the literature includes:

- death and injuries;
- psychological trauma, stress, emotional issues;
- physical illnesses;
- loss of homes, jobs, income, services;
- damaged infrastructure such as roads and service conduits;
- changed community connections;
- changes in relationships with authorities and others in the community;
- increased commuter time;
- temporary or permanent relocation;
- community outrage (at lengthy closures of roads and bridges for example);
- loss of trust of residents towards the government and authorities;
- loss of social and recreational activities;
- loss in business due to damage of land or facilities or interruption of transportation systems;
- damage to known environments, ecologies and habitats;
- break down in personal and public communication; and,
- increased responsibilities to care for self, others, domestic and commercial animals and assets (Osuchowski and Roberts, 2011; Cutter et al., 2008; Lindell and Prater, 2003).

Generally, people will have an accumulation of impacts as the stress and anxiety caused by the experience and the recovery process can severely diminish the health of individuals and the social wellbeing and capacity of communities (Cutter et al., 2008). This damaging impact is not confined to community members but also includes emergency service workers (Handmer and Hillman, 2004). The following section provides further details on specific areas of impact.

Health

Recovery from natural disasters can be a drawn out process (Cook et al., 2008) and as such, some social impacts, particularly health related impacts, can be ongoing or long-term. Depression, post-traumatic stress disorder (PTSD), anxiety, and substance abuse are common long term psychological impacts (Cook et al., 2008). People who are affected include those who may have lost their homes, belongings or jobs, were injured or had family members who were injured or killed and the emergency response workers who were involved in the event (Galea, 2007; Cook et al., 2008).

Cook et al. (2008) describe five categories of post-disaster community health impacts:

- 1) Chronic disability or pain following physical injury as a direct result of the disaster;
- 2) Infectious disease risk;
- 3) Chronic systemic illness;
- 4) Effects of malnutrition and trace element toxicity; and,
- 5) Mental health outcomes.

Injuries and death are the only direct impacts of natural disasters, while the other five categories occur after the disaster and can continue in the long term. Malnutrition (lack of adequate food) and trace element toxicity (from contaminated water, air or food) are self-explanatory, thus, only the remaining three categories are discussed below.

Infectious disease risk results from changes in the environment and service provision such as disruption in water supply, inundation of water treatment and sewerage plants, fungal spores and microorganisms in the air, and if a community is displaced for a long time, epidemics can become an issue if there is overcrowding, contamination of food and water sources or limited health care (Noji, 2005; Hooke and Rogers, 2005; Cook et al., 2008). For example, water damaged houses can be a source of mould spores which can cause allergies and respiratory illnesses (Brandt et al., 2006; Cook et al., 2008).

Chronic systemic illness can arise in the intermediate to long term due to disruptions in medical care and management, which may destabilise normal patterns of care for those who have chronic illnesses and require medications, ongoing procedures or a high level of care such as asthma, diabetes, epilepsy, heart disease or the elderly (Cook et al., 2008). Further, dispersal of toxic substances, such as human or agricultural waste, asbestos or petrochemicals may also pose risks into the future (Cook et al., 2008). Considering the bushfires that occurred in the Grampians in 2006, illness caused by contaminants in the ash was potentially an issue for Halls Gap and Dunkeld residents, visitors and those whose water source is Lake Bellfield, as bushfires can produce organochlorines and volatile organic compounds which can be hazardous to health (Young et al., 2004; Cook et al., 2008).

Mental health impacts have been well documented, with people commonly experiencing acute distress in the face of disasters. This can cause impaired concentration, confusion and attention deficits, as well as behavioural issues including change in sleep and appetite, ritualistic behaviours and substance abuse (Lindell and Prater, 2003, Helton et al., 2011). Suicide, child abuse and domestic violence have also been reported (Shultz et al., 2005; Wilson, 2006; Cook et al., 2008). However, most people will not be affected long term, particularly if they are able to maintain their social networks after the event (Lindell and Prater, 2003). However, a significant amount (up to a third) will continue to have mental health issues for up to a decade (Galea et al., 2005; Norris et al., 1999; Cook et al., 2008; Lindell and Prater, 2003). This is because mental health issues can also be a secondary impact of the disaster with unemployment, temporary or permanent displacement and financial hardship following a natural disaster causing long term mental health issues (Galea, 2005; Cook et al., 2008; Alexander, 1997).

The people who are often the most vulnerable to long term psychological effects include pregnant women, children, the frail elderly, people with pre-existing illnesses, racial and ethnic minorities, families of those who died in the disaster, those who are members of disenfranchised groups and emergency workers (Simeonova, 2011; Lindell and Prater, 2003; Mileti and Gailus, 2005; Fernandez, 2002; Cook et al., 2008; McFarlane and Van Hooff, 2009). The elderly are vulnerable to the long term psychological impacts due to decreased sensory awareness, physical impairment, socioeconomic limitations and chronic health conditions (Jia et al., 2010). Those who suffer the most from natural disasters tend to use 'emotion-focused coping' responses, which disrupt social functioning, while the majority of people use adaptive 'problem focused coping' activities to save their own lives and those around them (Lazarus and Folkeman, 1984; Lindell and Prater, 2003). Thus, it is those people who use emotion-focused coping responses that need to be closely monitored and supported during the recovery.

Further, to reduce the long term social impacts it is important to understand that different people will react to different types of stressors dependent on their relationship to the disaster (i.e. were they a direct victim, family or friends of victims, emergency workers, etc.). Each group of people will require different interventions to help them recover from the event. These are described in Taylor (1990). Since health impacts can continue on or only appear long after the event, there needs to be a focus on health requirements in the long term recovery phase (Dominici et al., 2005; Cook et al., 2008).

On a related matter, it should be noted that there can be some positive impacts from natural disasters, with increased numbers of people volunteering. Altruism is evident in actions such as people donating clothes and other household goods, and through helping behaviours (Tierney et al., 2001; Mileti et al., 1975; Drabek, 1986; Siegel et al., 1999; Lindell and Prater, 2003; Eyre, 2004). Volunteering in response efforts enhances community recovery and healing of those indirectly affected by the disaster, as volunteering transforms their feelings as victims into empowerment (Eyre, 2004). Further, living through a natural disaster can change people's risk perception, and increase hazard intrusiveness, where the disaster is in thoughts and discussions regularly. This can lead people to adopt measures at home to reduce their vulnerability to future disasters (Lindell and Prater, 2003).

Housing

For people who lose their homes in a natural disaster, the direct impact can be large and disruptive for considerable periods of time. Quarantelli (1982) described the four stages of housing recovery as:

- 1) emergency shelter somewhere safe from the elements;

- 2) temporary shelter where food preparation and sleeping facilities are sought from friends and family or commercial lodgings;
- 3) temporary housing where household routines can be re-established but not in preferred locations or structures;
- 4) permanent housing where household routines are re-established in preferred locations and structures.

This process often takes longer for those with low incomes who live in areas more vulnerable to disasters, have buildings that are built to older building codes or have fewer resources to re-establish their primary residence (Lindell and Prater, 2003).

Recovery can be further impacted by the availability of alternative housing (temporary and permanent), availability of housing support programs, building characteristics including affordability, quality and design and the conditions that government may place on rebuilding (Lindell and Prater, 2003). This can cause stress for those people affected and if they believe that there are administrative barriers preventing them from re-building their lives, this can lead to angst against governmental services, and people sharing a grievance about how the disaster recovery was handled can seek to change it through collective action (Lindell and Prater, 2003).

Employment

Damage caused by natural disasters can lead to temporary or permanent job loss, increasing local unemployment (Peek-Asa et al., 2012). Loss of employment can contribute to psychological problems, physical health issues and substance abuse (Peek-Asa et al., 2012). In addition, people may be reluctant to return to work due to issues with transport, feeling upset about the situation or feeling low in energy (Tovaranonte and Cawood, 2013). Further, people may have to move to a different location following the disaster, either temporarily or permanently, and so travel to work may become an issue (Tovaranonte and Cawood, 2013).

On the other side of the ledger, investment in new infrastructure arising from construction works in relief and recovery work can provide specific employment in areas like construction and transport. Such employment opportunities can be a powerful force for change and building resilience. For a theoretical modelling of this type of investment see Kalecki ([1945] 1990), with application to Australia by Bell (2002). These areas of the economy are not the same as where jobs are lost due to damage of sectors like tourism and business services.

Community Resilience

There has been a significant shift in the thinking of Australian emergency management policy triggered by several devastating disasters, which made it clear that emergency management frameworks needed to shift to a more sustainable approach that focused on preparation and mitigation, rather than on response and recovery (Commonwealth of Australia 2012). This has seen an increased emphasis on community resilience building programs to help communities better prepare for natural disasters, such as the Country Fire Authority's Fire Ready program. Community resilience in the context of disasters is the ability of a community to 'tolerate – and overcome – damage, diminished productivity, and reduced quality of life from an extreme event without significant outside assistance' (Mileti, 1999 p.4). This includes the capacity to reduce/avoid losses, contain the effects of disasters and recover with minimal disruptions (Cutter et al., 2008; Buckle et al., 2000; Manyena, 2006; Tierney and Bruneau, 2007). Although there is some debate in the literature, a community that is resilient has low vulnerability to disasters and thus the impact of a natural disaster on a resilient community will be lower than that for a vulnerable community.

What is not well understood is what makes one community more resilient compared to another community. Again, there is some debate in the literature about the exact components. However, there is some agreement that a resilient community is/has:

- highly connected to each other and to government and other support agencies;
- flexible and has a high adaptive capacity;

- sufficiently resourced to respond to disasters. Such resources will include volunteers, knowledge, skills and training, money and equipment;
 - aware of the risks of disaster, involved in the disaster management planning and are actively prepared for a disaster (i.e. has individual emergency plans);
 - ownership of the emergency planning and response process;
 - formed partnerships and collaborations between community, government and other emergency response and recovery agencies that enables a coordinated approach to disaster response and recovery;
 - clear lines of communication and information sharing in a two-way dialogue between community and emergency response and recovery agencies;
 - clear roles and responsibilities for community members and agencies during the preparation, response and recovery phases;
 - processes that enable the community to re-organise, improvise, change, and learn in response to a disaster;
 - infrastructure that is built to withstand disasters, is well maintained and not highly interconnected or coupled to other infrastructure as this can cause cascades of impact;
 - a range of mitigation measures in place to reduce the potential impacts;
 - good early warning systems;
 - compatible systems, common data collection points and interoperability across all emergency management agencies (Ainuddin and Routray, 2012; Cutter et al., 2008 and others)
- (These resilience and vulnerability factors are summarised in Figure 1).

Although the direct impacts of disaster are determined by the event characteristics, such as duration, intensity, magnitude, and rate of onset, they can be attenuated by the mitigating strategies and coping responses of the community (Cutter et al., 2008). Thus, emergency management needs to take a more community resilience-building focus and involve communities in planning, preparation, response and recovery. This will help to reduce the social impacts of future natural disasters. The following section describes briefly the influence of emergency response management on social impacts of natural disasters. A selection of resources for building community resilience is included in the Resources section, located at the conclusion of this literature review.

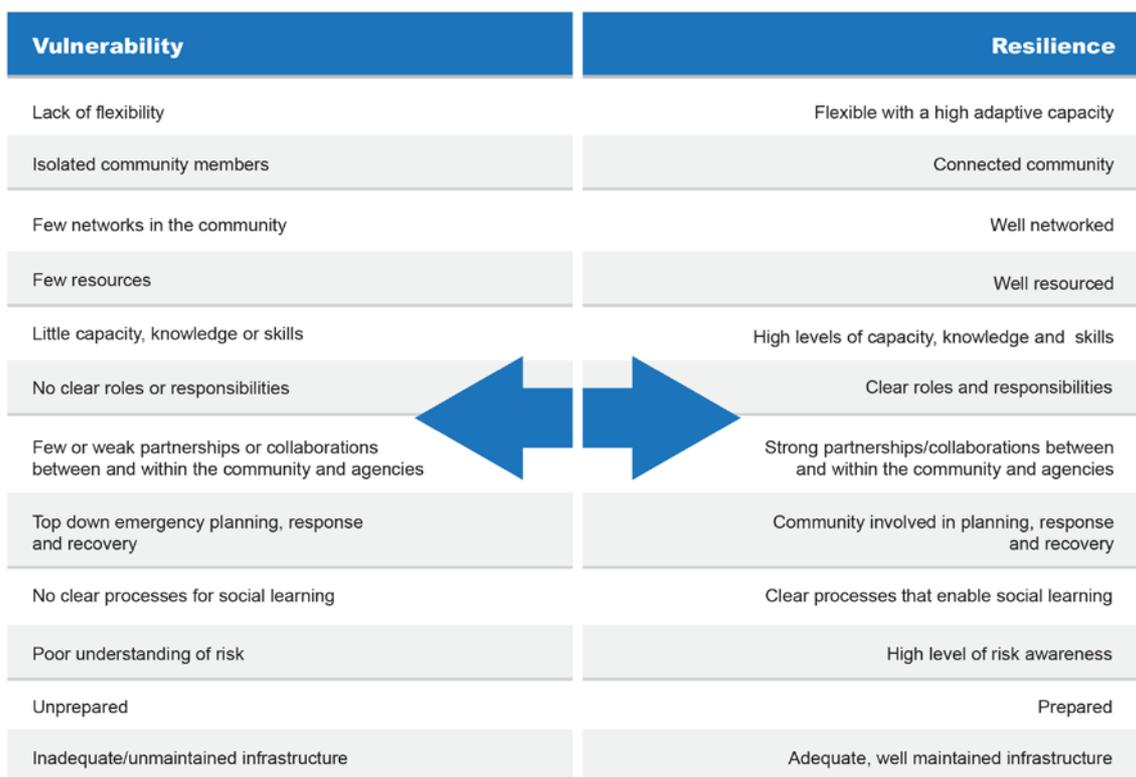


Figure 1. The continuum of resilience and vulnerability (created by Graymore, 2013).

The influence of emergency response management on social impacts

Eyre (2004) provides a guiding principle for disaster management, whereby 'disasters are about people and that responding to disasters – pre, during and post impact – is about managing and supporting people' (p. 23). Consequently, recovery strategies should focus on building resilience in the community, rebuilding social fabric, including rebuilding networks and communication lines, information and interaction opportunities, as well as harnessing the volunteers that come forth and providing them with means to help in the recovery phase (Gordon, 2004; Eyre, 2004). Steps need to be taken to enable the creation of communication systems that build a new context for the community that helps them define, interpret and evaluate the disaster experience, such as open group discussions. This will also help keep the lines of communication open within the community ensuring recovery information reaches all community members.

Further, the level of emergency preparedness and resources available for recovery can influence the level of physical and social impact (Lindell and Prater, 2003). Since both the physical and social impacts can negatively influence people's wellbeing, their ability to have meaningful relationships with other people, and their ability to work (Proudly, 2013), the level of preparedness of both the emergency and recovery organisations and individuals in the community is extremely important in reducing impacts.

Consequently, it is important to have the involvement of the community in the pre-emergency planning stage to build and maintain contact between community members and organisations and to consolidate the local knowledge (Gordon, 2004). 'Local people are part of the emergency and recovery process whether planned or not', and 'effective recovery can be achieved only where the affected community participates fully in the recovery and it has the capacity, skills and knowledge to make its participation meaningful' (Coles and Buckle, 2004, p. 6). Further, the different dynamics between working with community members as informed active partners in an emergency situation and one of control and command has significant impact on the degree of social impact experienced by those impacted.

Methods for measuring social impacts

A range of methods have been used to measure the social (and other) impacts of natural disasters including analysis of census data, self-reported surveys, case studies, economic assessments, and disaster impact indices. These methods have had varying levels of success in identifying and quantifying the social impacts. This is due to data inadequacy and inconsistency, the difficulties in identifying the impacts due to the disaster compared to other events in peoples' lives, complexity of impacts and the inadequacy of models that are used in disaster impact assessment, particularly some economic models and quality of life models (Sharma, 2010).

Census data was used in the USA (Friesma et al., 1979; Wright et al., 1979) to measure long term impacts of natural disasters, however, it did not find long-term effects at a community scale. Yet case studies of individual disasters in the USA reveal that there can be long term psychological impacts for a small number of people in affected communities (Lindell and Prater 2003). Other methods, such as indices based on models of impacts and impact assessment, suffer from taking a narrow view of impacts as they often have a focus on economic models and data already collected for other purposes. Consequently, they can miss important intangible social impacts that can only be identified by talking to people who were involved in the disaster.

Impact surveys or interviews that rely on self-reporting of impacts are the most common tools for understanding impacts on community and businesses (for example, the *Social Impacts of Natural Disasters Survey* carried out by Fieldworx (2013) to determine the impact of the Brisbane floods of 2011, Cyclone Yasi and the Black Saturday bushfires). These surveys look at the direct impact on the individual or businesses and the short to long term impacts across topics such as health, mental health, emotions, ability to work, employment, relationships with family and community, income, wellbeing, changes in behaviour (such as substance abuse), identity, coping ability, household finances, insurance, preparation and connection to the community and place. This in-depth

information can then be used to better prepare communities for future disasters and inform future emergency management and recovery plans by uncovering the wide range of impacts that can occur, as well as who are the most vulnerable, or most likely, individuals in the community to suffer the worst and more long term impacts. However, self-reported assessments do have some issues with accuracy as people are asked to recall how they felt and what happened when the disaster occurred and they may not recall accurately or may exaggerate or downplay the impacts they felt.

Conclusion

This review has illustrated that there has been little in-depth research into the social impacts of landslides, particularly the intangible social impacts such as psychological disorders and the functioning of the community. However, the literature on the social impacts of natural disasters has revealed that there is a wide range of social impacts that can occur over a long period of time, at least for some in the community. The review also provided insights into the suitability of methods used to understand the impact of natural disasters. Case studies that make use of self-reported impact surveys and interviews provide the most in-depth information that can be used to direct policy and planning for future natural disasters. Thus, to understand and document the social impacts that occurred as a result of the Grampians Natural Disaster, a case study approach was used, involving self-reported impact surveys and interviews. The survey and interview were designed to uncover the range of social impacts that were suffered by Halls Gap and Dunkeld residents, business owners, infrastructure organisations, and emergency workers after the Grampians Natural Disaster in 2011. Therefore, the topics covered include questions about:

- levels of preparedness
- the emergency response including what worked and what needs to be improved
- injuries incurred
- damage to property
- health and wellbeing
- how individuals are coping
- how relationships with family and community are enduring.

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Chapter 2: Economic Impact of Natural Disasters on Communities

Overview

This chapter reviews literature on natural disasters and their economic impacts as it affects communities at a spatial level. The chapter begins with identifying the nature of economic impacts and what that encompasses. Economic resilience to disasters is then explicated from the standard equilibrium perspective and then juxtaposed by the alternative dynamic perspective. The measures of economic impact are specified in the context of both perspectives. Then, the global economic scale of natural disasters is outlined, followed by an appreciation of the Australian situation when it comes to the economic impacts of natural disasters and in particular, landslides. Crucial to this review of economic resilience of 'natural' disasters is the significant impact on nature by human action (or lack of action) in areas like infrastructure and local government planning. The role of climate change in exacerbating the economic impacts of such disasters (and especially the less acknowledged landslides) is then briefly reviewed before a formal conclusion ends the chapter.

Nature of economic impacts

There is one central feature that unites all economic analyses of disasters. This is that disasters destroy assets, and that this destruction undermines the market flow of goods and services to a specific business ecosystem. This ecosystem can be global, national, regional or local. With such destruction, economic activity collapses, leading to disruption of people's sense of security, '...forcing relocation of household, commercial and government finances' (Handmer and Hillman, 2004, p.44). Two economic impacts emerge from this destruction. One is economic losses from tangible and intangible costs arising from negative effects of destruction. The other is positive economic resilience created by new opportunities. Disagreement occurs on the relative merits of incorporating both general impacts.

Equilibrium perspective

Standard economic research without any focus on resilience concentrates on economic losses alone, focusing on costs as a predisposition to returning economic activity to the economic structures that existed prior to the disaster. The assumption in these works is a need to return to the non-disaster baseline scenario, for example see the Bureau of Transport Economics (2001) study entitled *Economic Costs of Natural Disasters in Australia*. This position is upheld by those businesses that were in a position of strength and their public sector and governance supporters. Implicitly in such studies, economic resilience is seen as an equilibrium concept, to which any shock must be able to return to after the period of instability (Holling, 1973). Thus, costs are limited to what is required to return the ecosystem back to its state prior to the emergency, which ironically is a position of vulnerability from which the disaster occurred. From this perspective, cost-benefit analysis (CBA) is the major economic tool used since the exact measurement of costs incurred from the disaster, are balanced against the exact benefits known to be gained from restoring equilibrium.

The strength of these standard studies is the clear and specific manner in which the economic losses are identified and measured. The losses are classified in studies like Bureau of Transport Economics (2001) into three economic costs:

- *Tangible direct costs*: market identified losses resulting from physical destruction and damage to buildings, infrastructure, vehicles and agriculture. These are losses that impact directly on existing market operations and thus do not include any environmental costs. Notably for this current project, there is no landslide insurance coverage in Australia, thus all costs are privately absorbed (Osuchowski and Roberts, 2011).
- *Tangible indirect costs*: market identified losses occurring as a consequence of the disaster. These costs can be measured as losses to existing markets but only after the event. Notably these are disruptions to business (production, retail, tourism and other services) and networks

(transport, utilities, communications), agistment, clean-up, alternative accommodation and emergency relief. Notably, rising travel costs and cancellations often result from decrease in visitor numbers following disasters, in particular landslides which cut off tourist roads and make travel difficult.

- *Intangible costs*: all economic losses direct and indirect for which no market exists. These costs reflect significant negative impacts on the functioning ecosystem. Most notable are damages to the physical environment, death and injury, health impacts, household dislocation, and loss of culture, heritage and memorabilia. Then there is the related human frailty from such events that leads to guilt, anger and litigation in distribution or avoidance of costs. There are two reasons in landslide studies why such costs are ignored or limited to only looking at direct intangibles like public mitigation programs. The first is the assumption that many of these costs are minor because they are part of a natural cycle (dynamic variables cannot be handled). The second is the lack of an agreed method of valuing these costs, thus being generally disregarded in quantitative economic costs analyses.

Three measures can be adopted to estimate costs. Hedonic price method is based on the assumption that prices of goods in a market are affected by their characteristics revealed by the willingness to pay for these losses by consumers (Rosen, 1974). An example would be cost of construction reflected in the price of purchasing them, such as post-emergency house prices. Contingent valuation method is based on revealing preferences through survey-based economic techniques for the valuation of non-market resources, such as environmental preservation or the impact of contamination (Diamond and Hausman, 1994). Least cost alternate method is based on the total costs and benefits of alternatives to replace the physically damaged assets. This method includes not only cost of construction but also demand reduction measures that will ensure the disaster will have less chance of occurring (Stavins, 1998). An example would be adding a toll on a road near the landslides, or developing alternative paths that avoid the potential landslide areas. All three methods have the equilibrium perspective of requiring the return of the site to pre-disaster state.

The calculations of all these three category of costs, by any of the three cost measures above, are based on assumed economic and financial recovery back to some normality, or more formally, equilibrium (Holling, 1973). Since these calculations are made or funded by organisations with existing powerbases prior to the disaster, it is natural that they want to calculate economic losses to their pre-existing structures, and then look at risk reduction as the form of economic resilience (Kjekstad and Highland, 2009). They do not have interest in changing the structures so that the ecosystem is more resilient as this could threaten their power base and even question whether the pre-existing structures were in some way responsible or complicit with the size and shape of the disaster (Taleb, 2007).

These calculations are also based on the spatial region that is being included in the study of impacts. The spatial area of the economy being measured takes into account the total ecosystem that the spatial region denotes. From an Australia-wide economy perspective, the Bureau of Transport Economics (2001, p.15) study makes clear that 'business disruption costs typically should not be included. This is because business disruption usually involves a transfer between producers, without a significant loss in national economic efficiency'. At a national level, disruption costs are included only when the disaster affects the level of imports (increase) or exports (decrease). However, if the study aims to measure economic impacts on a smaller local or regional space, then the devastation for businesses directly, and the local community indirectly, can be very significant and needs to be calculated. Whether another region benefits from the disaster by increasing their economic activity on the basis of business disruption in the region under study is seen in such regional studies as an 'externality' (Hallegatte and Przulski, 2010, p.11).

The focus on economic losses by standard (non-resiliency) studies does not mean that economic benefits are completely ignored. The benefits identified in these studies are still based on an implied equilibrium approach to resilience, looking at non-structural changes. As an example, the Bureau of Transport Economics (2001) study identifies only three benefits:

- (i) *tangible direct* subsidies or relief payments made to affected persons or organisations in the region (p. 5);
- (ii) *tangible indirect* increase in prices of agriculture products that other farmers in other regions gain (p. 76); and

- (iii) *intangible* proposed mitigation measures (p. 89).

Dynamic perspective

Despite seminal work by Holling (1973) being produced 40 years ago, the alternative economic dynamic perspective to resilience has been advanced extremely slowly. Hill et al. (2008) define regions as 'resilient' as those that are shock resistant. This is distinct from the standard 'path dependant' equilibria of a regional economy which can result in it being restricted to inadequate and sub-optimal economic activity. This dynamic perspective is based on negating detrimental latent, imminent, or realised shocks and whether they emerge externally or from within the ecosystem. Thus, as Hill et al. (2008) state, resilient regions avoid being locked into restrictive low income level equilibria. Such regions resist a situation where the shock resets the same equilibrium or results in the equilibrium (path) developing a downwards trajectory of economic development (Christopherson et al., 2010). In this context, building resilience requires the presence of resilient institutions that foster and sustain economic development. If they do not, then the region suffers from inability to change and adapt in enough time to address negative shocks, resulting in institutional hysteresis. As Simmie and Martin (2010) note: 'Institutional hysteresis and unchanging cultures can also contribute to a lack of economic resilience' (p.42). More specifically, dynamic resilience is:

...the differential ability of a region's or locality's firms to adapt to changes and shocks in competitive, market, technological, policy and related conditions that shape the evolutionary dynamics and trajectories of that regional or local economy over time (Simmie and Martin, 2010 p. 28).

As Folke (2003) emphasises: 'In a resilient system, change has the potential to create opportunity for development, novelty and innovation. In a vulnerable system even small changes may be devastating' (p. 3). In an Australian study of community based regional resource management groups, Gooch and Warburton (2009) note that for these groups to be resilient, adaptability and transformability are necessary. Through innovation in building resilience, a regional system can secure a regional development economic trajectory that broadly addresses financial, social, and ecological crises affecting the region in a direction described as sustainable development (Courvisanos, 2012).

Handmer and Hillman (2004) apply the dynamic perspective of economic resilience to recovery from disaster in Australia. With the focus on the local ecosystem, this study asks rhetorically whether the aim of recovery is 'simply' to restore pre-disaster state with some aspects of the region never recovering, or instead embrace this devastation as an opportunity to make the local economy more resilient such that economic flows have built-in support to reflexively address future shocks. In adopting the latter strategy, the next time a disaster threatens, positive systems will come into place in anticipation of disaster.

From this dynamic perspective, the economic losses and benefits identified under the equilibrium perspective are still relevant, but limited. As described in Chapter 4, a more community centric engagement model for disaster planning and recovery allows for whole of government pre-emergency and emergency planning to be activated across the affected ecosystem. This aims to bring into the planning process business, education, households, and non-profit organisations in order to change the economic structures in a way that enables the affected region to become stronger. There are no assumptions about returning to normality in this approach. Economic benefits are then seen as opportunities for substantial strategic improvements following disasters, e.g. replacement of destroyed infrastructure with up-to-date facilities or new equipment for the commercial sector. This then becomes a longer term investment in sustainability. Aim of recovery should be to invest in the continued flow of finance to support such sustainable investment. The Australian Red Cross uses the analogy of 'plugging the leaking bucket' to draw attention to the benefits coming from re-circulation of finance within local economies compared to outsourcing goods and services. This requires more than 'thing recovery' in which the replacement of 'things' is the priority to the detriment of long term investment that supports local businesses and circulation of funds within the community. This is long term investment in strengthening community resilience, as referred to in chapters one and four of this literature review.

Global picture

To place the above perspectives into context, Blackwelder (2012) sets out an overview of the global economic scale of natural disasters. First it itemises ten large scale weather disasters in the USA for the first half of 2010. Costs for each disaster is specified in terms of all three types of economic costs, e.g. Hurricane Irene – 50 deaths and \$US7 billion, Upper Midwest flooding along Missouri River – \$US2 billion, Northeast January blizzard – 36 deaths and \$US2 billion, Midwest/Southeast May tornadoes – 177 deaths and \$US7 billion. Climate models predict growing frequency and intensity of such natural disasters attributed to global warming (Blackwelder, 2012). Harvey (2012) provides global estimates of such costs in 2010 at \$US1.2 trillion, wiping 1.6 per cent off global Gross Domestic Product (GDP), with estimates for 2030 rising to 3.2 per cent. This is further deepened by the manner that the existing western economic model, championed by the USA, has been implemented by China in its drive for economic growth. Brown (2011) argues that as a consequence of China's success, the western economic model will inevitably fail. This sends a powerful message that the time has arrived for a new economic model. The alternative model needs to be based on the dynamic perspective of economic resilience, which changes the price and supporting mechanisms on producing goods and services so as to factor in ecological costs of such intensified disasters. This is especially a policy issue in the energy sector which has such strong static economy dependence on fossil fuels driving climate destabilisation.

Alternative models for economic resilience need to be based on adaptive complex systems (CAS). CAS are built on strength and flexibility of relationships between agents within the system, developing critical capacity for adaptation to shocks or perturbations, such that a large number of agents (or components) interact and adapt frequently by learning to ensure strong resilience (Holland, 2006). There are various elements to such CAS that constitute a 'new economy'. One element is infrastructure powered by renewable sources of energy, that has a more diversified public transport system, and that reuses and recycles everything (Brown, 2011). Another element is a change in consumer behaviour to one that is driven by happiness, by working and owning less, and not growth. Polard (2012) argues that such behavioural change needs to unite western science with eastern philosophy.

Australian situation and landslides in particular

In 2012 the total economic cost of natural disasters in Australia was estimated to have exceeded \$A6 billion. With the growing awareness of the frequency of these events it is anticipated that '...costs will double by 2030 and rise to an average of \$A23 billion per year by 2050 even without the consideration of the potential of climate change' (Deloitte Access Economics, 2013, p.8). Prior to 2000 the focus of costs associated with natural disasters was on response to the disaster. Attention has now shifted to implementing strategies that mitigate the impact of natural disasters based on the estimation that '...money spent on disaster mitigation can be more than recouped in the amount saved in response and recovery afterwards' (Bureau of Transport Economics, 2001, p.1). Literature from 2001 estimated that for every \$1 spent in mitigation \$2 was saved. This ratio has increased to \$10 post-disaster saved for every \$1 spent pre-disaster. Currently the ratio of funding spent on post-disaster relief and recovery by the Australian Government (\$A560million) far exceeds that spent on 'pre-disaster resilience' (\$A50 million) (Deloitte Access Economics, 2013). Thus, although in Australia research and policy attention has shifted to pre-emergency planning, this has not been reflected in government action, which has stayed resolutely on post-emergency focus.

The 2001 Disaster Mitigation Research Working Group established frameworks for tracking costs of disasters in Australia (heatwaves and drought are excluded). To be included in the national data base, single events must have resulted in 3+ deaths, at least 20 injuries and/or \$A10 million worth of damage. Such threshold criteria is common in disaster studies, and as a result focus on economic costs for events with one major influence, whereas accumulated costs of smaller events like landslides could well have a similar if not increased impact (Osuchowski and Roberts, 2011). This has implications for rural local governments where smaller events tend to occur and the cost of impact may benefit from a formula not determined by high cost of human tragedy, infrastructure and property, but by being extended to the cumulative impact of multiple linked events on natural assets and cultural

heritage. In rural areas populations are smaller and, in some areas, older, placing a heavy burden on fewer people of such smaller cumulative events like landslides.

Specifically in respect to landslides, their frequency in Australia results in significant tangible economic losses to infrastructure, buildings, and vehicles and even more important intangible losses like death and injury (Geoscience Australia, 2007). It was not until the Thredbo landslide tragedy in 1997 that this form of natural disaster gained public recognition. Despite this, economic reports on natural hazards, notably the Bureau of Transport Economics (BTE; 2001) study, omit the consideration of landslide economic costs because such events do not satisfy threshold initial damage criteria and are located in less populous regional areas. As this BTE (2001) study acknowledges, this threshold problem extends to insurance coverage, where landslides are seriously underestimated with so many landslide cumulative events all occurring below the insurance threshold of \$10M or where there is also no insurance coverage at all. Thus, the cumulative impact of less high profile landslides has been largely overlooked in national risk and hazard cost analyses. Further, indirect and direct costs include the mitigation of future landslides, its adverse effects on water quality and streams, the irrigation losses due to landslips, secondary effects of landslide causing flooding, reduced real estate value, loss of industrial, agricultural and forest productivity, and reduced tourist revenue due to damaged facilities with disrupted transport systems (Osuchowski and Roberts, 2011).

One study on the economic impacts of landslides was conducted by Osuchowski and Roberts (2011) which examined seven case studies of landslides in the Wollongong region, including the August 1988 cumulative event of intense rainfall that resulted in one drowning fatality and approximately 148 landslides. This study noted that the distributed nature of shared costs across multiple departments and levels of government, multiple local government areas, along with costs borne by individuals, business and communities make these costs difficult to track and evaluate. The conclusion reached can be summarised in the following quote:

The case studies highlight that landslide issues affecting local assets as well as property can place significant strain on a local council as well as the local community. Ongoing road closures, continued movement of landslides in residential areas and the failure to implement engineering solutions due to insufficient resources demonstrates that mitigation and remedial action is often too costly for WCC [Wollongong City Council] and its community, and that the legal and social burden on WCC is great.

(Osuchowski and Roberts, 2011, p.46)

As the quote attests to, the low threshold but cumulative nature of landslides, and the ongoing problems that continue long after the landslide events, clearly point to the need for a dynamic perspective to economic resilience. Recognition that the costs of many landslide events individually do not reach the threshold amount for analysis but that the cumulative costs in the one area far exceed this amount, is further testament to the need for a dynamic perspective. However, the extensive data and its analysis prevent this outcome from being achieved. A number of landslide inventory data bases exist at local government level but are not consistently compatible with national databases. At a local level the unique nature of different landscapes and capacities to respond are frequently recorded as narratives or in qualitative data (Handmer et al., 2002). The Wollongong study highlights the ongoing problems local councils in particular face with effectively managing a hazard that can be beyond their budgetary capacity to mitigate and the need for access to funding to assist (Osuchowski and Roberts, 2011). The limited capacity of all governments to support pre- and post-emergency planning limits the ability of regions to build resilience. Also, unplanned remediation works can significantly disrupt local government budgets over a number of years.

The private sector in the community is also significantly impacted by the lack of recognition of the economic impacts of landslides. Landslide costs continue to be absorbed directly by individual property owners as well as by infrastructure authorities and local governments. This is not the case with flood, fire, cyclones and earthquakes (Osuchowski and Roberts, 2011). Such concerns have been exacerbated following the 2008 Global Financial Crises (GFC) as the private sector has become less able to address such uncertainty-based concerns when facing more immediate financial woes (Courvisanos, 2012).

Climate change and economic impacts of landslides

To place climate change in the context of natural disasters, a survey of the 500 largest global companies was conducted by the Carbon Disclosure Project in 2012. In this survey with 80% response rate, revealed what climate change (or more specifically global warming) means for these business:

Recent extreme weather and natural events have tested companies' business resilience and increased their level of understanding of the timeframes of the physical risks they associate with climate change. Physical risks are viewed as tangible and present, impacting companies' operations, supply chains and business planning. The majority of companies (81%) report physical risks and the percentage of companies that view these risks as current have nearly quadrupled from 10 per cent in 2010 to 37 per cent in 2012. (Carbon Disclosure Project, 2012, p.43)

This reduced resilience by global companies due to climate change raises the risk of significant increased tangible costs (equilibrium concept) in an ecological environment that has much greater uncertainty (dynamic concept). The Climate Institute (2012) study on managing risks to Australia's infrastructure provides both a static costs perspective to economic impacts, as well as a dynamic long term investment perspective to climate change concerns. It notes the main climate change risk is intensified rainfall and its effect on road and rail due to increased flooding. This results in greater potential risks of landslides followed by road collapse and washout of roads and rail tracks.

Conclusion

Two major concerns arise from this review. One is the issue of inappropriate cost models for determining landslide costs because of the different type of landslide movement and damage (e.g. some are slow moving), with accompanying lack of data and research. This issue affects regional Australia much more than other natural disasters, and is exacerbated by climate change. Better quantification of landslide costs is essential to develop informed policy and practice. Why are landslides treated with much less importance than other natural hazards? This leads to the second issue of concern. The dominant equilibrium perspective to damage-based research lends itself to econometric analysis of natural disasters that are major events that occur irregularly and have a specific, tight timing end point. With landslides, there is cumulative causation (Ricoy, 1987) arising from the small but cumulative impact of multiple linked events (such as the initial flood event, subsequent evaluations, the landslides and road closures) over a much longer period of time. To better understand the cumulative impacts, complex adaptive systems methods that take a dynamic perspective of economic and community resilience need to be developed, however these have not been adopted in Australian disaster studies. This Grampians study will require such an approach. Further, the survey instruments used for this study have a strong time scale base to them to ensure such dynamic analysis can be conducted. Also, data recorded by different agencies that are linked to Northern Grampians and its partners will further enable this analysis.

Of major implication for the community and local government is the nature of eligibility criteria for relief funding, which excludes most landslide related events. This means there is a need for a different evidence base than insurance/relief funding/economic reports, which have the limitations identified in the previous paragraph. In this study, the historically lengthy local government records in the Grampians region may provide important local information on vulnerable sites and histories but are not nationally compatible. This should allow some dynamic analyses to be conducted. A number of reports note constructive work being done by the NSW fire-brigade on a relevant framework may prove relevant to this study. From such analyses, physical infrastructure provision, together with enhanced strategic development assessment planning, consistent geospatial mapping, technical improved building standards and targeted community and business education programs could lead to savings for all levels of government, business and individual households. This requires a long-term time horizon for all such analyses, and not mere risk reduction short term exercises.

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Chapter 3: Environmental Impact of Natural Disasters on Communities

Environment is a broad term which can encompass both the natural and built environments. Natural disasters impact on both, creating vulnerability for humans and other species (Wisner et al., 1994). While much has been written on the impacts of natural disasters in Australia such as floods (e.g. Yeo, 2002; Boon, 2013), cyclones (e.g. Anderson-Berry, 2003; Callaghan, 2003; Li, 2009), storms (e.g. Andrews and Blong, 1997; Leigh and Kuhnelt, 2001) and fires (e.g. McLennan et al., 2013; Whittaker et al., 2013), comparatively little has been published on landslides.

Landslide events can impact the built environment such as urban structures, service conduits, transport corridors and energy distribution networks, both directly and at a remote distance. For example, a landslide may destroy buildings and roads, but will also affect the sewers, water supplies, electrical lines and access for those people in the surrounding areas (Brabb and Harrod, 1989; Highland and Bobrowsky, 2008). Since landslides occur in mountainous areas, road links are particularly vulnerable to disruption, even if the landslide occurs outside settled areas. Often alternative routes do not exist, or lengthy detours are required. In Victoria, main roads such as the Great Ocean Road have been closed for several months due to landslide events (Dahlhaus et al., 1987; Miner, 1999; Dahlhaus, 2003), creating a significance inconvenience for the local residents and impact on business.

The AGS LRM framework (Leventhal, 2007), guidelines (AGS, 2007) and practice notes (Walker et al., 2007) provide the details of how to qualitatively and quantitatively assess the landslide risk, with a focus on the human environment. In a consequence analysis, the LRM practice notes acknowledge that the elements at risk may include:

- Property, which may be subdivided into portions relative to the hazard being considered;
 - People, who either live, work, or may spend some time in the area affected by landsliding;
 - Services, such as water supply or drainage or electricity supply;
 - Roads and communication facilities;
 - Vehicles on roads, subdivided into categories (cars, trucks, buses).
- (Noting that these should be assessed and listed for each landslide hazard).

However, the LRM practice notes also acknowledge other consequences such as:

- Environmental, where the elements at risk are environmental (rather than man-made), such as forests or water bodies;
- Social, where the consequences of the landslide may have an impact on social conditions, such as the cost of disruption to traffic where roads are affected;
- Political, where the consequences may not be acceptable in political terms.

The impacts on the man-made environment also require consideration of the temporal spatial probability ($P(T:S)$). This includes mobile elements at risk (e.g. persons walking or running, cars, buses, trains, etc.), varying occupancy of buildings (e.g. night/day, week/weekends, summer/winter), and the possibility that persons may be warned beforehand and evacuated. It is generally observed that people on a fast-moving landslide are more likely to experience the movement and escape, than those below the landslide which flows or falls onto them.

In estimating the risk, Walker et al. (2007) state that quantitative risk estimation involves integration of the frequency analysis and the consequences.

For property, they state that the risk can be calculated from:

$$R_{(Prop)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(Prop:S)} \times E$$

Where

- $R_{(Prop)}$ is the risk (annual loss of property value).
- $P_{(H)}$ is the annual probability of the landslide.
- $P_{(S:H)}$ is the probability of spatial impact by the landslide on the property, taking into account the travel distance and travel direction.
- $P_{(T:S)}$ is the temporal spatial probability. For houses and other buildings $P_{(T:S)} = 1.0$. For Vehicles

and other moving elements at risk $1.0 < P_{(T:S)} > 0$.

$V_{(Prop:S)}$ is the vulnerability of the property to the spatial impact (proportion of property value lost).

E is the element at risk (e.g. the value or net present value of the property).

And for loss of life, the individual risk can be calculated from:

$$R_{(LoL)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(D:T)}$$

Where

$R_{(LoL)}$ is the risk (annual probability of loss of life (death) of an individual).

$P_{(H)}$ is the annual probability of the landslide.

$P_{(S:H)}$ is the probability of spatial impact of the landslide impacting a building (location) taking into account the travel distance and travel direction given the event.

$P_{(T:S)}$ is the temporal spatial probability (e.g. of the building or location being occupied by the individual) given the spatial impact and allowing for the possibility of evacuation given there is warning of the landslide occurrence.

$V_{(D:T)}$ is the vulnerability of the individual (probability of loss of life of the individual given the impact).

A full risk analysis requires the consideration of all types of landslide hazards for a site (e.g. boulder falls, debris flows) and all the elements at risk. Obviously, this is not an easy task or one that can be completed at the time of an emergency. A full LRM analysis begins with a hazard analysis, requiring the characterisation of landslide types and an analysis of their frequency (Leventhal, 2007). In municipal planning, this results in landslide susceptibility zoning - developing a landslide inventory and maps showing landslides, source areas and areas where they may travel on to regress in to (AGS, 2007). The next step is landslide susceptibility zoning which extends landslide hazard zoning by assigning an estimated frequency (annual probability of a landslide event). Finally, landslide risk zoning takes into account the hazard and the consequences, assigning annual probability of property loss and/or lives lost for the elements at risk.

An assessment of consequence and risk to the man-made environment is more certain than the natural environment. Estimating the value of the natural environment requires skills in ecological economics, which is still an emerging discipline (Costanza et al., 2007). However, some guidance is provided in the handbook to the Australian Risk Management Standard (Standards Australia, 2009) on 'Managing environment-related risk' (Standards Australia, 2012). The handbook makes the point that environmental risks are not related to jurisdictional boundaries. Indeed, some aspects of environmental-related landslide risk may be regional (e.g. impacts on waterways, or high-value remnant vegetation) or global (e.g. impacts on migratory birds, or threatened species). In some cases risk treatments may require agreement across jurisdictional boundaries (e.g. National Park boundaries, road reserves, creek reserves) and the resulting controls may have a profound effect for organisations and individuals at the local, regional, state or national scale, and the environmental-related risks may need to be addressed at all these levels (Standards Australia, 2012).

Complexity is introduced to an evaluation of the impact of landslides on the environment because of the limits of current knowledge and understanding of how ecosystems function and respond to the change (Standards Australia, 2012). It is long recognised that landslides are a natural process by which our landscapes evolve (Hills, 1940; Conacher and Dalrymple, 1977) and that ecological systems have evolved with the landscapes. Resilience of species to recover from natural disasters and recolonise disturbed ground has been observed (e.g. Reice et al., 1990; Sedell et al., 1990), however little information was found in the published literature regarding the recovery of the natural environment following landslides.

By comparison, landslides have long been recognised as a form of land degradation, usually associated with the clearing of the native vegetation (e.g. Dahlhaus and MacEwan, 1997; Dahlhaus et al., 2006) or logging (e.g. Jakob and Weatherly, 2008). Landslides create turbidity in waterways, accelerate erosion and deposit sediment into urban water supplies (Brabb and Harrod, 1989). Similarly, landslide dams, formed when a landslide blocks a river, can result in severe changes to the river environment and create a new hazard in their own right (Wisner et al., 1994; Peng and Zhang, 2012). Landslide dams are quite common and if they persist through time, create new lake

environments such as Lake Elizabeth in south west Victoria and Lake Tali Karng in Gippsland, both regarded as high value environmental assets (Joyce and King, 1980).

Grampians context

Many of the issues briefly discussed above directly relate to the landslide events of January 2011 in the Grampians.

Impacts on the built environment were dramatic: with little or no warning, roads were closed for many months, severing transport links and local communication corridors (GHD, 2011); private and public property was damaged; residents were evacuated and interim guidelines formulated (NGS, 2013); infrastructure damage closed areas of the National Park (DSE, 2011); landslide susceptibility zoning for the areas most at risk were mapped (GHD and ASMG, 2011); and water supply to rural residents was impacted due to water quality impacts (Wallis and Graymore, 2012).

Impacts on the natural environment were equally dramatic, but not well documented. The risk assessment completed shortly after the events by the Bushfire Rapid Risk Assessment Team recorded damage to the environment and cultural values, including '*...loss of significant fauna due to the inability to continue predator control programs*' (DSE, 2011).

The landslides impacted assets across multiple land management tenures and required multi-jurisdictional cooperation to resolve the immediate risks. The impacts are further discussed in the report.

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Chapter 4: Emergency Management Best Practice for Natural Disaster

Current literature for emergency management best practice in Australia and internationally has been largely focused on community support and resilience during response and recovery to emergencies and disasters. This is evident in national and state manuals for responding to emergencies and in current discussions found in Australia's emergency management institute journal. These will be explored briefly, below. It should be noted that resources outlined in this section relate more broadly to best practice across all disasters (natural and human made) and not specifically landslides.

An exploration of international literature and best practice about provisions and interventions to meet the needs of people affected by emergencies is contained in the report by Eyre (2006). Commissioned by the UK government, the review focused on the psycho-social impacts and implications across disasters, however the logic and best practice could be attributed to other areas of impact following disaster.

Eyre proposes that much of the current knowledge about assistance and management for disasters has occurred through understanding the psycho-social impacts of disaster and responding to people's needs across the disaster 'timeline' (pre-, within-, and post-disaster). This has contributed to the knowledge base and provided the foundation for current best practice. In the very earliest stages of a disaster, 'proactive outreach' is essential and includes support for bereavement and contact with those affected. Eyre recommends that interventions for disaster at this early stage should also focus on empowerment and in building resilience and strengths, capabilities and self-sufficiencies in parallel with the provision of support services for those affected by disaster. In examining the literature around emergency service planning Eyre ascertained that there was evidence for communities to be involved in this process, facilitating citizen preparedness and educating individuals, families and communities surrounding emergency responses.

In the medium to long term after a disaster, Eyre highlights the importance of strategies for outreach and information as being essential for effective psycho-social support. Visits to disaster sites should be carefully managed, and the coordination of psycho-social support services from different groups – their roles and functions – should be clearly identified by the coordinators of psycho-social support following disaster.

A key recommendation from Eyre's report is for greater consideration of, and better planning for psycho-social support following disaster. Eyre outlines various considerations when developing models of psycho-social support following disaster, including (but not limited to):

- Integrated planning for prepared, training and exercising activities for response at local, regional and national levels;
- Joint planning is required in the short term, as well as for medium and long term disaster recovery;
- Flexible and appropriate approach is essential, incorporating proactive outreach and communication strategies;
- Models should include principles of community resilience and support processes. It is important for individuals and communities to actively participate in the recovery and development strategies;
- Develop service goals and design recovery strategies and program goals with input and participation from the community (Eyre, 2006, pp. 78-79).

More recent literature, particularly from Australian Emergency Management focuses on community resilience and communication. Emphasis is now being placed on building stronger communities before a natural disaster occurs, and to then draw upon these core community strengths to build longer term support for communities following disaster. This is because communities that are strong before a disaster are better able to recover (National Emergency Management Committee, 2011).

The recent review of the Victorian flood warning and response by the Victorian Floods Review (VFR) (Comrie, 2011) demonstrates a number of shortcomings of the State's emergency management arrangements. Comrie (2011) identified a number of factors including:

- the lack of an overarching policy framework or centralised operational control leading to an uncoordinated structure which breaks down in the face of large scale emergencies;

- barriers in communication, coordination, interoperability and information sharing and collation;
- lack of clarity over roles and ownership;
- lack of municipal resources;
- gaps in the flood warning system which need to be tailored to local needs;
- lack of adequate consideration for local knowledge (Comrie, 2011).

The VFR was also in agreement with others that the most effective way to make 'our communities safer is to build their resilience to natural disasters' (Comrie, 2011, p. 5). Consequently, this approach is gaining momentum and is becoming more widely accepted and adopted both nationally and internationally. However, the practicalities of implementing approaches to resilience whilst working from a linear process may be problematic.

The AGS LRM framework (Leventhal, 2007) based on the Australian standard provides a systematic, disciplined and rigorous approach to landslide risk for municipal planning and strategic emergency management in Australia. In particular, it provides the authorities with unambiguous, logical and defensible processes and practices for the assessment of landslide risk. It can inform the development of strategies and decision making to protect all classes of assets which are threatened by landslides. Throughout the risk management process, three elements are essential (Standards Australia, 2009):

- Consult and communicate: Burgman (2005) suggests that those bearing the risks need to be involved from the outset in all stages, recognising that human perceptions and values affect experts and analysts as strongly as other stakeholders. At the very least, consultation and communication is essential to clarify the roles and responsibilities of the State government agencies, emergency volunteers and municipal authorities. Throughout the risk management process, regular communication is required to inform and educate stakeholders of the risk and risk treatment options.
- Monitor and review: monitoring and reviewing the risk assessment may be in the form of third-party audits as quality assurance. Regular monitoring of the effectiveness of the treatment is essential and should result in a regular re-evaluation of the risks. This is particularly important in landscapes undergoing continuous land-use change (which results in continuous hydrologic change) and changing climates.
- Recording the process: recording the risk management process is usually required as part of the legal and business requirements of an organization and should include a risk register and incident database.

In a paper on the current model of disaster response and building community resilience, Rogers (2011) proposes the importance of adopting best practice to extend and enhance Australia's current emergency management approach, currently comprising four keys areas of operation:

- 1) Preparing for emergencies;
- 2) Preventing emergencies;
- 3) Responding to emergencies;
- 4) Recovering from emergencies.

This model is often abbreviated to the PPRR approach. Rogers suggests the current model needs to be refined and for this to occur, it needs to draw on international best practice. This is essential for building both anticipation into, and assessment of, risks that comprises a holistic approach to the disaster 'life-cycle' and security management. This draws upon the increased move towards national resilience and resilience strategies in emergency management.

Nicholls (2012) recently explored the importance of communication in producing and supporting resilient communities, before and in the face of natural disaster. The authors identify dialogic communication (two-way communication where there is speaking and listening on both sides with the feedback mechanism central) as pivotal to fostering community resilience in the face of disaster, across all stages of natural disaster, from prevention and preparation of disaster, to exacerbate the emergency response during crisis and finally, to facilitate recovery.

Resilience in Australia's disaster management policies is certainly gaining momentum. Prosser and Peters (2010) suggest the move to incorporate resilience in policy has been informed by national and international advocates, including the United Nations and the APEC that are now seeking to improve disaster resilience for communities and improve long term risk reduction. However, the authors comment that concepts of resilience are somewhat at odds with traditional models of policy thinking, which is an adopted linear and reductionist approach using restricted conceptual models to solve problems. They propose the linearity of this approach is insufficient in meeting the complex requirements of building community resilience.

The Australian Emergency Management Institute (2011) has prepared a series of handbooks for emergency services management. The Community Recovery Handbook is a comprehensive guide to recovery in Australia for planners, managers and others when working with communities to design and deliver services and activities for recovery management and service delivery. The handbook draws widely on the PPRR approach (mentioned earlier: prevention, preparedness, response, recovery) but where planning preparedness and recovery should encourage and promote individual and community resilience and in which innovation and adaption are facilitated and resilience leads to recovery from disaster (Australian Emergency Management Institute, 2011, p. 3).

In outlining the divisions of duties, the handbook indicates that all levels of government provide support to communities during a disaster. In most areas of Australia, local government is considered to be the 'key lead agencies in disasters' (p.3). State and Territory departments provide the emergency-related services including, health, social welfare and recovery services, education, agriculture, policing and policy (emergency management and building control). The Commonwealth government does not have direct response to local or emergency services, but provides financial assistance for affected communities and supports cost sharing for States and Territories to relieve the financial burdens of disaster.

The roles and responsibilities for managing landslide risk for Federal, State and Territory and local government are outlined in Chapter 8 of *Natural Hazards in Australia: Identifying Risk Analysis Requirements* (Middleman, 2007). These are summarised below:

- Australian Government: Focus on establishing community safety. It has a priority through awareness, education, research and planning to reduce the risk of natural disasters and landslides.
- State and Territory Governments: Legislative responsibilities and approaches to managing landslides vary between states and territories; for legislative requirements all refer to the Australian Geomechanics Society (2000) *Landslide Risk Management Concepts and Guidelines*. A key role for all States and Territories is to support and partner local governments to undertake risk assessments and mitigation measures. They have responsibility for planning and policies of land and of protecting key transportation infrastructure.
- Local Government: Responsible for minimising risk and establishing controls for slope management resides with local government. As such, risk assessments in land planning to minimise loss due to landslides (using appropriate information) is the responsibility of local government. Implementation of planning and zoning responsibility for landslides does vary between LGAs.

Australian Emergency Management Institute (2011) Handbook places emphasis on affected communities leading their own community recovery and of recovery agencies providing support to communities to manage their own recovery process. The handbook draws widely on literature surrounding the potential value and importance of individual and community resilience before, during and after a disaster. For those involved in the management and recovery, a range of community engagement methods are proposed (including clear and transparent engagement with communities about decision making) to facilitate optimal outcomes.

Developing a framework to support and strengthen communities through resilience is the cornerstone of the Council of Australian Governments (COAG) National Strategy for Disaster Resilience (2011) to minimise the adverse effect of disaster in Australia. This new approach broadens the responsibility of disaster planning and response from emergency management agencies to the whole community and encourages building community resilience. As outlined below:

This new focus on resilience calls for an integrated, whole-of-nation effort encompassing enhanced partnerships, shared responsibility, a better understanding of the risk environment and disaster impacts, and an adaptive and empowered community that acts on this understanding (Emergency Management Committee, 2011, p. 3).

Seven actions are outlined in this COAG document to necessitate change and build disaster resilience. Communication with the community is key to the success of planning appropriate approaches that address flexibly through emergency services and communities following disaster. These actions include:

- Leading change and coordinating effort: through shared and coordinated leadership with leaders drawn from government, business, not for profit, and communities;
- Understanding Risk: knowledge and planning of local disaster risks, including improved information and data sharing;
- Communicating with and educating people about risks;
- Partnering with those who affect change: Working together and identifying experts;
- Empowering individuals and communities to exercise choice and take responsibility;
- Reducing risk in the built environment;
- Supporting capabilities for disaster resilience.

For further information about these strategies and examples of the progress some communities have made see the National Strategy for Disaster Resilience, Companion Booklet (Commonwealth of Australia, 2012).

In June 2013, the Australian Business Roundtable for Disaster Resilience and Safer Communities released a White Paper prepared by Deloitte Access Economics (2013) title *Building our Nation's Resilience to Natural Disaster*. This paper focuses on the 'prevention' approach of the current PRRR Emergency Management Approach and proposes a clear opportunity to build safer and resilient communities in Australia through a sustainable and comprehensive approach to managing natural disasters and to reduce the economic burden of disasters (p. 9). To do this, greater investment in building community resilience and a broader, shared response to natural disasters is required (Deloitte Access Economics, 2013).

Three recommendations are outlined in this paper as a mechanism for implementing a new approach for pre-disaster activities at the National level. These include:

- Improved coordination of pre-disaster resilience by adopting a National Resilience Advisor and establishing a Business and Community Advisory Group. This recommendation is based on the premise that community resilience should be central to government decision making for the effective coordination of activities at business, community and individual level. It is proposed that this could be facilitated with the support of the Business and Community Advisory Group, and with policy and decision-making input from business and not for profits.
- Commit to long-term annual consolidating funding for pre-disaster resilience. It is proposed that government commitment should be channelled into the consolidating mitigation outlays and to funding programs that fosters mitigation infrastructure and related activity. This will assist in consolidating information and data that can then be used to implement local responses by local government, communities and businesses.
- Identify and prioritise pre-disaster investment activities that deliver a positive net impact on future budget outlays. Mitigation activities should be cost-effective and lead to positive outcomes for pre-disaster resilience.

Indeed, the paper by Gabriel (2003) written a decade ago, proposes a model of community safety planning, integrated at the municipal local government level, to develop a holistic model of community safety planning. By responding to State government legislation and funding, community safety planning can be managed at the local government level by local personnel. This ensures commitment and ownership of the model and promotes resilience and responding to key risk management principles including:

- Identify, analyse, and prioritise risk;
- Treat risks;

- Acknowledge existence of residual risks;
- Plan and prepare emergency operations.

Late in 2012, the State Government of Victoria released its Victorian Emergency Management Reform White Paper. The document outlines improvements and reforms to Victoria's current emergency management protocols and updates past arrangements in light of reports into the 2009 Victorian Bushfire Royal Commission and 2010-2011 Floods Warnings and Responsibilities. While reforms have already been/are being implemented as a result of the outcomes from recent events in Victoria, the White Paper outlines new governance arrangements for a collaborative approach to emergency management and the associated responsibility for this. A stronger approach for community involvement in the planning of emergency disasters is proposed with a vision for 'A sustainable and efficient emergency management system that minimises the likelihood and consequences of disasters and emergencies on the Victorian community' (Victorian Government, 2012, p. 1). The paper presents three principles for meeting the vision that comprises community, collaboration and capability across five strategic priorities (each with a series of actions for achieving the priority), specifically:

- Building community resilience and community safety;
- Streamlining governance arrangements;
- Establishing clear and effective response and control arrangements;
- Strengthening emergency management planning processes;
- Building capacity and capability of the emergency management sector.

This White Paper, as with many of the recent emergency management documents and leading literature, places strong emphasis on engaging with communities to strengthen resilience in preparation for and in response to natural disaster. This reflects a 'ground-up', preventative approach in which knowledge at the community level is viewed as instrumental to the preparation, response and recovery of emergency events. Building community resilience is based upon their engagement with the approaches and this requires collaboration between services and key members of the community, including government, local business, essential services and not-for-profits (Victorian Government, 2012 p. 4). This 'bottom-up' approach recognises that local knowledge and ownership are key elements in effective response and recovery process as they enable greater local flexibility and lead to greater levels of community resilience (United Kingdom Cabinet Office, 2010; Prosser and Peters, 2010; Coles and Buckle, 2004).

There are a number of examples of bottom-up approaches to community planning and emergency management that can build community resilience including neighbourhood programs such as Fireguard (www.cfa.vic.gov.au/plan-prepare/community-fireguard/); Community Planning Strategies by the Centre for Rural Communities (www.ruralcommunities.com.au); Borderlands (www.borderlands.org.au); Commonground (www.groupwork.com.au/commonground.html); City of Port Phillip Weather Ready Plan (<http://www.enviroehub.com.au/weather-ready/>); and the nine steps of collaborative community engagement (Shiel, 2013). Each approach involves the community in local forums of different types enabling local authorities to work collaboratively with them to plan, prepare, respond and recover from natural disasters.

Emergency management in Victoria is currently guided by the Emergency Management Manual Victoria (Department of Justice, 2013). This manual provides guidance on the roles and responsibilities of emergency response organisations in mitigation, planning, response and recovery for the whole range of emergencies from natural disasters to acts of terrorism. When an emergency occurs the manual provides direction for which agency should be the control agency for the emergency, as well as who is responsible for individual services, support and repair/rebuilding during relief and recovery phases of the response. However, this manual does not include landslides in the manual, which means there is little guidance on which agency should take control and what to do in when one occurs. Thus, the control agency for landslides falls on Victorian Police, as they are listed as the control agency for 'other threats against person, property or environment' (Department of Justice, 2013, p. 7-4).

The Emergency Management Manual, in response to the National Strategy for Disaster Resilience and the Victorian Emergency Management Reform White Paper has taken on board some of the best practice emergency management approaches (Department of Justice, 2013). For example, building

community resilience is listed as a priority for emergence response, relief and recovery, as well as the involvement of affected community in emergency management.

In summary, this chapter of the literature review outlines current thinking associated with emergency responses. There is a strong and growing acceptance of the importance of community resilience and community engagement in the response to disaster situations, led by local government (the recognised leader in disaster situations). Recent, national frameworks are incorporating methods to improving community resilience in response to disaster, with emphasis on pre-disaster planning and on mitigation.

For all communities and local government areas, there is a strong mandate to adopt strategies for improving commitment and response by the community to potential disaster. In the planning stages for responding to natural disaster activities planning activities should include representatives from the community and draw directly on the principles outlined by the COAG brief through the leadership of change, understanding risk, strong communication, partnership to effect change, empowering individuals in making decisions and taking responsibility.

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- Prosser, B., and Peters, C. (2010). Directions in disaster resilience policy. *The Australian Journal of Emergency Management*, **25**(3), 8-11.
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United Kingdom Cabinet Office. (2011). Strategic national framework on community resilience. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/60922/Strategic-National-Framework-on-Community-Resilience_0.pdf

Victorian Government. (2012). *Victorian emergency management reform: White paper*. Retrieved August 26, 2013, from http://www.dpc.vic.gov.au/images/images/featured_dpc/victorian_emergency_management_reform_white_paper_dec2012_web.pdf

Resources

Research into building community resilience

A systematic approach to community planning that progresses understanding of roles and responsibilities of local government and regional organisations is documented in the following:

Caling, T. (2005). Bruthen and District Study Circle. *New Community Quarterly*, Vol. 3. (No.4. Summer).

Paton. L. (2005). Study circles and community development. *New Community Quarterly*, Vol. 3, 22-24.

Sheil H. and Smith, R. (2006). From margins to the mainstream. *The Changing Nature of Australia's Country Towns*. Eds: Rogers, M., & Jones, D. VURRN press, Ballarat: www.vurnnpress.com.au.

Sheil, H. and Cartwright, K. (2005). Making local knowledge work. *New Community Quarterly*, Vol. 3 (No.4. Summer) 14-21.

Sheil, H., Pugliesie, T., and Gay, L. (2004) Local values and local knowledge shaping community involvement: Role of regional university. *New Community Quarterly*, 2, 13-20.

Twite, B. (2005). The Bena Study Circle. *New Community Quarterly*, Vol. 3, 39-41.

Planning tools and programs

The Buchan Neighbourhood House established and maintained a 'Community Information Flow' between agencies (many external) and locals acting as a trusted broker keeping everyone more informed over a sustained period (Davies 2010; www.ncq.org). A relationship developed over several 'fire seasons'. Communities do not arrive at this point in isolation – skilled facilitators able to bring together the diversity of views within a community are a key component of implementing this shift.

The CFA Fireguard website (www.cfa.vic.gov.au/plan-prepare/community-fireguard) documents changing experiences of community's that have carried out risk assessment and set up phone-trees. During fires they actively informed central brigades of fire spotting enabling the brigade to work more effectively - 'they knew more than us'.

The East Gippsland Shire Sustainability Kit can assist in clarifying roles and responsibilities. The primer kit, matrix and cards facilitate engagement from individual, household, community, organisational, government and international levels in a constructive and flexible way that clarifies roles, identifies shared responsibilities and opportunities for collaboration on desired agendas: http://www.eastgippsland.vic.gov.au/About_Us/Our_Environment/Environment_Groups_and_Events

Strengthening Seven Small Communities (Sheil H. S., 2006) – Shire of Latrobe Valley (Sheil, 2006) employed facilitators through local government to work with communities to develop plans (www.vurnnpress.com.au).

Centre for Rural Communities Community Planning Strategies: www.ruralcommunities.com

Borderlands: www.borderlands.org.au

Commonground: www.groupwork.com.au/commonground.html

City of Port Phillip Weather Ready Plan: <http://www.enviroehub.com.au/weather-ready>; Contact: Sally Moxham at City of Port Phillip

Community initiatives

Blaze aid: blazeaid.com.au

Guides and manuals

Community development in recovery from disaster: <http://www.em.gov.au/Documents/Manual29-CommunityDevelopmentInRecoveryFromDisaster.pdf>

Reducing the Community Impact of Landslides: <http://www.em.gov.au/Documents/Manual24-ReducingtheCommunityImpactofLandslides.pdf>

Appendix B

Research collection tools:

Interview Schedule for Infrastructure Organisations and Emergency Services Management Consultants

1. Please describe you/ your organisation's involvement in responding to events during the Grampians Natural Disaster Event? And during the recovery phase?
(If not answered in response to Question 1). Please describe you /your organisation's role during the Grampians Natural Disaster Event and recovery phase?
2. Please describe you/your organisation's level of preparedness to respond to events during the Grampians Natural Disaster Event? And during the recovery phase?
3. Please describe the most significant contribution/s that you/your organisation made in response to events during the Grampians Natural Disaster Event? And during the recovery phase?
4. Please identify any improvements that you/your organisation could make that would improve/enhance your response to natural disaster events and recovery operations in the future?
5. Has you/ your organisation's preparedness to respond to natural disaster in future changed since its response to the Grampians Natural Disaster Event? And during the recovery phase? If so, please describe these changes.
6. Please outline the costs to you/your organisation during the Grampians Natural Disaster Event? And during the recovery phase? Please estimate (and list) the direct/indirect costs for your organisation in responding to this event? In recovery phase?
7. Please describe the level of coordination across all emergency services and related organisations in response to the Grampians Natural Disaster Event and in recovery phase? What worked well across all organisations? What could be improved for future response planning?
8. Is there any other information you would like to share from your organisation's perspective that has not been included in the questions above.

Interview Schedule for community organisations and local businesses

1. Please describe how your business/your community organisation was affected by the events during the Grampians Natural Disaster Event? And during the recovery phase?
2. Please outline the impacts (social, economic and environmental) of this event on your business/organisation?
3. Please outline the costs to you/your organisation from the Grampians Natural Disaster Event? And during the recovery phase? Please estimate (and list) the direct/indirect costs for your organisation in responding to this event? In recovery phase?
4. Please rate and describe your business/your organisation's level of preparedness to the Grampians Natural Disaster Event? And during the recovery phase? (Rating level: 1 – 10; 1 = not prepared; 10 = very prepared).
5. Please identify any internal improvements to your organisation that could improve/enhance your organisation's' response to natural disaster events in the future?
6. Please identify any linkages or other external arrangements that your organisation could make to improve/enhance your organisation's' response to natural disaster events in the future?
7. Please describe the level of coordination with the emergency services and related organisations in response to the Grampians Natural Disaster Event and in recovery phase? What worked well for your business/organisation? What could be improved for future response planning?
8. Is there any other information you would like to share from your organisation's perspective that has not been included in the questions above.

Surveys

Survey: Individuals/Residents

Social Impacts

1.1 Briefly outline how you and your family were impacted by the Grampians natural disaster event.

1.2 At the time of the event, rate the impact it had on you and your family.

Very little impact	Low impact	Neither low nor high impact	High impact	Very high impact
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.3 During the Grampians natural disaster event, was there a direct threat to you and your family?

Personal safety Family members Home/property Possessions
 No direct threat (go to question 1.5) Other: _____

1.4 Describe the direct threat to you and your family during the event.

1.5 Did you, your family, friends or neighbours receive an injury as a result of the event?

During the event During the recovery Now No injuries received (go to question 1.7)

1.6 Describe the injuries received by you, your family, friends or neighbours.

1.7 Estimate how prepared you and your family were prior to the Grampians natural disaster event.

Very unprepared	Unprepared	Neither prepared nor unprepared	Prepared	Very prepared
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.8 Please provide reasons for your response:

1.9 What impact do you think the event has had on you and your family's health and wellbeing?

Very negative	Negative	Neither negative nor positive	Positive	Very positive
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.10 What impact do you think the event has had on the following?

	Very negative	Negative	Neither negative nor positive	Positive	Very positive
Your ability to cope with difficult circumstances in your life	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Your ability to cope with another natural disaster	<input type="checkbox"/>				
Your relationships with family and friends	<input type="checkbox"/>				
Your relationships with people in your community	<input type="checkbox"/>				

1.11 Based on your response to the above question, please describe how your ability to cope was impacted.

1.12 Identify any social costs to you/your family/your community during the recovery.

Community Impacts

2.1 Thinking about the social and economic impact of the Grampians natural disaster management strategies in your community, how prepared were the disaster management services?

	Very unprepared	Unprepared	Neither prepared nor unprepared	Prepared	Very prepared	N/A
During the event	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
During the recovery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2.2 Please describe the reasons for your response.

2.3 Identify which aspects of the Grampians natural disaster management strategies worked well at the following stages.

During the event: _____

During the recovery: _____

2.4 What aspects of the Grampians natural disaster management strategies could be improved at the following time points.

Prior to a natural disaster event: _____

During a natural disaster event: _____

During the recovery of a natural disaster event: _____

2.5 What linkages within the community need to be developed in order for the community to be better prepared for a natural disaster event?

Economic Impacts

3.1 What was the overall impact of the Grampians natural disaster event on your household finances?

Very negative	Negative	Neither negative nor positive	Positive	Very positive
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3.2 Describe how the event impacted your household finances.

3.3 What was the impact of the event on your household finances during the recovery?

Very negative	Negative	Neither negative nor positive	Positive	Very positive
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3.4 Describe how your household finances were impacted during the recovery from the event.

3.5 Describe the economic (e.g. unemployment) and financial (e.g. loss of income) impact of the event for you and your family at the following stages.

During the event: _____

During the recovery: _____

3.6 Thinking about the economic and financial impact of the event, identify whether you and your family incurred financial costs associated with the following (tick as many as appropriate):

	During the event	During the recovery	Now	No financial costs incurred	N/A
Your property and contents (covered by insurance or not)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your household income	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your household savings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your income/wage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3.7 Please describe and estimate the financial costs you and your family incurred.

Environmental Impacts

4.1 Have you observed changes to the physical or natural environment by the Grampians natural disaster event?

During the event During the recovery Now No changes observed (go to question 5.1)

4.2 Describe the changes you have observed.

4.3 Identify when the changes impacted you and your family.

During the event During the recovery Now No impact experienced (go to question 5.1)

4.4 Describe how these changes impacted you and your family.

4.5 Thinking about the impact of the Grampians natural disaster event on the physical or natural environment, identify and estimate (where appropriate) the costs of these impacts to you and your family at the following stages.

During the event:

During the recovery:

Now:

4.6 Have the changes to the physical or natural environment that impacted you and your family been resolved?

Yes No (go to question 4.8)

4.7 Explain how these changes were resolved. Go to question 5.1.

4.8 Explain why these changes have not been resolved.

Other Comments

5.1 Please provide any other information you would like about you and your family's experiences during or since the Grampians natural disaster event.

About you

This information will be used to group your responses with other survey participants.

6.1 Which local government area do you live in? _____

6.2 Which town or locality do you live in? _____

6.3 How long have you lived in this town or locality?

Less than 1 year 1 - 2 years 3 - 4 years 5 - 6 years
 7 - 8 years 9 - 10 years More than 10 years Unsure

6.4 What is your gender?

Male Female

6.5 What is your age?

- Under 18 years old 18 - 24 years old 25 - 34 years old 35 - 44 years old
 45 - 54 years old 55 - 64 years old 65 - 74 years old 75 or more years old
 Prefer not to say

6.6 Which one of the following best describes your main activity at the moment?

- Paid full-time work Paid part-time or casual work Studying or training
 Looking for work Doing unpaid voluntary work Retired
 Home duties Other: _____

6.7 Which of the following best describes your household?

- Single person household
 A couple
 Young family - youngest child under 6 years of age
 Middle family - youngest child aged 6 to 15 years
 Older family - youngest child over 16 years or age
 Group or shared household
 Other: _____

6.8 Which of the following have you answered this survey as?

- An individual My family representative Other: _____

6.9 Which of the following broad ranges best describes your total gross annual household income?

Please include all income including pensions and allowances for all household members.

- Less than \$25,000 \$25,000 - \$39,999 \$40,000 - \$64,999 \$65,000 - \$79,999
 \$80,000 - \$129,999 \$130,000 or more Unsure

Survey: Businesses and Community Organisations

Social Impacts

1.1 Briefly outline how your business or organisation was impacted by the Grampians natural disaster event.

1.2 At the time of the event, rate the impact it had on your business or organisation (please tick).

Very little impact	Low impact	Neither low nor high impact	High impact	Very high impact
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.3 During the Grampians natural disaster event, was there a direct threat to your business or organisation?

- | | |
|---|---|
| <input type="checkbox"/> Personal safety | <input type="checkbox"/> Work colleagues/staff members |
| <input type="checkbox"/> Business or organisational property | <input type="checkbox"/> Business or organisational content/possessions |
| <input type="checkbox"/> No direct threat (go to question 1.5). | <input type="checkbox"/> Other: _____ |

1.4 Describe the direct threat to your business or organisation during the event.

1.5 Did anyone in your business or organisation receive an injury as a result of the event?

- During the event During the recovery Now No injuries received (go to question 1.7)

1.6 Please describe the injuries received.

1.7 Estimate how prepared your business or organisation was prior to the Grampians natural disaster event.

Very unprepared	Unprepared	Neither prepared nor unprepared	Prepared	Very prepared
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.8 Please provide reasons for your response:

Community Impacts

2.1 Thinking about the social and economic impact of the Grampians natural disaster management strategies in your community, how prepared were the disaster management services?

	Very unprepared	Unprepared	Neither prepared nor unprepared	Prepared	Very prepared	N/A
During the event	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
During the recovery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2.2 Please describe the reasons for your response.

2.3 Identify the aspects of the Grampians natural disaster management strategies that worked well at the following stages.

During the event: _____

During the recovery: _____

2.4 What aspects of the Grampians natural disaster management strategies could be improved at the following time points.

Prior to a natural disaster event: _____

During a natural disaster event: _____

During the recovery of a natural disaster event: _____

2.5 What linkages within the community need to be developed in order for the community to be better prepared for a natural disaster event?

Economic Impacts

3.1 What was the overall impact of the Grampians natural disaster event on your business or organisation's finances (i.e. revenues and costs)?

Very negative	Negative	Neither negative nor positive	Positive	Very positive	N/A
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3.2 Describe how the event impacted your business or organisation's finances.

3.3 What was the impact of the event on your business or organisation's finances during the recovery?

Very negative	Negative	Neither negative nor positive	Positive	Very positive	N/A
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3.4 Describe how your business or organisation's finances were impacted during the recovery from the event.

3.5 Describe the economic impact (i.e. turnover, market share, competitiveness) of the event for your business or organisation at the following stages.

During the event: _____

During the recovery: _____

3.6 Thinking about the economic and financial impact of the event, identify whether your business or organisation incurred costs associated with the following (tick as many as appropriate):

	During the event	During the recovery	Now	No costs incurred	N/A
Property and contents (covered by insurance or not)	<input type="checkbox"/>				
Business or organisational income	<input type="checkbox"/>				
Business or organisational savings	<input type="checkbox"/>				
Ability to retain or employ new staff	<input type="checkbox"/>				
Ability to retain or expand the size and operations of the business or organisation	<input type="checkbox"/>				

3.7 Describe and estimate the costs your business or organisation incurred.

3.8 What internal systems and external linkages has your business or organisation put in place in order to better prepare for a natural disaster event and the recovery phase?

Environmental Impacts

4.1 Have you observed changes to the physical or natural environment from the Grampians natural disaster event?

During the event During the recovery Now No changes observed (go to question 5.1)

4.2 Describe the changes you have observed.

4.3 Identify when, or if, the changes impacted your business or organisation.

During the event During the recovery Now No impact experienced (go to question 5.1)

4.4 Describe how these changes impacted your business or organisation.

4.5 Thinking about the impact of the Grampians natural disaster event had on the physical or natural environment, identify and estimate (where appropriate) the costs of these impacts to your business or organisation at the following stages.

During the event: _____

During the recovery: _____

Now: _____

4.6 Have the changes to the physical or natural environment that impacted your business or organisation been resolved?

Yes No (go to question 4.8)

4.7 Explain how these changes were resolved. Go to question 5.1.

4.8 Explain why these changes have not been resolved.

Other Comments

5.1 Please provide any other information you would like about your business or organisation's experiences during or since the Grampians natural disaster event.

About your business or the organisation you represent

This information will be used to group your responses with other survey participants.

6.1 What business or organisation are you involved in? _____

6.2 What is the size of your business or organisation?

- | | |
|--|--|
| <input type="checkbox"/> Micro (1-5 employees) | <input type="checkbox"/> Small (6-19 employees) |
| <input type="checkbox"/> Medium (20-199 employees) | <input type="checkbox"/> Large (200 or more employees) |

6.3 What sector does your business or organisation operate in?

- | | |
|---|--|
| <input type="checkbox"/> Accommodation and food services | <input type="checkbox"/> Administrative and support services |
| <input type="checkbox"/> Agriculture, forestry and fishing | <input type="checkbox"/> Arts and recreation services |
| <input type="checkbox"/> Construction | <input type="checkbox"/> Education and training |
| <input type="checkbox"/> Electricity, gas, water and waste services | <input type="checkbox"/> Financial and insurance services |
| <input type="checkbox"/> Health care and social assistance | <input type="checkbox"/> Information media and telecommunications |
| <input type="checkbox"/> Manufacturing | <input type="checkbox"/> Mining |
| <input type="checkbox"/> Natural resource management | <input type="checkbox"/> Professional, scientific and technical services |
| <input type="checkbox"/> Public administration and safety | <input type="checkbox"/> Rental, hiring and real estate services |
| <input type="checkbox"/> Retail trade | <input type="checkbox"/> Transport, postal and warehousing |
| <input type="checkbox"/> Wholesale trade | <input type="checkbox"/> Other: _____ |

6.4 What town or locality is your business or organisation located? _____

6.5 How long has your business or organisation been operating in this town or locality?

- | | | | |
|---|--------------------------------------|--------------------------------------|---------------------------------------|
| <input type="checkbox"/> Less than 1 year | <input type="checkbox"/> 1 - 3 years | <input type="checkbox"/> 3 - 5 years | <input type="checkbox"/> 6 - 10 years |
| <input type="checkbox"/> 10 or more years | <input type="checkbox"/> Unsure | | |

6.6 What is the position you hold in the business or organisation? _____

6.7 Please provide your business or organisation's postcode. _____

