COMMUNITIES LIVING WITH HAZARDS

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4

Transport and evacuation planning

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At the conceptual level, disasters can be divided into those with a warning of more than a few hours, and those with a warning of less than a few minutes. This chapter considers disasters with sufficient warning periods to be able to evacuate vulnerable people away from the expected high impact areas. The chapter also develops lessons and recommendations based on actual preparation for a major cyclone storm surge in Cairns, resulting in planning recommendations and conclusions based on ecologically sustainable development (ESD) principles and practicability. All the case studies explored on evacuations are related to community safety and capacity building: involve the community and provide effective information and early warning to the community at risk.

In all disaster risk reduction work, the core goal is to minimise loss of life and injury. Reducing loss of expensive or highly sentimental items is also of some importance. Planning and community involvement can prepare people to minimise loss through precautionary evacuations. Case studies from north Queensland form the basis of recommendations developed here.

A cyclone storm surge and evacuation network modelling project conducted over three years for Cairns in far north Queensland forms one end of the spectrum of study – in the worst case, about 54,000 people in Cairns would need to be evacuated to shelter higher and safer than their own homes, ahead of an extreme cyclone storm surge. However, land-based flooding would block most of the exit roads from the low coastal suburbs.

This chapter considers a range of threats with some warning time, and issues and strategies to maximise the mobilisation of people out of the most severe danger zones.

Threat types

There are both ‘sudden threats’ – land slide, earthquake, tsunami; and ‘signalled threats’ – cyclone, major winds, fire, flood. Threats, with or without warnings, form the basis for the evacuation matrix in Table 4.1 below.

Table 4.1 Evacuation matrix of safety responses

	Sudden Threats: Virtually no warning		
	Land slide	**Earthquake**	**Tsunami**
Safety response	Stay in strong structure	Stay in strong structure	Flee to higher ground at outflow of sea

	Signalled Threats: Usually some warning		
	Cyclone/major wind	**Fire**	**Flood**
Vulnerability of present environment	If likely in surge, must evacuate; if weak shelter, must evacuate	House material, surrounds, water available. If poor, leave early.	May be inundated, may be cut off
Vulnerability of individuals	High = earliest	Weak and young leave early	Judgements of flood height
Distance to secure shelter	The further, the earlier	The further, the earlier	The further, the earlier
Present safety of route/vulnerability en route	Know in preparation	Know in preparation	Know in preparation
Means of travel	Reliability and suitability	Reliability and suitability	Reliability and suitability
Community cohesion	Help available	Help available	Help available

The key issues for disaster planners are the extent of expert warning there may be, and the extent of public warning for a given threat. Also, it is critical to know who is vulnerable, where the safest shelter is and how vulnerable people get to shelter. Disaster managers attempt to balance the politics of calm or panic as it relates to public safety: how much should the public know?

With virtually no warning hazards such as landslides, earthquakes and tsunamis, the Prevention and Preparedness components of the Integrated Emergency Management System model of Prevention, Preparedness, Response and Recovery is to have strong structures in landslide or earthquake areas. In tsunami scenarios, the ideal situation is to have a public education program which advises that if the sea is observed to be withdrawing that this is an immediate signal to escape to high ground in all haste. This discussion considers threats with warnings, making precautionary evacuation possible.

Case studies explored include Cloncurry, Magnetic Island and Cairns.

Floods

The following discussion considers some lessons learned from major floods in north Queensland. Flooding and storm surge due to cyclones are signalled threats.

In Cloncurry in March 1997, floodwaters two metres higher than any flood in the hundred years prior were experienced. People did not believe it possible, so tended to under prepare (King & Goudie, 1998). By interviewing flood-affected people in Cloncurry, it was learned that there was disbelief, support from neighbours, a need for a better warning system, and a need for more public awareness and involvement. People would generally move themselves or their possessions ahead of potential flood damage earlier, if faced with a similar threat (see Figure 4.1 below).

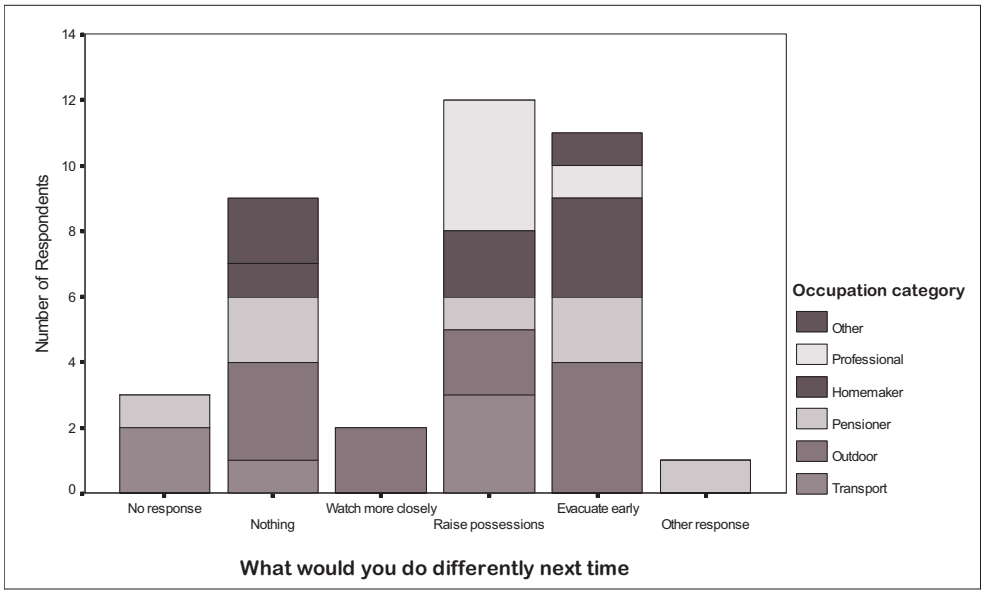

Figure 4.1 Lessons learned by Cloncurry flood victims

Figure 4.2 **Cloncurry resident showing height of flood waters through a ruined storage shed.**

Figure 4.3 **Force of the Townsville flood, 1998**

All the rock in Figure 4.3 was transported by high-energy water flow in the January 1998 flood, described as a 1 in 200 year flood. The implied force of the water shows why driving into floodwaters may lead to major safety problems. The experience of fieldwork on Townsville's Magnetic Island showed that well-intended thoughts of travel during heavy rain may not be possible because of flooded roads. Considering land-based flooding ahead of a cyclone and storm surge may be the single most important factor in survival for people in low-lying costal areas which are prone to cyclones.

Cairns, cyclone surge and the road network

The goal of the three-year study reported below was to define the role and implications for the road network's weak points ahead of a cyclone storm surge in Cairns, and produce recommendations.

The cyclone storm surge research approach was to establish the following:

- The nature of the hazard;
- Public vulnerability and awareness;
- Likely maximum surge height;
- Implications of land-based flooding;
- Who is vulnerable, and where and when they should go;
- Preferred movement of people;
- How the preferred movement could be implemented.

The most obvious weakness is the many flood points in the Cairns road network (indicated by the numbers of stars in Figure 4.4 below). The following sections of this discussion consider the road network flooding in some detail, then strategies to help achieve an early and precautionary evacuation. These strategies, as detailed below, include local inundation maps, definition of a maximum total flood contour, billet brokers, flood spotters and mobile sirens.

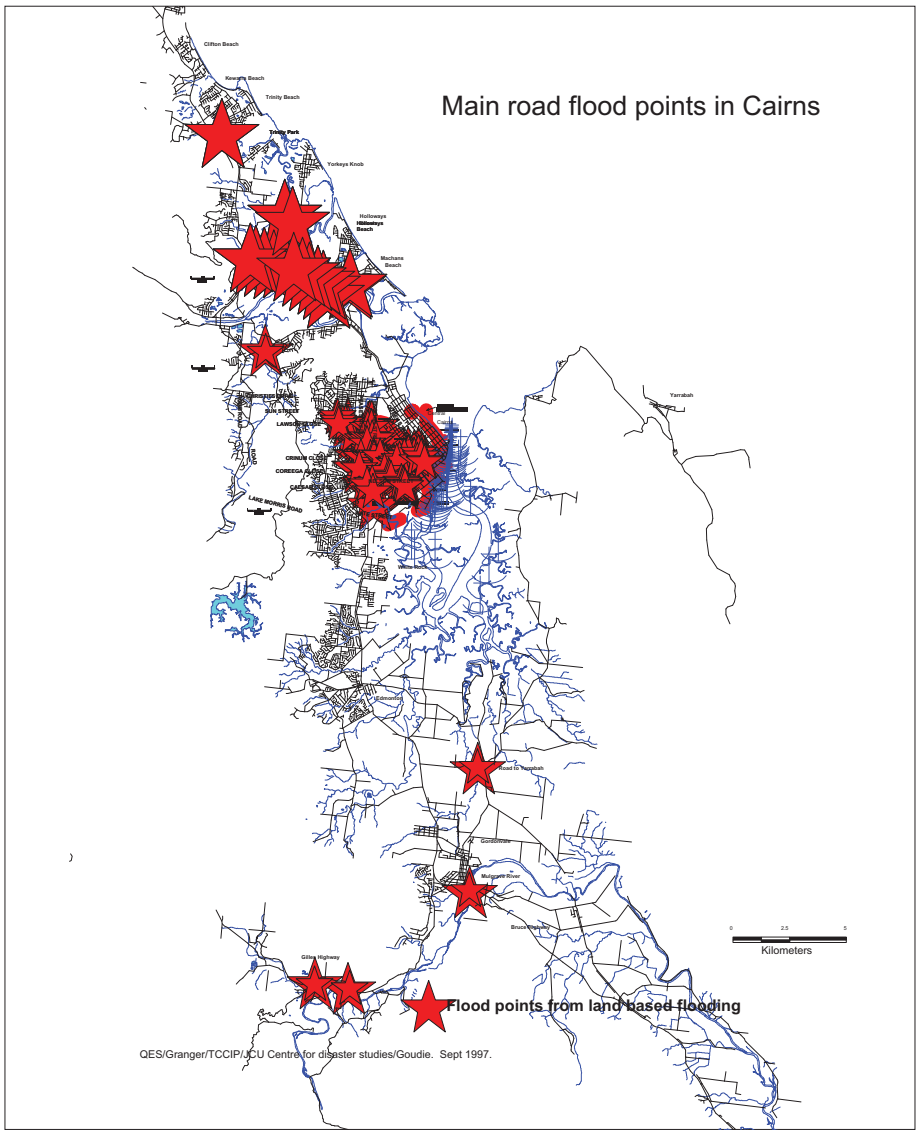

Figure 4.4 Main flood points in the Cairns road network

The proximity of the spring tide to the height above sea level of much of the Cairns central business district shows how vulnerable much of the Cairns central area is to even a small storm surge (figure 4.5 below).

Figure 4.5 Cairns building near foreshore during spring tide

Summary outcomes

- The road network will impose severe restrictions on last minute evacuations.
- Flood waters may cut evacuation routes days before a cyclone strikes.
- An evacuation spread over many hours to safe local shelter will minimise traffic congestion as the threat heightens.
- Accumulation of vehicles on the 'threatened' side of floodwaters normally garaged in the vulnerable northern beaches will make further arrivals transferring to 'high-clearance' vehicles increasingly chaotic. Hence the need for early departures and marshalling points on highest ground within the vulnerable communities.
- The evacuation procedures developed are likely to form the basis of response in Cairns for many years to come. Consideration of the likely increase in frequency and severity of cyclones caused by the enhanced greenhouse effect should be included (Minnery & Smith, 1994). Further, sustainable urban development should include explicit cyclone preparation and response strategies in all areas of ongoing urban growth.
- Prior to a surge, about 6,000 vehicles and 25,000 people (ABS, 2002) will be located on the main Cairns floodplain. About 2,000 households in that area do not own cars.

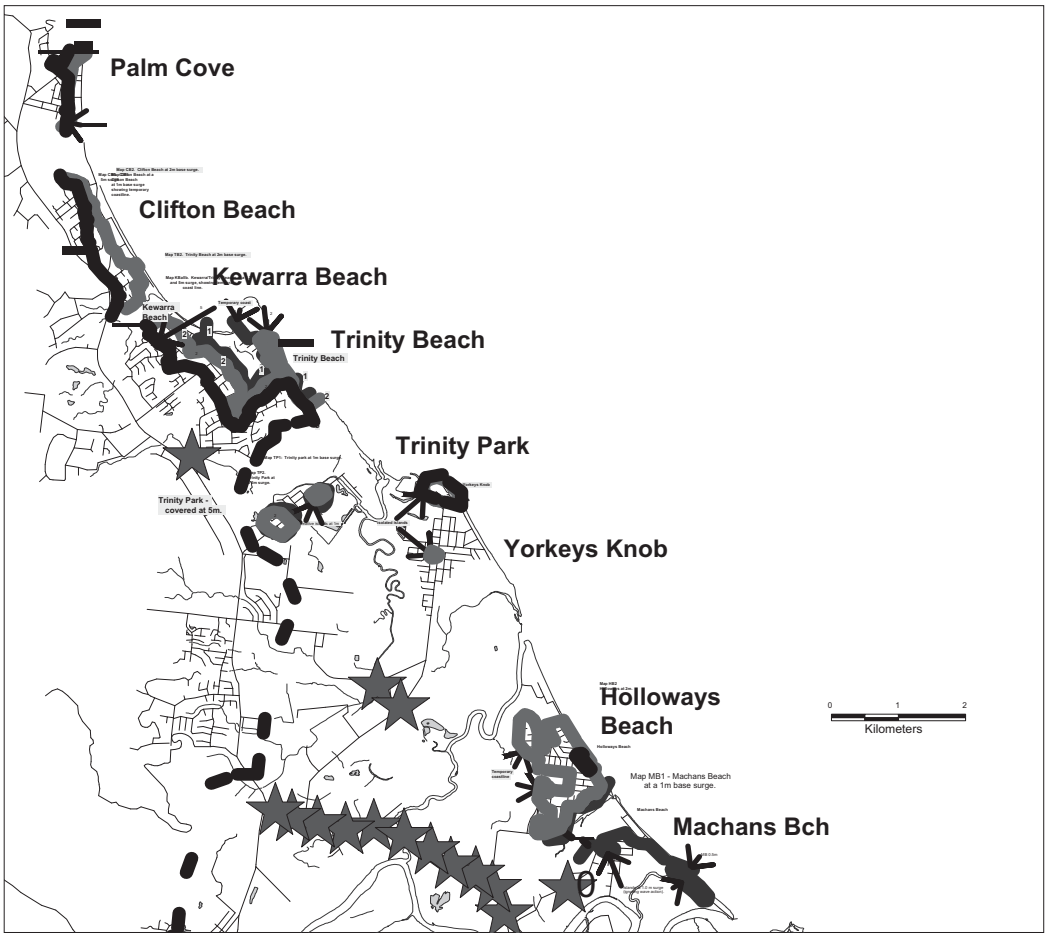

Figure 4.6 Detail of land-based flooding in the Cairns northern beach roads.

In Figure 4.6 the stars indicate the local flood points, the dark lines would be the 5m temporary coast and the light lines the 2m temporary coast. This figure indicates that early evacuation would be needed in most of the northern beach suburbs.

For the Cairns central area, Figure 4.7 below there are five components: local land-based flood areas; 'dry' exit routes; and three coast line levels at one metre, two metres and five metres. The stars show the local flood areas in central Cairns. This flooding may occur days before the cyclone and storm surge. The dark continuous lines show the 'dry' exit routes around the flooded areas (traffic lights are adjusted to help exit flow). After flooding and evacuation, the heavy dotted lines show the 'temporary coast line' at one

metre, two metres and five metres surge above Highest Astronomical Tide (HAT - king tide).

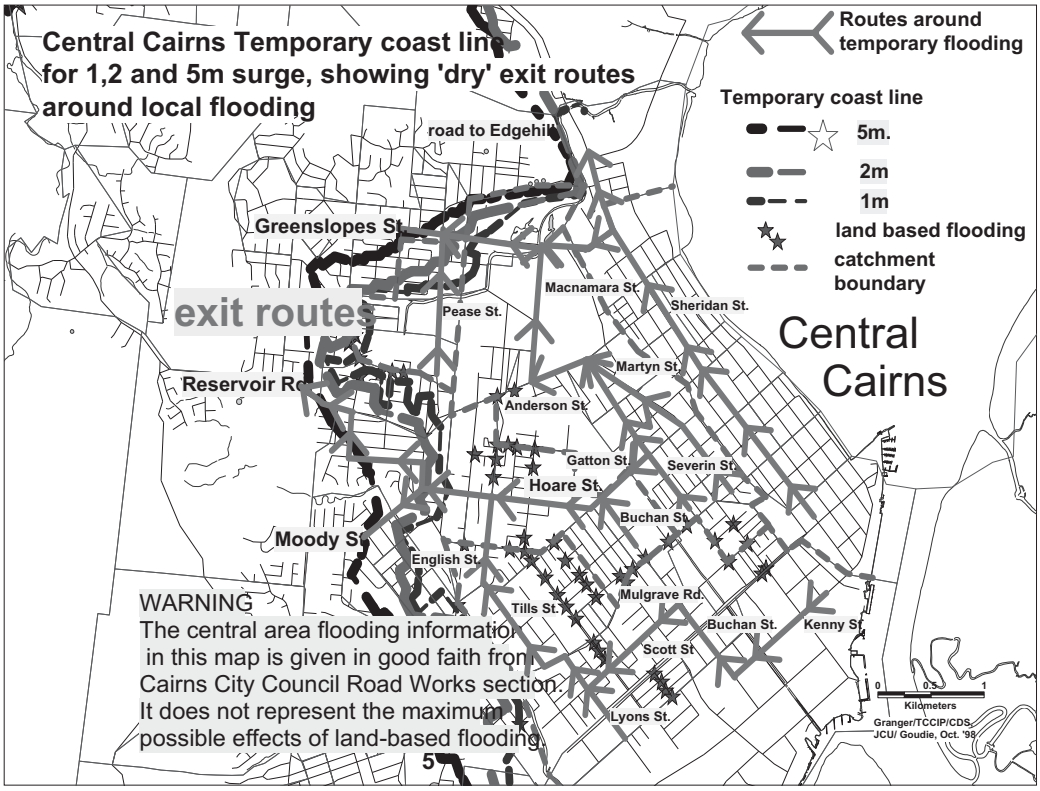

Figure 4.7 Detail of temporary coast lines and 'dry' inner Cairns exit routes.

The temporary coast lines and the following information are all based on a digital elevation model (DEM), with a general accuracy of about 250mm for elevations for every building in Cairns. The methods developed through the Tropical Cyclone Coastal Impact Program (TCCIP) process have relied heavily on the DEM. This elevation data has allowed for the mapping of ground contours at ½ metre intervals. Transport planning will be successful if no-one is trapped and drowned. Transport planning is fully dependant on an informed public undertaking early and voluntary response.

Evacuation layers

Generation and study of hundreds of such maps above implies that evacuation should be conducted at the one metre, two metre and five metre extreme surge height (see Figure 4.7), erring on the side of early and precautionary evacuation.

Examination of Figure 4.7 shows vulnerable buildings on: the coastal edge and low points (to one metre); the broad coastal plain of inner Cairns and lowest parts of all the northern beach suburbs, including Trinity Park (to two metres) and progressively more of the beach suburbs; and a relatively narrow upper edge at the beginning of the mountainous base of the Cairns flood plain. Thus there are three basic evacuation layers.

The Figure 4.8 below provides an example of pockets and areas of one community vulnerable to surge at heights of one metre, two metres and five metres above HAT. These layers were selected because of the shelf-like low coastal topography in the Cairns area.

The only viable evacuation strategy to best minimise loss prior to or during a significant cyclone storm surge in Cairns is early, precautionary 'self evacuation' to relatively safe domestic shelter on higher ground, mainly within Cairns. Precautionary evacuation is recommended because cyclones have erratic paths (Lourensz, 1977), and their effects are not fully predictable (JCUNQ, 1972).

Increased political and community involvement are necessary parts of successful evacuation. Roads to the south and west are likely to be blocked by land-based floodwaters. The primary objective is for vulnerable people to move from low-lying, threatened areas to the homes of friends, relatives or networked contacts living on higher ground. Destination shelters would ideally be strong, and away from large trees and major debris sources, with socially similar households. The whole community should be involved in storm surge preparation. Early public involvement will help clarify community needs and encourage cooperative behaviour. This will minimise direct and formal demands on the disaster response when the next major cyclone threatens Cairns.

The following issues are critical for successful pre-surge road use:

- Knowing the flood areas in the road network;
- Commitment to precautionary evacuation;
- Well known evacuation zones;
- Political support and community preparation;
- Fully pre-arranged private billets.

Loss of life and loss of portable valuables will be minimised by developing the following features:

- Strong political support for public education;
- Sponsorship and public involvement;

- Local inundation maps in retail outlets;
- Local 'billet brokers';
- Local 'spotters' placed at known flood points to report as waters rise, their information may trigger evacuations if a large cyclone is in the vicinity;
- Local siren warnings;
- Local maximum urban flood contour;
- Self-organisation in the tourism industry for their staff and guests.

The aim is to encourage early self-evacuation to pre-arranged private shelter on higher ground. Along with work being done by the Cairns Disaster Management Group, this may be best achieved by the following:

- placing maps like Figure 4.8 in every convenience store in the vulnerable areas of Cairns; these maps would be specific to the usual 'catchment' of each store;
- placing maps in shopping mall displays in the Cairns area, which could be organised through sponsors and the displays could be posted from October to March inclusive.

A legend could be developed so that each dot, in Figure 4.8 below, represents a business or house, for example, red dots could mean people must evacuate up to 0.75m above floor level; yellow might mean water over property; and white could mean relatively surge free.

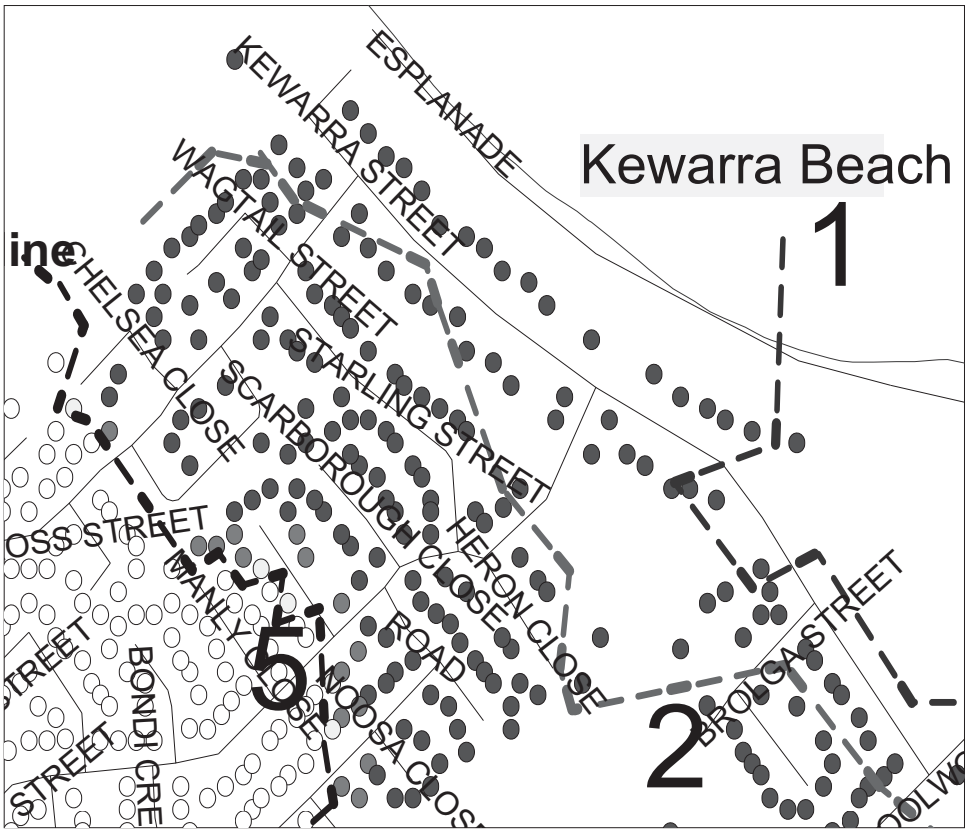

Figure 4.8 Kewarra Beach at a 1, 2 and 5m (above HAT) surge

'Billet broker' details

For the many residents of low-lying areas of Cairns who do not have their own informal networks to arrange overnight billeting, there is a clear need to have 'billet brokers' (Goudie, 1996). Interested and active members of various community groups in Cairns could fulfil this role. Such activities would need seed funding to cover phone, newsletter printing and mailing costs, plus, perhaps, a little support for the parent groups involved. In this way, people in the vulnerable, low-lying areas would be facilitated to form a contact with a welcoming household on higher ground, well before land-based flooding or gale-force winds prevent safe passage from lower to higher ground. A major cyclone threat would trigger an early, *ad hoc* response, engendering an attitude of a 'practice', an 'overnight picnic', rather than a 'false alarm'. These ideas are at the conceptual stage only.

Mobile or fixed sirens

Research in Cloncurry and on Magnetic Island found that not enough people listen to the radio and the television information is just not localised or specific enough. Development and implementation of an effective siren-based public warning system is recommended to avoid people being ignorant of danger which could cost lives. It could be argued that luck played a significant part in saving four people from drowning on Magnetic Island during the 1998 floods. The use of a mobile siren system could be piloted in a small population area like Magnetic Island, and developed for all areas of Queensland which are flood or fire prone.

For sirens to be effective there would need to be widespread information as to what they meant, and what should be the individual responses. Radio and local talks, along with local letter drops would help prepare residents and managers for the practice runs. It is suggested that the siren signals (see below) are sounded at 11 am on the first Sunday of October and November (before the wet season), to familiarise people with the sound, and the preferred response. Further, mobile sirens already exist in the community on police and emergency vehicles, thus the infrastructure costs are near zero.

The sirens could have the following three levels of alarm, and one all clear signal:

- Danger looming, stand by, or respond in a precautionary way (perhaps three short blasts, repeated periodically);
- Respond to danger (equivalent to an order to evacuate, perhaps one short and two long blasts);
- Danger imminent, prepare for impact (perhaps three long blasts);
- An all clear signal may be useful as well (perhaps long, well-spaced blasts).

Selected evacuation details

To maximise community safety in the ways outlined, it is recommended that seed funding be provided to establish community storm surge groups and billet brokers. To maximise tourist safety, logically the tourism industry should take full responsibility (under the direction of Emergency Services authorities) for the safe relocation of their own staff and guests (Drabek, 1994). The industry has many buses, ‘adequate’ shelters, and an accurate record of visitors in the area at any given time.

There is a clear need to establish staggered evacuation procedures for all vulnerable people requiring an ambulance. It is suggested that various health authorities provide a mapped database (e.g. MapInfo or Latitude) of people

in their care who may need special attention (updated each October). If they live in the low lying-areas of the beach suburbs, they will need to be moved before exit routes are compromised.

More vulnerable people: the elderly; the infirm; the disabled; tourists; and those without cars or rides with friends or neighbours in the lowest areas, should be the first to be moved. This should occur in sequence: when a 'recommendation to evacuate' is given, evacuees without use of private transport should board evacuation buses at specified marshalling points within vulnerable communities. It is important to note that people may leave earlier if a strong police anti-looting presence is provided. Local government, guided by federal consistency, should consider the development of appropriate signs to identify routes and destinations. Finally, vertical evacuation utilising sound high-rise commercial buildings, could be designated as 'shelters of last resort' for people trapped in the inner city area (Smith, 1995).

Other general recommendations

- There is a need for effective communications for SES personnel. For example, many had difficulty contacting each other on Magnetic Island in 1998.
- More detailed public education should be provided about the dynamics of flooding specific to each catchment, and the link roads between catchments.
- In line with current government policy, fully involve the community in 'urban segments' to ensure 'safe' upslope shelter. For example, the golf club rooms in Picnic Bay, or the Sports Club rooms in Horseshoe Bay on Magnetic Island. What extra items are needed? Who will help the infirm?
- In Cairns, debris and weak points in the road network immediately after any cyclone flooding would be identified and checked by Queensland Transport/Main Roads Department/Road Transport Construction Services and Cairns City Council, aiming to allow the maximum number of people to return to their properties as soon as possible. Initially, the Main Roads Department would work on problems north of the Barron River and Cairns City Council to the south.
- Community service television announcements and footage of Cairns road flood-points may help encourage early self-evacuation of vulnerable people to 'safe' shelters.

- Modelling of a cyclone category 5 storm surge of five metres, with funnelling, wave reach and flooding should be used to define a 'local contour of safety' - the local maximum flood height, which could be prominently indicated where it crosses major roads. People can be encouraged to negotiate their own billets with friends, relatives, work-mates or other contacts above that line, but within their own sector of the city (e.g. discouraging people in low-lying areas in the south waiting until danger is imminent before travelling to friends on high ground in the far north of the city).
- Use the roads early when the decision to evacuate has been made.
- Education, community involvement, billet brokers, mobile sirens and *ad hoc* precautionary evacuation are likely to minimise the social impacts of major cyclone storm surges in vulnerable coastal centres.
- Research methods which combine computer modelling, interviews, a planning team, literature search and guided by sustainability principles and community involvement may be used widely in preliminary planning.

Conclusion

Research from other locations in north Queensland illustrate the potential problem to be faced by people in the region and unless lives are to be placed at risk, effective strategies for self-evacuation of households must be developed in cities such as Cairns which is clearly vulnerable to storm surge flooding.