

Community Risk in **Mackay**

A multi-hazard risk assessment



by **Miriam Middelmann** and **Ken Granger** (editors)

Australian Geological Survey Organisation



Department of Industry, Science and Resources
Minister for Industry, Science and Resources
Senator the Hon. Nick Minchin

Parliamentary Secretary: The Hon. Warren Entsch, MP

Secretary: Russell Higgins

Australian Geological Survey Organisation
Executive Director: Neil Williams

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Cities Project

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FOREWORD



COMMUNITY RISK IN MACKAY A MULTI-HAZARD RISK ASSESSMENT

The Australian Geological Survey Organisation (AGSO) is Australia's national geoscience research organisation. Its Cities Project takes the leading role in researching a range of natural hazards and how they impact upon urban communities. In Mackay these hazards include earthquakes, floods, and severe wind and storm tide from tropical cyclones.

The Mackay study is the second in a series of multi-hazard risk assessments examining community vulnerability to a range of natural hazards in urban communities. It furthers previous work done in Cairns (Granger and others, 1999).

The report will be a valuable resource to those who are responsible for, or interested in, the management of these risks. Increased community safety, and consequently more sustainable and prosperous communities is the primary focus of this research.

The results are very useful. The effectiveness of mitigation measures such as wind loading provisions illustrates that we can really do something about reducing the impact of natural hazards on the Australian community.

This booklet provides an introduction to the Mackay multi-hazard risk assessment.

I urge you to investigate the comprehensive information in the full report on the Compact Disk. This is important, groundbreaking work and I commend it to you.



The Hon. Warren Entsch MP

Parliamentary Secretary to the Minister for Industry, Science and Resources

Parliament House

Canberra ACT 2600

Tel: (02) 6277 4656

Fax: (02) 6277 8537

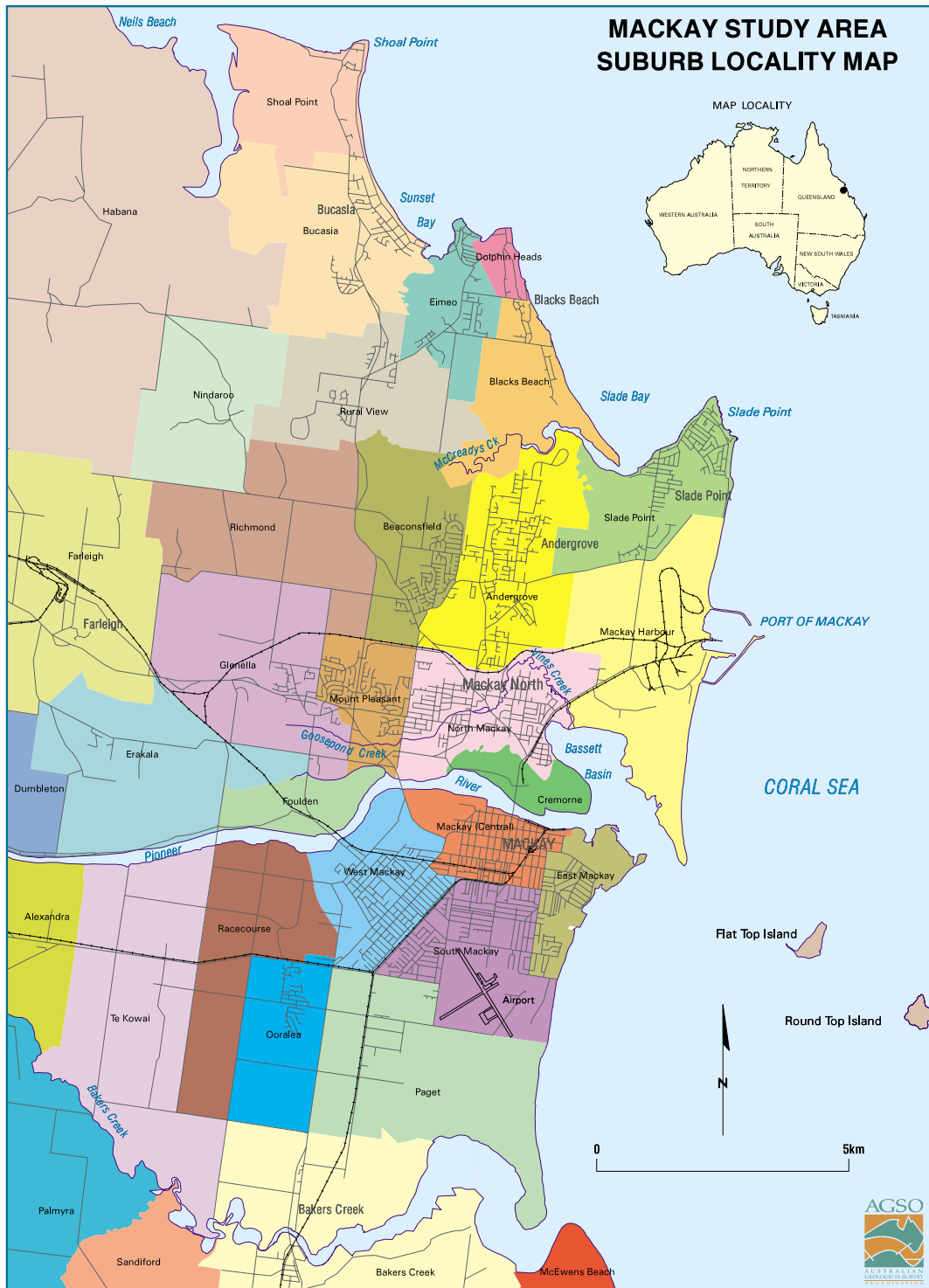


Figure (i): Mackay location map

BACKGROUND

The AGSO Cities Project was established in 1996 to undertake research directed towards the mitigation of the risks faced by Australian urban communities that are posed by a range of geohazards. Geohazards are broadly defined to include all earth surface processes with the potential to cause loss or harm to the community or the environment. The ultimate objective is to improve the safety of communities, and consequently make them more sustainable and prosperous. The Cities Project is using a series of case studies in Australian cities to develop and test its science and techniques. Mackay is the second of these multi-hazard case studies. It builds on multi-hazard risk assessment work already published by AGSO (Granger and others, 1999) on Cairns.

Mackay, in Central Queensland, is one of the State's larger regional cities. It lies about mid way between Brisbane and Cairns, being some 800 km in a direct line, or 970 km by road from Brisbane (Figure (i), see left). Mackay City has a resident population of approximately 71 400. The Mackay urban area, which is the focus of this study, is home to around 59 000 people.

Risk is the outcome of the interaction between a hazard phenomenon and the elements at risk within the community (the people, buildings and infrastructure) that are vulnerable to such an impact. The risk relationship can be expressed as:

$$\text{Risk}_{(\text{Total})} = \text{Hazard} \times \text{Elements at Risk} \times \text{Vulnerability}$$

The vast majority of information, relationships and processes involved in understanding risk are spatial in nature. We have, therefore, made extensive use of geographic information systems (GIS) to drive our analysis and assessment. Risk-GIS, as it has been christened in the Cities Project, is a fusion of the decision support capabilities of GIS and the philosophy of risk management expressed in the standard AS/NZS 4360-1995 Risk Management. The processes in which Risk-GIS are applied, and our understanding of the risk management process, are summarised in Figure (ii).

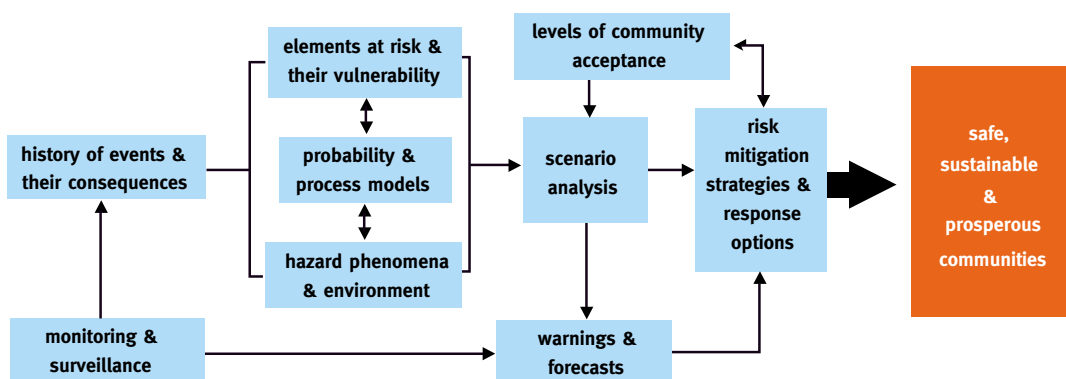
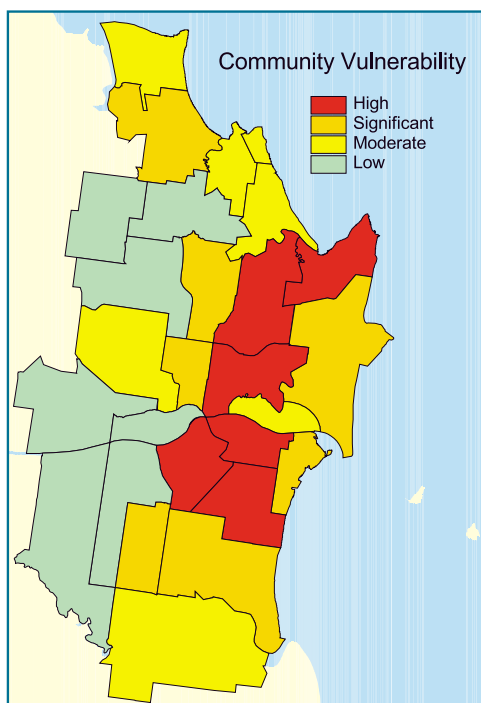


Figure (ii): Cities Project understanding of risk management and Risk-GIS processes

COMMUNITY VULNERABILITY

We have adopted a systematic approach to describing the elements at risk in the community and their vulnerability to hazard impact. This description groups the various elements into the five themes of setting, shelter, sustenance, security and society (the 'five esses'). The topics addressed under these themes include the following.

- **Setting:** Basic regional data for themes including the physical environment (climate, vegetation, geology, soils, land use, topography, elevation, etc.), access (external links by major road, rail, air, marine and telecommunications infrastructures), administrative arrangements (local government, suburb and other administrative boundaries), and population and its distribution.
- **Shelter:** The buildings that provide shelter to the community at home, at work and during recreation. Access to shelter is also significant, so information on mobility within the community is needed.
- **Sustenance:** Modern urban communities are highly reliant on their utility and service infrastructures such as water supply, sewerage, power supply and telecommunications. These so-called lifelines are significantly dependent on each other and on other logistic resources such as fuel supply. The community is also dependent on the availability of food supplies, clothing, medical supplies and other personal items.
- **Security:** The security of the community is measured in terms of its health and wealth and by the forms of protection that are provided. Physically, these may be assessed by the availability of facilities such as hospitals, nursing homes, industries, commercial premises, agricultural land use, ambulance stations, fire stations, police stations and works such as flood retention basins and levees. Also important are socio-demographic and economic issues related to the elderly, the very young, the disabled, household income, unemployment, home ownership and the resources available at the fire and police stations.
- **Society:** This includes the more intangible measures such as language, ethnicity, religion, nationality, community and welfare groups, education, awareness, meeting places, cultural activities and so on. Some of these may be measured in terms of the facilities that they use, such as churches, meeting halls, sporting clubs, libraries and so on. However, the more meaningful measures, such as education, relate specifically to the individuals, families and households that make up the community.



These data provide a detailed quantitative description of specific aspects of the city's risk environment. However, in isolation, they do not provide an adequate measure of overall community vulnerability. Nor do they individually reflect the relative levels of vulnerability across the city. To overcome these shortcomings we have developed an overall vulnerability profile of Mackay by which to identify those suburbs that provide a disproportionate contribution to community risk because of the number and nature of the elements at risk they contain.

Figure (iii) shows the distribution of suburbs according to their overall contribution to community vulnerability.

Figure (iii): Mackay vulnerability profile

EARTHQUAKE RISK

At least six earthquakes have been felt in Mackay since 1874 but none has caused significant damage. The level of earthquake risk in Mackay is moderate. For more frequently occurring events, damage will be low. However, earthquakes, like severe winds, have the potential to impact upon the entire Mackay community, and strong but rare events (e.g., those with an average recurrence interval, or ARI, of 1000 years or more) will cause damage to many buildings.

There is a strong association at the suburb level between earthquake exposure and community vulnerability (Figure (iv)). This association can be traced to the history of development of the city. The port and nearby suburbs were developed first and these are situated on flat, alluvial ground. Most of Mackay's most vulnerable, older buildings are found in these areas.

The Australian earthquake and wind loadings standards are effective mitigation tools, and new buildings are expected to perform relatively well in earthquakes. However, about two-thirds of all buildings in Mackay pre-date earthquake and wind loading standards. In the ARI = 475 year earthquake 'code' scenario, an indicated 16% of all buildings will be damaged, mostly at a minor level.

The economic risk posed by earthquake in Mackay is substantial, especially in the older parts of the city. Electric power distribution, medical facilities and commercial businesses may be particularly at risk.

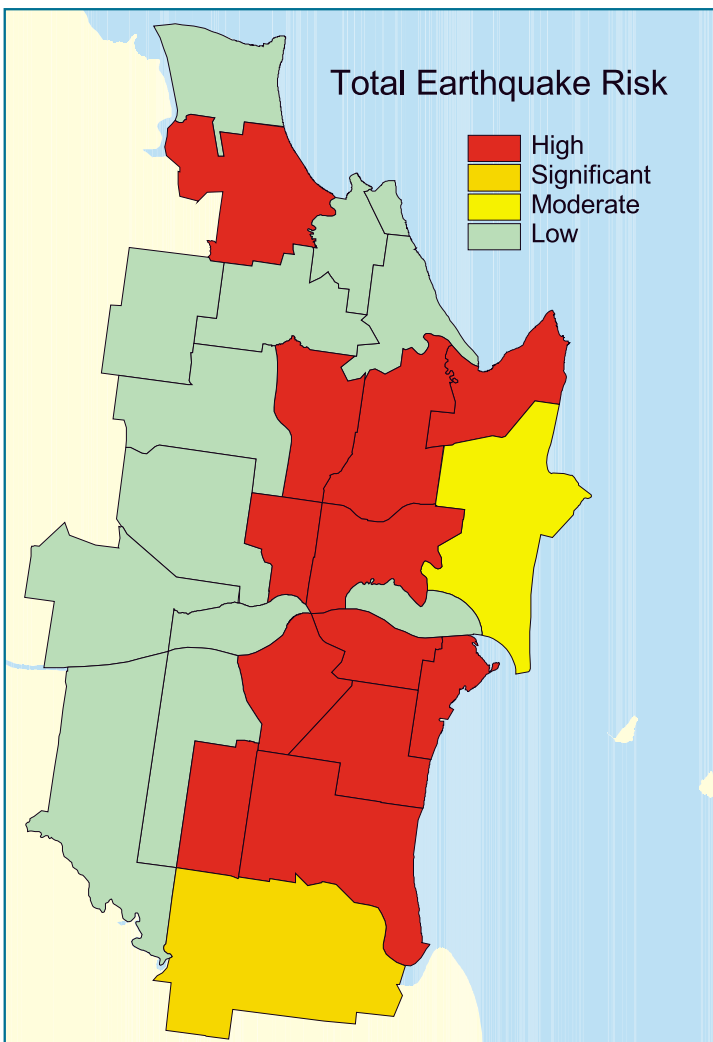


Figure (iv): Earthquake total risk profile

FLOOD RISK

Flooding of the Pioneer River poses a considerable threat to Mackay (Plate (i) see next page). Major flood levels in the Pioneer River have been reached twenty times since 1884, giving an ARI over the past 115 years of around six years. Seventeen of the 29 suburbs in Mackay are susceptible to inundation from the Pioneer River. Other suburbs may also be susceptible to inundation by local storm water surcharge but they were not considered in this assessment. The suburbs that contain the more significant concentrations of residential and commercial development are located adjacent to the Pioneer River, largely as a consequence of the development of the city, though the area is flood prone (Plates (ii) and (iii) see next page).

A program of levee construction began in the 1960s and is still continuing. The height of the current levees is low, however, and flood levels higher than that experienced in 1958 (approximately a 40 year ARI), would overtop and possibly breach the levees. Flooding is, however, generally of short duration and an effective flood warning system is operated by the Bureau of Meteorology in conjunction with the Pioneer River Improvement Trust. This provides sufficient time for residents to take steps to protect their property and for emergency services to conduct precautionary evacuations if that course of action is indicated. Damage and loss of life can therefore be minimised as long as the **community is aware and prepared**.

Figure (v) shows the total flood risk profile for the Pioneer River.

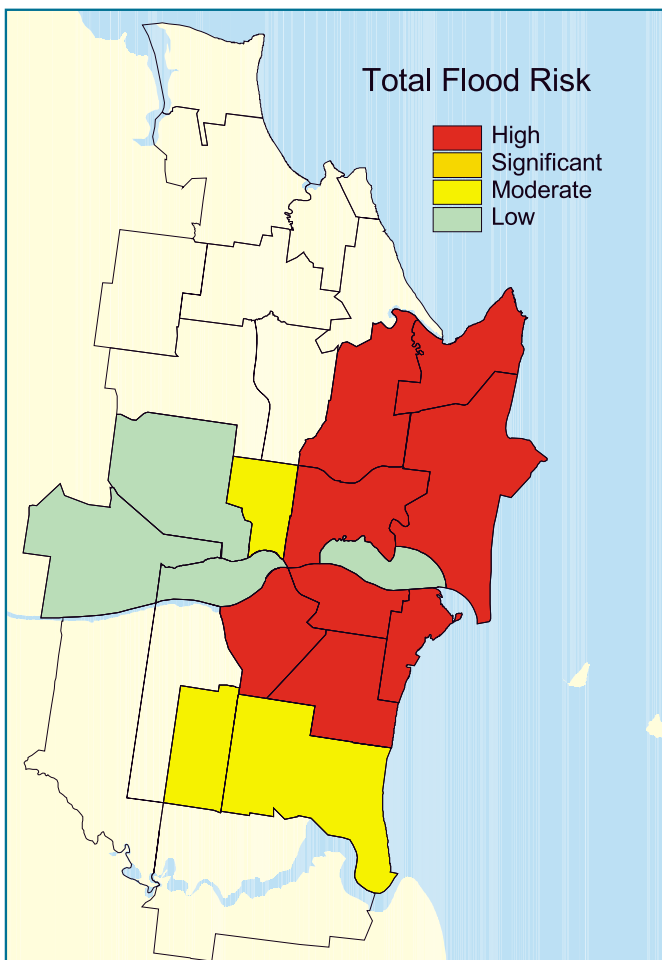


Figure (v): Pioneer River total flood risk profile



Plate (i): Foulden February 1958 - devastation following one of the worst floods in Mackay

Collection: Mackay Daily Mercury



Plate (ii): Cremorne February 1958 - Rescuers at work *Collection: Mackay Daily Mercury*

Plate (iii): Mackay early 1991 - Flooded Hospital Bridge

Collection: Mackay Daily Mercury



CYCLONE RISK

Tropical cyclones bring the multiple threats of strong winds, heavy rain, storm tide inundation and high seas to Mackay (Plate (iv)). Since 1862 at least 48 cyclones have passed within 150 km of the city. The greatest natural hazard impact upon Mackay was caused by the cyclone of 21 January 1918, when the combined effects of storm surge and strong winds damaged more than three-quarters of the buildings in the town and claimed at least 30 lives (Plate (v)). Cyclonic winds similar to those experienced in 1918 would still cause significant levels of building damage today. Distance from the coast and age of settlement are the key determinants in wind risk in Mackay (Figure (vi) see next page).



Plate (iv): Mackay 1938 cyclone - damage at outer Harbour works *Collection: John Oxley Library, Brisbane*



Plate (v): Mackay 1918 cyclone – destroyed Masonic Hall, Wood Street. Unroofed Star Theatre in background

*Collection:
John Oxley Library,
Brisbane*

Given the capacity of the cyclone monitoring and warning system operated by the Bureau of Meteorology, it is now highly unlikely that the Mackay community will be caught by surprise by tropical cyclone. Thanks to the annual community awareness campaign mounted jointly by the Bureau of Meteorology, the Queensland Department of Emergency Services and Mackay City Council, there is a high level of community awareness of the risk and how to cope with it. The risk to life from destructive cyclone winds, therefore, should be low and confined to the foolhardy who ignore the warnings and advice, or those who do not hear or understand the warnings.

Storm tides, or super-elevated sea levels accompanying cyclones, also present a significant threat to Mackay. In the 1918 cyclone, 13 people were drowned by a storm tide that inundated low-lying and coastal areas to a depth of about two metres above the highest astronomical tide. A similar event today would damage about 4000 buildings and require the evacuation of about 11 000 people.

The conventional response to an impending cyclone impact is for people to take shelter in their own homes. This is an appropriate and proven strategy except in those areas that would be subject to storm tide inundation. In those areas many people would be exposed to building collapse and would be at significant risk of drowning, especially were the level of inundation to exceed one metre over floor level.

Evacuation of those people at risk must be completed before the winds reach the strength at which it ceases to be safe to be out of doors (typically six hours before the cyclone's eye reaches the coast). For storm tide events with ARIs of more than 100 years, a considerable effort would be required to manage the numbers of evacuees that would be involved. Delay in commencing a major evacuation process increases the risk of people being caught in their homes, in the open or in their transport when the cyclone hits, because of gridlock on the roads leading out of the danger area. Figure (vii) shows the total storm tide risk profile.

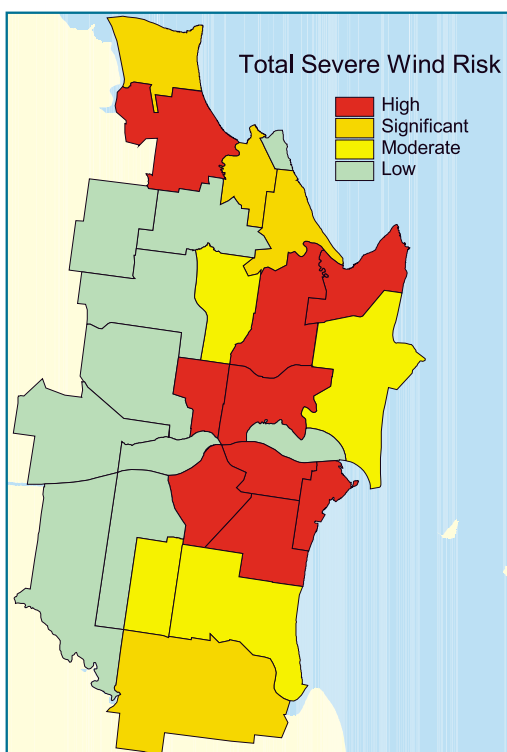


Figure (vi): Destructive wind total risk profile

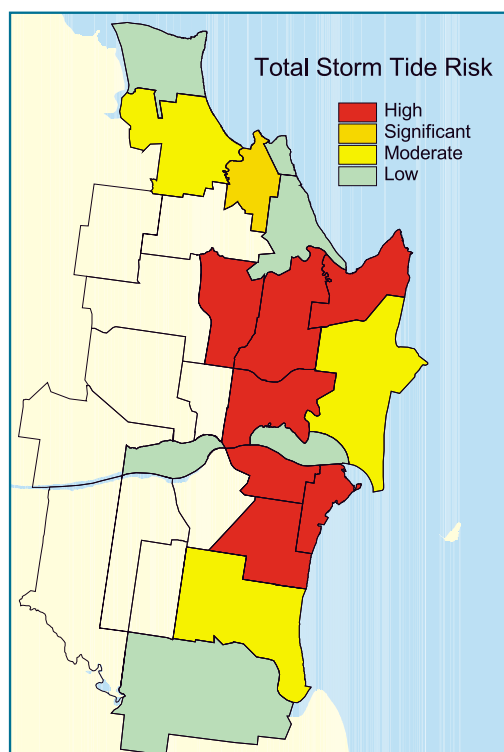


Figure (vii): Storm tide total risk profile

RISK EVALUATION

Flooding from the Pioneer River poses the greatest geohazard threat to Mackay, largely because significant floods occur frequently. Severe wind and storm tide from tropical cyclone rank equal second in the risks they pose. Storm tides and severe winds both hold the potential to cause more damage across Mackay than floods in very rare events (e.g., ARI = 1000 years). The risk posed by earthquakes to the Mackay community ranks fourth.

IS MACKAY A RISKY PLACE?

Mackay has a **moderate level of risk exposure** to hazard events that occur relatively frequently, those with an ARI of 50 years or less. Events within this range will cause some property loss and put lives at risk. However, the existing warning systems and other mitigation strategies already in place should minimise the potential loss of life and economic impact, **provided the population is aware and prepared.**

Despite this being a period of sustained population growth, there have been no fatalities directly attributable to the impact of a natural hazard in the Mackay community in the past two decades. This is due to the fact that there has been no significant earthquake and very few major cyclone or flood impacts during that time. It can also be attributed to the Council's program to implement hazard-based planning constraints, to introduce and enforce building codes and maintain an effective local emergency management capability. These risk mitigation strategies have minimised the exposure of new developments to hazards and maximised resilience of structures to the more common hazard impacts.

The Mackay community has a high level of residual risk exposure to flood, severe wind and storm tide. Mackay has a much less, but significant, residual risk exposure to earthquakes. Flood, cyclonic wind and storm tide events with an ARI of 100 years or more will inevitably cause significant economic harm and potentially some (and possibly significant) loss of life. In these rarer and more extreme events, the loss of critical facilities and the impact on specific community functions such as business activity, especially in Central Mackay, North Mackay, Mackay Harbour, Paget and West Mackay, will add to the magnitude of the risk posed directly by the hazard event itself. These secondary risks are likely to have an effect for a considerable period of time after the initial impact and will significantly increase the direct economic and social costs. Consequently, the community will be faced with a long recovery and restoration period. This is especially significant given the Mackay community's heavy reliance on disaster-sensitive industries such as agriculture and tourism.

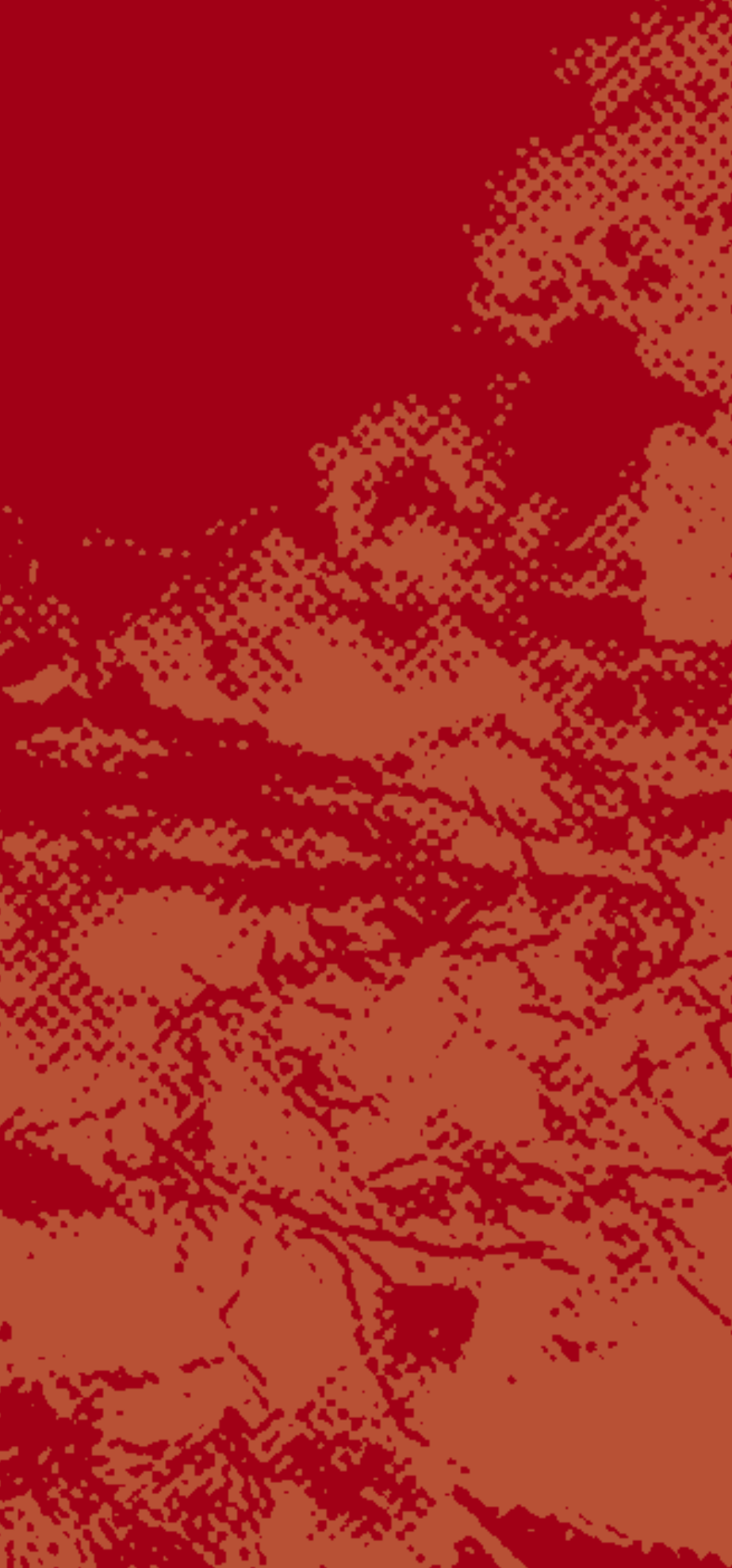
It is not feasible to eliminate all risk. However, the implementation of long-term planning strategies (such as the relocation of critical facilities, the 'retrofit' of key buildings and the 'flood proofing' of roads) and maintenance of vigorous community awareness campaigns and involvement in the community risk management process can reduce risk to a lower level.

STRATEGIES

A wide range of risk mitigation strategies are available, many of them of a low cost and non-structural nature. The sooner mitigation strategies are adopted by the Mackay community the faster community risk will be reduced.

Some mitigation strategies include the:

- development of a strong commitment to the process of risk management by the whole community;
- creation and maintenance of appropriate information to support risk management decision making;
- operation of effective hazard monitoring and warning systems;
- creation and maintenance of a strong level of community awareness through an ongoing program of risk communication;
- ongoing review and update of building and planning standards and codes;
- ongoing enhancement of emergency management plans, training and resources;
- implementation of effective plans to protect critical facilities, such as the hospitals, the loss of which will compound community hardship and risk; and,
- building of cost-effective structural defences.



INSTALLATION GUIDE FOR CD-ROM REPORT

COMMUNITY RISK IN MACKAY A MULTI-HAZARD RISK ASSESSMENT

This CD-ROM contains the above-titled report in standard Adobe Acrobat pdf format.

To view this report, the Adobe Acrobat Reader v4.05 or later must be installed.

To install Adobe Acrobat Reader v4.05 for WIN95/NT, double click on the file ar4o5eng.exe and follow the installation procedure.

Once the Reader is installed, double click on the Mackay.pdf to launch the report.

PLEASE NOTE: If you require an Acrobat Reader for a different platform, other than the one supplied on this CD-ROM, consult Adobe's web site <http://www.adobe.com/acrobat> for a free download.



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