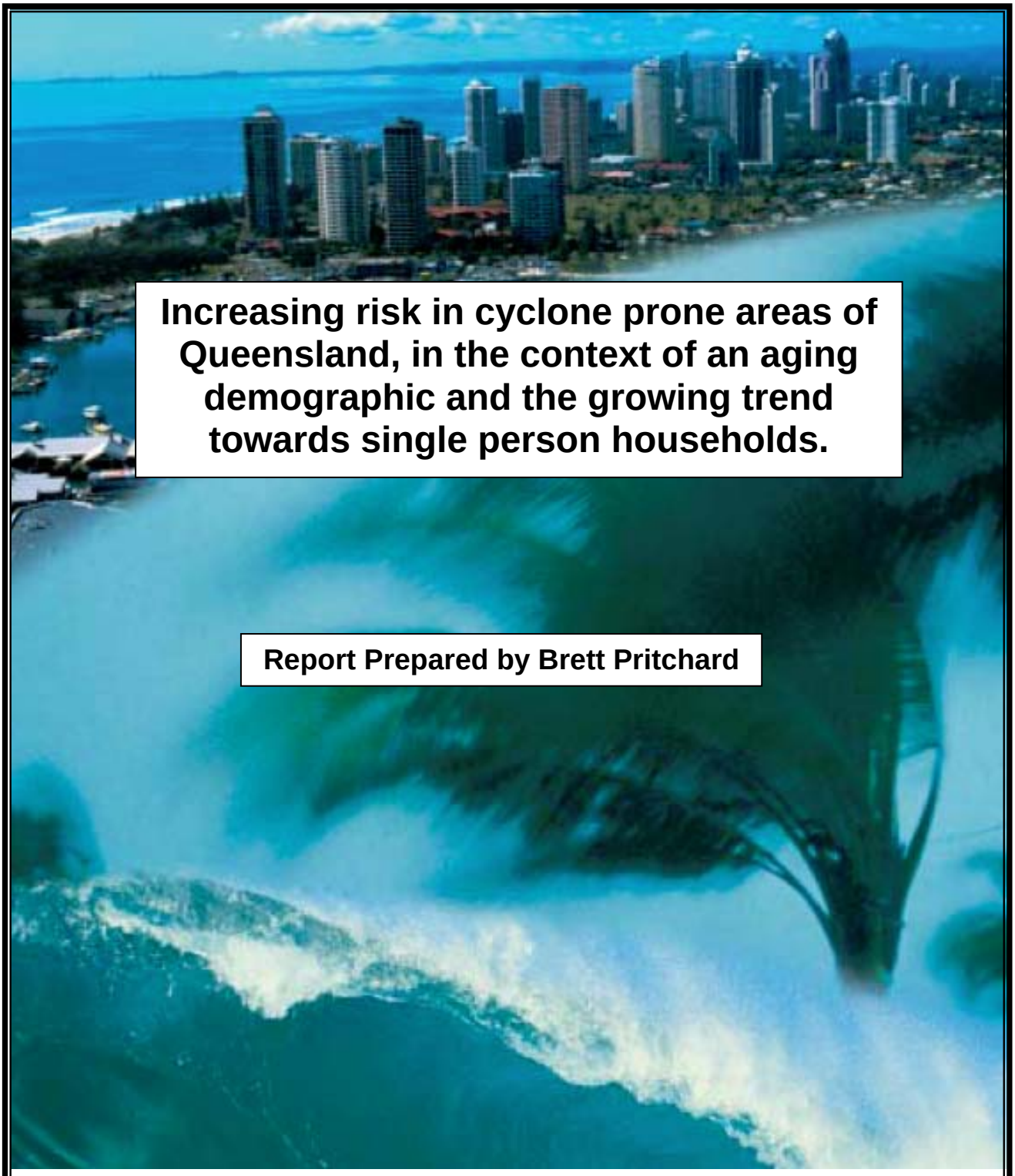


Increasing risk in cyclone prone areas of Queensland, in the context of an aging demographic and the growing trend towards single person households.

Report Prepared by Brett Pritchard

Based on data obtained from:
King, D. & Goudie, D. (2006) *Cyclone Larry March 2006 - Post Disaster Residents Survey.* Centre for Disaster Studies, James Cook University; Australian Bureau of Meteorology.

CDS
Centre for Disaster Studies James Cook University

CONTENTS

1. Introduction

Queensland faces an increasing risk of damage due to cyclonic activity in the future for a number of reasons. As this study will show there is a projected increase in hazard, exposure and vulnerability to natural disasters. The growing coastal population and associated growth in infrastructure, linked with climate change induced extreme weather conditions, dramatically increases both the hazard of and exposure to cyclones, storm surge, flooding and severe storms.

This paper examined the premise that, along with this projected increase in hazard and exposure, Queensland is also facing increasing community vulnerability to disasters due to a changing demographic. Most of the literature on vulnerability identifies both the aged and the socially and physically isolated as being particularly vulnerable. (Buckle 1999:23) Australia has an aging population, along with a growing trend towards single person dwellings (ABS 2004a:2). The article will compare the potential vulnerability of people 60 years and older who live alone with the wider community. The major source of information will be the report *Cyclone Larry March 2006 - Johnstone Shire Post Disaster Residents Survey* prepared by King and Goudie (2006), and the accompanying data. This article will explore the following:

1. How did Cyclone Larry affect older people in lone households compared to others?
2. Were those in this cohort living in older dwellings (>30yrs.) more at risk than those living alone in newer dwellings (damage to house, house and/or contents insurance)?
3. Did those living alone have more or less contact with friends/family than those living with others?
4. Did those people in this group feel more or less concerned at the approach of Cyclone Larry?
5. Were this group more or less likely to expect a storm surge associated with cyclonic conditions?
6. What level of preparations did this group make, both pre-cyclone season and due to the cyclone warning?

(Jenner. 2006:64)

Cyclone Larry *destroys buildings and vegetation and floods the local area.*

2. Increasing risk in a changing world

"'Risk' is the probability of a loss, and this depends on three elements, hazard, vulnerability and exposure. If any of these three elements in risk increases or decreases, then risk increases or decreases respectively" (Crichton 1999:102). This paper puts forward the proposition that, in Queensland in relation to cyclone-based disasters, all three elements of risk are increasing and are projected to increase further in the future. The following diagram (Figure 1.) adapted from Crichton (1999:102) pictorially represents this growing risk.

Figure 1. Increasing Risk of Cyclone-based Disasters in Queensland

Increase in exposure of homes and infrastructure to cyclone-prone and storm surge:
- increase in coastal infrastructure,
- increase in area affected, due to climate change.

Increase in community vulnerability due to changing demographics:
- increased population,
- increased aged population,
- increase in single households.

Increase in severity of tropical cyclones and storm surge/ flooding, due to climate change

Although this paper is primarily concerned with increasing risk due to increased community vulnerability based upon data from the *Cyclone Larry Post-Disaster Residents Survey* (King & Goudie 2006), the first section will briefly discuss the increase in the severity of the hazards concerned (i.e. cyclones and storm surge) and the increase in exposure to those hazards. Natural disasters such as floods, bush-fires and tropical cyclones "… cause more than $1.14 billion damage each year to homes, businesses and the nation's infrastructure, along with serious disruption to communities"(COAG 2002:vi). "In developed countries, the 1990s saw an increase in the cost of natural disasters resulting from storms and floods"(Dore 2000:46) Scientific research indicates that more extreme weather events, and large-scale single events with more severe cyclones, storms and floods, are expected in the future"(COAG 2002:vi).

2.1 Exposure: Increase in coastal infrastructure

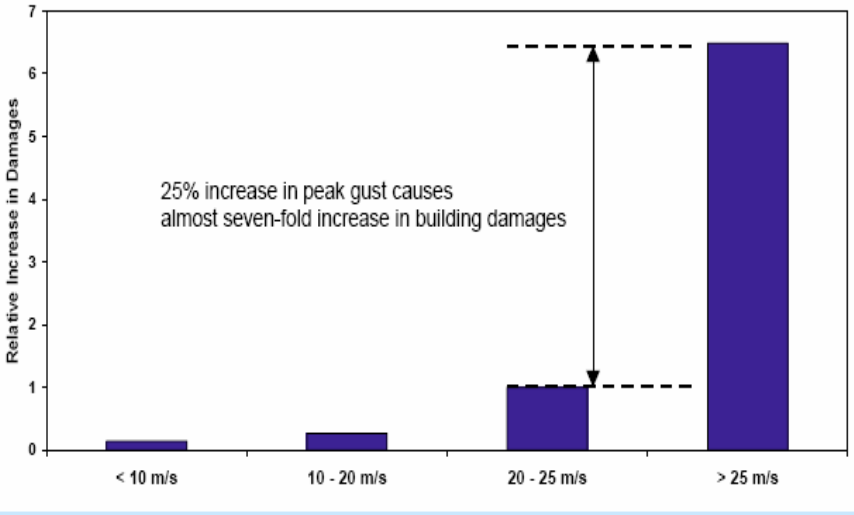
"Coastal assets may be damaged by high winds and/or waves and the resulting erosion…[and]…[i]n some coastal locations, storm surge may cause significant damage"(Walsh 2004:17). As more than 97% of the coastal foreshores in Queensland is in public ownership "…the State has a very limited liability for providing protection to development on the coast"(Walsh 2004:23). Coastal areas are experiencing an increase in built infrastructure, as between 1996 and 2001 coastal Local Government Areas experienced considerably higher average annual growth rates than Brisbane's and Queensland's overall average growth rates for the same period. (ABS 2004b) "Our urban communities are becoming more vulnerable to the effects of natural hazards; coastal regions are particularly prone and are impacted by intense storms, cyclones and the effects of earthquake"(Hayne & Schneider 2002:153).

2.2 Hazard: Climate change and extreme weather events

"Population and development increases are a paramount influence on community vulnerability, however, external forces; e.g. climate change, sea level rise…can also effect community vulnerability"(Hayne & Schneider 2002:153). The recent Stern Review, *The Economics of Climate Change*, states that "[t]he consequences of climate change will become disproportionately more damaging with increased warming. Higher temperatures will increase the chance of triggering abrupt and large-scale changes…[such as]…sudden shifts in regional weather patterns like the monsoons or the El Niño"(Stern 2006:56). "By increasing the amount of energy available to fuel storms, climate change is likely to increase the intensity of storms"(Stern 2006: 78). Current research over all ocean basins indicates that the number of category 4 and 5 hurricanes has almost doubled since 1970, and "[t]his trend is not inconsistent with recent climate model simulations that a doubling of CO2 may increase the frequency of the most intense cyclones…"(Webster et.al. 2005:1846). This upward trend in tropical cyclone destructive potential is expected to lead to a substantial increase in hurricane-related losses in the twenty-first century (Emanuel 2005:686).

There is an emerging consensus that maximum wind speeds associated with tropical cyclones are likely to increase by 5-10%, accompanied by increases in peak precipitation rates of 20-30%. (Walsh 2002:75) As shown by Fig. 2, a 25% increase in peak gusts causes an almost seven-fold increase in building damages. In addition climate change and associated predicted increase in the severity of extreme events increases both the hazards associated with tropical cyclones and the extent of the area exposed to cyclonic effects, such as storm surge and flooding.

Figure 2: Damage costs increase disproportionately for small increases in peak wind speed



(Stern 2006:79 – Figure 3.10)

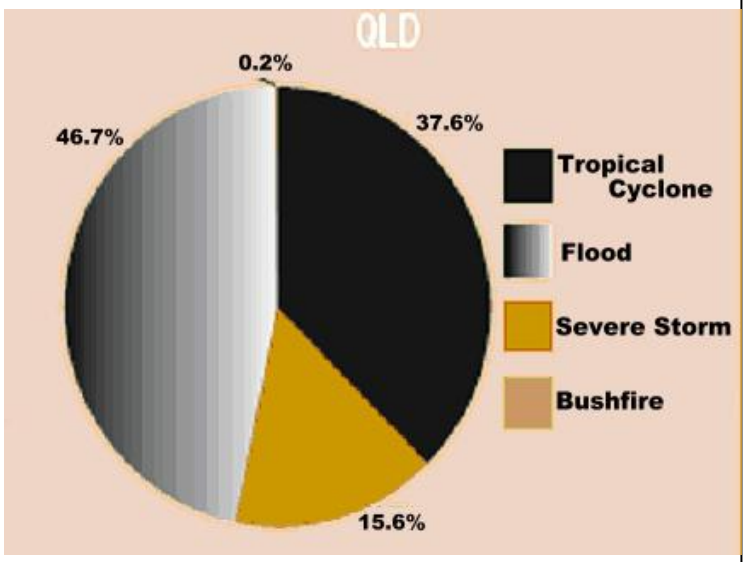
A recent report by the Australian Greenhouse Office (2002:26) states "[r]ising sea level, more severe tropical cyclones and increased intensity of oceanic storm surges are likely with climate change…[and that]… tropical cyclone intensity around Cairns in northern Queensland could increase by 20% by about 2050." A further study found that due to climate change the average area inundated in Cairns by events with a return period of 100 years is found to more than double by 2050 (McInnes 2003:206). Many other Queensland coastal communities face similar increase in risk due to the projected rise in the intensity of climate-change induced natural hazards.

2.3 Vulnerability: demographic changes

2.3.1 Increasing population density in disaster prone areas

"A large population in a hazardous location alone defines maximum vulnerability"(King 2001:155). "Between 2001 and 2026 Queensland is projected to experience the fastest household growth in Australia…(ABS 2004a:3)". This increase in population is of concern as the most disaster-related damage since 1967 "…occurred in the eastern seaboard States, particularly in New South Wales and Queensland, which accounted for 66 per cent of Australia's total cost and 53 per cent of the total number of disasters"(Bureau of Transport Economics 2001:55). In Queensland 87% of the population lives within 30km of the coast (King and Gurtner 2005:4), putting the majority of the population at risk of cyclonic effects. "In Northern Australia an increasing population is also steadily increasing in vulnerability as people move into flood and cyclone prone areas"(King 2001:155).

Figure 3. Queensland: Costs by type of disaster 1967–1999



(Bureau of Transport Economics 2001:33)

As can be seen be Figure 3, cyclones, floods and severe storms are the major types of disaster in Queensland. "The reality…is that as long as people continue to build and develop along the coastline they remain vulnerable to sea related hazards"(King & Gurtner 2005:9). "A recent study by CSIRO on the combined effect of demographic changes and climate change shows that a warmer climate may result in an increased risk of coastal inundation in populated areas"(COAG 2004:9).

The cost of these disasters to the Queensland community is already considerable (Table 1.), and rising sea levels, combined with increased storm intensities and storm surge heights, along with increases in the value of buildings in the vulnerable regions, will likely increase these losses (CSIRO 2002). This is not only due to an increased population in these areas, but also because even a small increase in such environmental factors as flood level or peak wind speed (Figure 2) can have a major impact on infrastructure.

Table 1. Queensland: Cost of Disasters 1967-2006

	Homes Damaged	Homes Destroyed	People Affected	Cost A$ million
Cyclones	12,960	267	337,700	908.7
Severe storms	28,418	136	2,143,820	819
Floods	11,980	56	226,650	666.8
Flash floods	6,240	14	63,700	94
Bushfires	3	18	30,570	3
TOTAL	**59,601**	**491**	**2,802,440**	**2,491.5**
Accessed from EMA Disasters Database <www.ema.gov.au/>				

2.3.2 Australia's increasing aged population

"Australia's estimated resident population (ERP) at June 2004 of 20.1 million people is projected to increase to between 24.9 and 33.4 million in 2051, and to between 22.4 and 43.5 million in 2101" (ABS 2006a). "Queensland is projected to experience the largest increase in population between 2004 and 2051, increasing by 3.0 million people (77%) to reach 6.9 million people, resulting in Queensland replacing Victoria as Australia's second most populous state in 2041"(ABS 2006a).

In addition to a population increase, which in itself would lead to increased vulnerability, "[t]he age composition of Australia's population is projected to change considerably as a result of population ageing"(ABS 2006b). In 2004 the proportion of people aged 65 years and over was 13%, but by 2051 this is projected to increase to between 26% and 28%. (ABS 2006a)

2.3.3 Increasing number of lone older person households

"Between 2001 and 2026 [l]one person households are projected to increase particularly quickly in Queensland, growing by between 87% and 153%...(ABS 2004a:3)". In 2005 24% of persons aged 65 and over lived alone (ABS 2006), and the number of older Australians living alone is expected to increase. "By 2026 the number of older Australians aged 75 years and over living alone is projected to increase to between 844,000 and 962,000, accounting for between 34% and 39% of older Australians…"(ABS 2004a:2).

Lack of social contact increases vulnerability, as there is less chance of assistance reaching these people in a disaster situation. "Isolated, less visible groups have less access to crisis support and personal networks"(Handmer 2003:59). People who live alone on average have less contact with both friends and family, and this isolation increases with age (Table 2). People who are 60+ and live alone generally spend over 19 hours per day on their own, which is considerably more than in younger lone households.

Table 2. Social Context of Time Spent by People Living Alone, 1992

Social context	Aged 15-24 hours/day	Aged 25-59 hours/day	Aged 60+ hours/day	Total hours/day
Alone	10.5	14.5	19.2	16.9
With family only	2.0	1.6	1.8	1.8
With friends only	9.7	6.2	2.0	4.0
With family & friends	0.2	0.5	0.2	0.3
Other	1.6	1.2	0.8	1.0
				(ABS 1996)

Table 3. Housing Tenure by Age and Household Type, 1994

	60+ lone households	60+ couple households	60+ TOTAL
Tenure type	**%**	**%**	**%**
Owner	70.0	85.4	76.8
Purchaser	4.2	5.9	5.2
Renter	21.5	7.5	11.5
- Public	11.3	3.4	5.6
- Private	7.3	3.4	4.6
Other	4.3	1.1	6.5
			(ABS 1996)

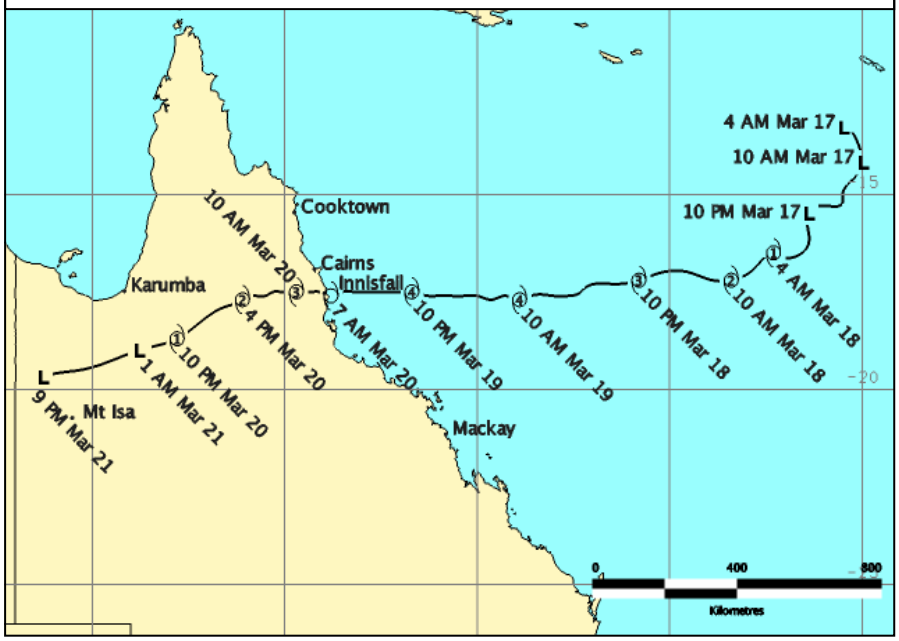
People over 60 living alone are nearly twice as likely to be in rental accommodation than others in their age group (Table 3). This also increases this group's vulnerability, as non-home owners do not have insurance or the chance to rebuild. After a disaster situation accommodation can be scarce, and this group could have difficulty gaining alternative accommodation.

3. Cyclone Larry Johnstone Shire Post Disaster Residents Survey

3.1 Severe Tropical Cyclone Larry

"Severe Tropical Cyclone Larry crossed the tropical north Queensland coast near Innisfail during the morning of 20 March, 2006…Major damage to homes and other buildings was caused by Larry as well as extensive damage to local crops"(BoM 2006).

Figure 4. Track of Severe Tropical Cyclone Larry (BoM 2006)



As can be seen from the map to the right (Fig. 4) Cyclone Larry moved relatively fast. Larry was classed as a Category 5 cyclone when crossing the coast, with estimated maximum wind gusts of up to 290 km/h and storm surge of 2 to 3 metres between Mourilyan and Cardwell. (BoM 2006) The impact on coastal dwellings and infrastructure was substantial, with many buildings damaged (Table 4.).

Table 4. Damage caused by Cyclone Larry

Location	***Damage***
Mareeba / Eacham / Millaa Millaa	93 damaged properties
Babinda	80% of buildings damaged
Flying Fish Point	15% of homes damaged
Innisfail	50% of homes damaged 35% of private industry damaged 25% of Government buildings damaged (schools etc)
Etty Bay	40% of homes suffered roof damage
East Palmerston	70% of homes damaged
Silkwood	worst affected location 99% of homes lost roofs or suffered structural damage
Kurrimine Beach	30% of homes damaged 15% of private industry damaged
El Arish	30% of homes damaged 50% of private industry damaged
Bingil Bay	30% of homes damaged
Mission Beach	30% of homes damaged 20% of private industry damaged 45% of caravan park damaged
South Mission Beach	20% of homes damaged 20% of private industry damaged
Jappoonvale	Possible tornado damage
	(BoM 2006)

3.2 Background to *Johnstone Shire Post Disaster Residents Survey*

Following the impact of Cyclone Larry on Johnstone Shire and surrounding communities on 20th March 2006, a team of five researchers from the **Centre for Disaster Studies** carried out a post disaster household survey. The survey was carried out on a face-to-face interview basis, beginning on Saturday 25th and concluding on Tuesday March 28th. The research team consisted of:

- Dr Douglas Goudie: Centre for Disaster Studies (team leader)
- Dr Dale Dominey-Howes: Macquarie University
- Sonia Leonard: Centre for Disaster Studies (coordinator)
- Irna Rusch: JCU postgraduate
- Kiah Williams: JCU postgraduate

Eight separate areas/communities were covered – Innisfail Estate, East Innisfail, Flying Fish Point, Coconuts, Kurrimine Beach (one individual was interviewed in Innisfail), South Johnstone, Mourilyan and Babinda. The survey interviewed a representative from 147 participating households that held a total of 471 people at the time the cyclone impacted. A limitation of this data is that it was a household survey, and as such the research team did not interview many occupants of the possibly 1 in 20 household that had been rendered uninhabitable by cyclone Larry. The Centre for Disaster Studies published the survey results as the *Cyclone Larry Johnstone Shire Post Disaster Residents Survey* (King and Goudie 2006).

3.3 Methodology for data selection from the survey for this report

As stated in the introduction, the aim of this study is to analyse the differing effect of Cyclone Larry on people 60+ living alone using data obtained by the *Cyclone Larry Johnstone Shire Post Disaster Residents Survey*. A limitation is that for the purposes of this report data obtained from 137 of the 147 households was used, as the other 10 households did not disclose household member ages and therefore could not be included. The findings are also limited due to the small sample of 60+ single households included in the study. The household demographic breakdown is detailed in Table 5.

Table 5. Demographic breakdown

Household type	*Number of households*
60+ single	14
60+ with others	51
<60	72
ages not given	10
Total	147

For the purposes of this report I have referred to those over 60 as older/elderly:

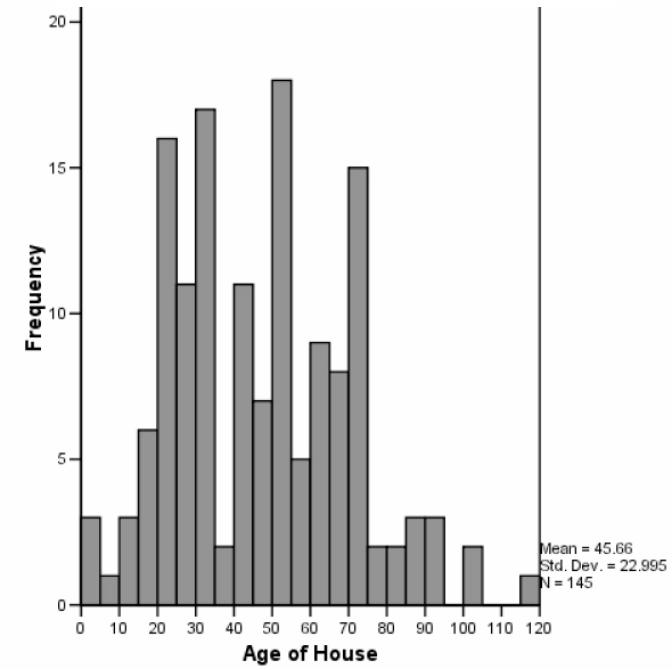
1. To enable a sufficient sample size to analyse (from the data, there were approximately half the households with at least one member 60+ and half where all were <60);
2. As many people are retired by or at 60 years of age, and therefore do not have employment-related contacts or support net-works;

Using SPSS software I constructed a number of graphs based on data from the *Johnstone Shire Post Disaster Residents Survey*, using the categories in Table 5. I have given all results as percentages to allow comparison with other studies. Please note that as the target group in this study is relatively small (only 14 total 60+ lone households) any observed trends would need to be confirmed by further surveys.

4. Results

4.1 Background: House age/property insurance/ property damage

Figure 5. Age of houses in the study area



"Severe Tropical Cyclone Larry is the first severe tropical cyclone to cross near a populated section of the east coast of Queensland since Rona in 1999, and the effects of the winds on buildings were devastating"(BoM 2006). Table 4 (p.7 of this report) details house damage by suburb in the impacted area. "Cyclone resistant building codes came in during the mid-1970s so that those dwellings that are less than 30 years old are more likely to have greater Cyclone resistance in their structures"(King and Goudie 2006:45-46). As can be seen from Fig 5 (King & Goudie 2006:44), the majority of the houses covered by the study are over 30 years old. It should be noted that although age alone is not an adequate indicator of potential damage, as other factors such as size, shape, materials, and topography could all have an effect (Henderson and Harper 2003:18) a study on damage to buildings in the Innisfail area found "[m]ore recent housing fared considerably better than older housing"(Henderson et.al. 3:2006). King and Goudie (2006:46) reported that "…the elderly residents were fairly consistently insured and that many of them lived in older houses". While 83% of 60+ single households live in houses over 30 years old, only 69% have house and content insurance and 31% have no insurance at all (Table 6). This leaves a section of this cohort economically vulnerable, as they may not have the financial resources after a disaster situation to rebuild or replace damaged items. As noted in section 2.3.3 of this report (Table 3), 60+ single households are nearly twice as likely to be renting as others of their age group. This could partly explain the lower percentage of insurance coverage.

Table 6. House age/Property Insurance/Damage

	Household age			
	60+ single	60+ with others	<60	Total
House age				
<30 yrs.	17%	31%	20%	24%
30+ yrs.	83%	69%	80%	76%
Property insurance				
House only		8%	1%	4%
Contents only		6%	13%	9%
House & contents	69%	82%	59%	69%
None	31%	4%	27%	19%
Property damage				
Minor	79%	41%	38%	43%
Some damage	14%	31%	26%	27%
Minor to windows		8%	7%	7%
Roof damage from trees		8%	4%	5%
Damage to walls		4%	6%	4%
Vegetation destroyed			6%	3%
house shaking		2%		1%
damage to other properties/farm			1%	1%
roof loss	7%	4%	10%	7%
none		2%	3%	2%

4.2 Time became concerned/ Expectations of storm surge

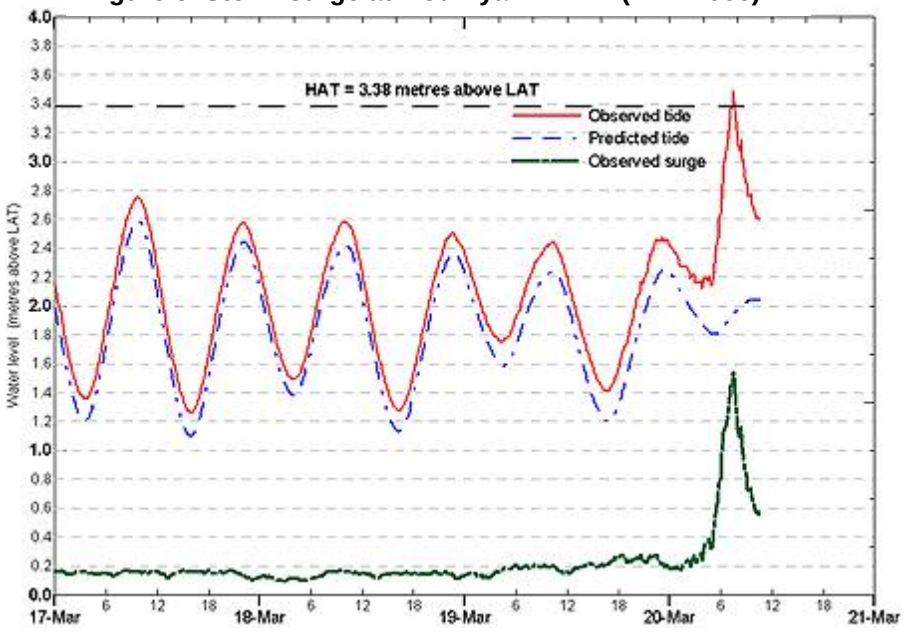
Although the majority of 60+ lone households became concerned about Cyclone Larry at the same time as the wider population, a significant number of this group stated they felt no concern whatsoever (15% as opposed to 2% for the average). This could be due to personal characteristics such as independence, self-sufficiency, stability, etc., or because this group felt sufficiently prepared. However it could also be due to a lack of information due to social isolation or other factor/s.

Table 7. Time became concerned/ Expectations of storm surge

	Household age			
	60+ single	60+ with others	<60	Total
Time became concerned about Larry				
Saturday or earlier	8%	12%	15%	14%
Sunday	46%	41%	51%	46%
Monday	31%	45%	34%	38%
not concerned	15%	2%		2%
Expectation of storm surge				
Yes	43%	57%	71%	63%
No	57%	43%	28%	36%
maybe			1%	1%

What is of note is the large percentage of this cohort who had no expectation of a storm surge (57% as opposed to an average of 36%). "All tropical cyclones on or near the coast are capable of producing a *storm surge*, which can increase coastal water levels for periods of several hours and significantly affect over a 100km of coastline"(Department of Natural Resources & Mines 2004:6). "While tsunamis are currently a topical issue, severe cyclones, storm surges and flooding are just as serious and can be equally destructive" (King & Gurtner 2005:9). A number of towns on the Queensland coast, including Cairns and Townsville, are just above sea level and thus are vulnerable to quite minor storm surges. (Handmer 2006:34)

Figure 6. Storm surge at Mourilyan (EPA 2006)



Severe Tropical Cyclone Larry caused a significant storm surge, with sea levels exceeding the predicted tide by over 1.75m at recording stations close to landfall and surges of greater than 0.5m experienced at all recording stations from Cairns to Townsville. (BoM 2006) More extensive flooding was avoided as predicted tides were approximately 1.5m below the Highest Astronomical Tide (HAT) at the time, so the total water level only just exceeded HAT by a few centimetres. (BoM 2006) Figure 6 (above) shows the height of the storm surge at Mourilyan recording station, the closest station to where Cyclone Larry crossed the coast.

4.3 Preparation: pre-cyclone and due to warning

This section looks at the preparations made by residents, both pre-cyclone season and during the cyclone warning period for Cyclone Larry. The most obvious pattern is the large number of 60+ lone households (31%) who made no preparations prior to the cyclone season at all (Table 8). The 60+ lone households were also less likely to prepare or purchase additional items due to hearing a cyclone warning (Table 9). This group were more than twice as likely to do nothing compared to others in their age group. This seems at odds with the perception among this group that the adequacy of their preparations was either excellent/good or pretty good (Table 8), however King and Goudie (2006:35) noted in general "[t]hose who took no action largely felt that they were prepared and there wasn't much more to do", which could indicate this group felt adequately prepared prior to cyclone season.

Table 8. Preparation pre-cyclone

	Household age			
	60+ single	60+ sharing	<60	Total
Time of beginning preparations				
Saturday or earlier	23%	47%	23%	33%
Sunday	46%	49%	70%	59%
none made	31%	4%	7%	8%
Adequacy of Preparations				
Excellent/good	92%	94%	76%	85%
Pretty good	8%	2%	13%	8%
Fair		2%	10%	6%
Poor		2%	1%	1%
Preparation for Cyclone season				
Yard clean up	36%	25%	25%	26%
House preparation	7%	12%	13%	12%
Emergency kit	7%	4%	4%	4%
Nothing	21%	35%	35%	34%
Shopping	21%	22%	17%	19%
all	7%	2%	6%	4%

Table 9. Preparations due to warning

Preparations prompted by warning					***Purchases during warning***				
	Household age					Household age			
	60+ single	60+ sharing	<60	Total		60+ single	60+ sharing	<60	Total
tape windows		4%	3%	3%	Batteries	7%	2%	3%	3%
Clear yard	21%	29%	32%	30%	Tinned Food		2%	1%	1%
Buy supplies		4%	8%	6%	Fresh food		2%	1%	1%
Buy fuel		2%		1%	Fuel		6%		2%
Repair building/trim vegetation	7%		1%	1%	Check or buy generator		2%	1%	1%
Secure car and/or boat			1%	1%	All of batteries, candles, food, fuel	14%	16%	40%	28%
Secure other belongings		10%	1%	4%	Nothing	57%	25%	18%	25%
Nothing	36%	16%	17%	18%	Batten down/ clear yard	7%	22%	19%	19%
Store water	21%	4%	3%	5%	store water			3%	1%
food preparation		2%		1%	Store water & clear up	7%	10%	3%	6%
clear yard & secure boat		4%	10%	7%	batteries & candles			1%	1%
Clear up, shop & secure	14%	20%	18%	18%	food	7%	6%	4%	5%
Buy supplies & store water		4%	3%	3%	Secure, clear & shop		8%	3%	4%
Store water & secure belongings		2%	3%	2%	secure personal belongings			1%	1%

4.4 Support: Contact with friends or family/special needs /emotions and reactions

There is a definite trend indicating during Cyclone Larry 60+ lone households were more likely to be isolated, have less contact with family or friends, were less likely to have contact with neighbours, and were more likely to stay in their house throughout the event. This finding is in line with data from the Australian Bureau of Statistics, which found that the isolation experienced by lone households increases with age (Section 2.3.3 Table 2).

Table 10. Contact with friends, neighbours and family

	Household age			
	60+ single	60+ with others	<60	Total
Family contactable				
Yes	57%	90%	94%	89%
No	21%	8%	3%	7%
No others	21%	2%	3%	5%
Contact with other relatives				
Yes	87%	98%	86%	91%
No	13%	2%	8%	6%
Other family & relatives in Larry				
Yes	57%	84%	66%	72%
No	29%	16%	32%	26%
No others	14%		1%	2%
Contact with neighbours				
Yes	57%	67%	68%	66%
No	43%	33%	32%	34%
Other visitors				
Other family visited		48%	10%	22%
Other friends visited	20%	4%	13%	10%
None	80%	48%	78%	68%
Stay in House				
Yes	100%	92%	83%	88%
No		8%	17%	12%

This isolation dramatically increases the vulnerability of this group. Not only is there less chance of information or warnings being passed on via word-of-mouth, there is less chance this group will receive assistance both while preparing for an oncoming cyclone and if injured during the event. To mitigate this vulnerability a system of some type should be set up to ensure contact with these people during disaster events.

Table 11. Special needs

	Household age			
	60+ single	60+ with others	<60	Total
Special needs - type				
Medical	50%	47%	25%	39%
Elderly/Frail	50%	35%	8%	26%
Disabled		18%	33%	23%
Special needs				
Yes	15%	34%	17%	23%
No	85%	66%	83%	77%
Special needs met				
Yes	100%	76%	77%	77%
No		24%	23%	23%

One positive statistic is that only 15% of 60+ lone households reported they had special needs, and 100% of these people had those needs met (Table 11). It is possible that this group are more self-reliant and thus managed to fulfil many of their special needs themselves. Half of this group stated their special needs were related to being elderly/frail and the other half medical. As they are used to living alone they may have ensured prior to the cyclone that their dwelling was already set-up for an elderly/frail resident and they had sufficient medicine, rather than relying on outside assistance.

Turning to the emotions experienced by people impacted by Cyclone Larry, King and Gurtner (2006:34) found "[w]hile the small number of single parents with young children were more strongly in the scared category, the elderly and special needs households are not significantly different from the rest of the population". This picture changes, however, when one looks at 60+ lone households compared to the rest of the population. Upon hearing the cyclone warning, while only slightly more than the average percent in this group reported being worried (21%), a larger than average percent stated they felt both prepared and calm (Table 12). Unfortunately a larger than average percent also stated they did not take the situation seriously, and 43% took no action.

Table 12. Emotions/reactions

	Household age			
	60+ single	60+ with others	<60	Total
Feelings on hearing cyclone warning				
Very scared	7%	6%	6%	6%
scared	7%	27%	30%	26%
worried	21%	16%	18%	18%
concerned		16%	11%	12%
prepared	21%	10%	11%	12%
excited			3%	1%
calm	29%	16%	8%	13%
strong		2%		1%
did not take it seriously	14%	8%	10%	10%
annoyed/angry			3%	1%
Acted on Feeling				
Increased Preparations & activity	43%	53%	51%	51%
No action	43%	20%	17%	21%
Stay calm/don't scare others	7%	22%	23%	21%
confused	7%	2%	1%	2%
evacuated			4%	2%
listen to warnings			3%	1%
upset		4%	1%	2%
Personal effect				
additional costs			4%	2%
shaken	21%	24%	21%	22%
disoriented	14%	4%	6%	6%
lucky/community spirit	14%	8%	6%	7%
distressed or stressed		26%	18%	19%
frustrated			3%	1%
loss of business/work		10%	13%	10%
inconvenienced	7%	10%	10%	10%
no effect	7%	8%	7%	7%
worried	29%	8%	6%	9%
loss of belongings	7%	2%	7%	5%
guilty			1%	1%

As to the personal effect, 29% of 60+ lone households stated they felt worried and 14% felt disorientated. However it should be noted that the responses to these survey questions "…is obviously a simplification of what for many people was probably a complex of emotions"(King and Goudie 2006:34). For example, a large number of survey respondents who stated they were distressed or stressed may have meant the same as worried.

What this study does show is that more research needs to be carried out on the emotional impact of disaster situations on older lone households. As shown in section 2.3.3 of this study, this group is most likely to face social isolation and therefore the implementation of an emotional support system is necessary to help decrease their vulnerability during disaster situations.

5. Conclusions

INCREASING HAZARD

Due to climate change, scientific research indicates and more extreme weather events and large-scale single events with more severe cyclones, storms and floods, are expected in the future.

Even minor increase in intensity of natural events can lead to dramatically increased costs, as damage costs increased disproportionately to the rising intensity of an event. A small increase in wind speed results in a much greater damage level to buildings, while a small increase in flood heights leads to much greater areas being inundated.

INCREASING EXPOSURE

Between 2001 and 2026 Queensland is projected to experience the fastest household growth rate in Australia. Between 2004 and 2051Queensland is projected to experience the largest increase in population, increasing by 3.0 million people (77%) to reach 6.9 million people.

Coastal areas are experiencing a faster growth rate than the average for Queensland as a whole, leading to a rapid increase in the number of people living in exposed areas. As more than 97% of the coastal foreshores in Queensland is in public ownership the State has a very limited liability for providing protection to development on the coast.

INCREASING VULNERABILITY

The age composition of Australia's population is projected to change considerably as a result of population ageing. Between 2004 and 2051 the proportion of people aged 65 years and over is projected to increase from 13% to 26% - 28%. Having a large section of the population of this age, who could require medication or increased assistance during an emergency situation, increases the vulnerability of the community as a whole.

Between 2001 and 2026 lone person households project to increase particularly quickly in Queensland, growing by between 87% and hundred and 53% in that time. Lone person households are more vulnerable than the wider community, thus this increase in lone person households could lead to increased community vulnerability as a whole.

In 2005 nearly a quarter of persons aged 65 and over lived alone, and the number of older Australians living alone is expected to increase. Although the majority of people over 60 own their own home, 60+ single households are nearly twice as likely to be renting as others of their age group, and also are less likely to have house and contents insurance. The vulnerability of lone person households increases with the occupant’s age, with older people experiencing increased social isolation.

- 31% of 60+ lone households had no house or contents insurance, as compared to 4% of people their age living with others and 19% for the average. This may be because of lower home ownership.

- 15% of 60+ lone households expressed no concerned about cyclone Larry, as compared to only 2% of people their age living with others and 2% to the average. Further research would need to be carried out to ascertain the psychological reasons that this lack of concern, as it may be due to either complacency or because this group felt sufficiently prepared prior to the cyclone season.

- Although everyone should have expected a storm surge, 57% of 60+ lone households stated they had no expectation, compared to 43% for people their age living with others and 36% for the average. Considering the likelihood of a storm surge it is of concern that such a large percent of the population had no expectation. As it was there was a storm surge of over 1.75 m at some areas, but extensive flooding was avoided as at the time the cyclone crossed the coast the tides were approximately 1.5 m below the Highest Astronomical Tide level. These results show further education concerning storm surge is required, not just for 60+ lone households but also for the public as a whole.

- The results showed that 60+ lone households may either have felt they were adequately prepared prior to that cyclone season, and so there wasn't much else to do upon hearing the cyclone warning, or else they made the least preparations due to cyclone warning than any other group for other reasons (complacency, apathy, etc.). More research needs to be done in this area to clarify this result.

- There is a definite trend showing this group were more likely to be isolated, were less likely to have contact with neighbours, family or friends, and were more likely to stay in their house throughout the event. This is in line with data from the Australian Bureau of Statistics, which found that the isolation experienced by lone households increases with age. This group is most likely to face social isolation, and therefore the implementation of an emotional support system is necessary to help decrease their vulnerability during disaster situations.

In conclusion, the increased risk of natural disasters Queensland faces due to climate change (*HAZARD*) and increasing coastal population/infrastructure (*EXPOSURE*) could be exacerbated by an aging demographic linked with the increasing trend towards lone households (*VULNERABILITY*). As a statistically small number of households were examined by this study (14 total 60+ lone households) further studies should be done in this area, and potential mitigation strategies devised if necessary.

REFERENCES

ABS (1996) *4102.0 - Australian Social Trends, 1996*. Australian Bureau of Statistics, Commonwealth of Australia, Canberra. Accessed 15/09/2006 at www.abs.gov.au/ausstats/abs@.nsf/2f762f95845417aeca25706c00834efa/90e51fb0bf87c261ca2570ec0073d3b3!OpenDocument

ABS (2004a) *Household and Family Projections, Australia, 2001 to 2026*. Australian Bureau of Statistics, Commonwealth of Australia, Canberra. Accessed 15/09/2006 at www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3236.02001%20to%202026?OpenDocument

ABS (2004b) *1301.0 - Year Book Australia 2004: How many people live in Australia's coastal areas?* Australian Bureau of Statistics, Commonwealth of Australia, Canberra. Accessed 15/09/2006 at www.abs.gov.au/Ausstats/abs@.nsf/Previousproducts/1301.0Feature%20Article32004?opendocument&tabname=Summary&prodno=1301.0&issue=2004&num=&view=

ABS (2006a) *3222.0 - Population Projections, Australia, 2004 to 2101*. Australian Bureau of Statistics, Commonwealth of Australia, Canberra. Accessed 15/09/2006 at www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/3222.0Main+Features12004%20to%202101?OpenDocument

ABS (2006b) *4102.0 - Australian Social Trends, 2006*. Australian Bureau of Statistics, Commonwealth of Australia, Canberra. Accessed 15/09/2006 at www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/5547D397B45616D1CA2571B000102D64?opendocument

Australian Greenhouse Office (2002) *Living With Climate Change: An overview of selected potential climate change impacts on Australia*. Australian Greenhouse Office, Department of the Environment and Heritage, Commonwealth of Australia, Canberra. Accessed 6/9/06 from www.greenhouse.gov.au/impacts/overview/index.html

BoM (2006) *Severe Tropical Cyclone Larry*. Bureau of Meteorology, Commonwealth of Australia, Canberra. Accessed 23/10/06 from www.bom.gov.au/weather/qld/cyclone/tc_larry/

Buckle, (1999) Re-defining community and vulnerability in the context of emergency management. Australian Journal of Emergency Management, Spring 1998/99, pp. 21-26.

Bureau of Transport Economics (2001) *Report 103: Economic Costs of Natural Disasters in Australia*, Bureau of Transport Economics, Commonwealth of Australia, Canberra. Accessed 22/09/2006 from www.btre.gov.au/docs/reports/r103/r103.aspx

COAG (2004) *Natural Disasters in Australia: Reforming mitigation, relief and recovery arrangements*. Council of Australian Governments (COAG), High Level Group on the Review of Natural Disaster Relief and Mitigation Arrangements. Commonwealth of Australia, Canberra. Accessed 22/09/2006 from www.dotars.gov.au/disasters/publications/index.aspx

Crichton, D. (1999). *The Risk Triangle*. Natural Disaster Management. J. Ingleton. London, Tudor Rose: 102-103.

CSIRO (2002) Climate Change and Australia's Coastal Communities. CSIRO, Commonwealth of Australia. Accessed 16/08/2006 from www.dar.csiro.au/publications/CoastalBroch2002.pdf

Department of Natural Resources & Mines (2004) *Queensland Climate Change and Community Vulnerability to Tropical Cyclones, Synthesis Report August 2004.* Department of Natural Resources & Mines, Queensland State Government. Accessed 22/09/2006 from www.longpaddock.qld.gov.au/ClimateChanges/pub/OceanHazardsMenu.html

Dore, M. (2000) *The importance of measuring the costs of natural disasters at a time of climate change*. Australian Journal of Emergency Management, Spring 2000, pp. 46-51.

Emanuel, K. (2005) *Increasing destructiveness of tropical cyclones over the past 30 years*. Nature, Vol.436, 4 August 2005, Nature Publishing Group, pp.686-688.

Environmental Protection Agency (2002) *State Coastal Management Plan - Queensland's Coastal Policy*. Environmental Protection Agency, The State of Queensland. www.epa.qld.gov.au/environmental_management/coast_and_oceans/coastal_management/state_coastal_management_plan/

EPA (2006) *Media - Wave and Tide graphs of Cyclone Larry*. Environmental Protection Agency, The State of Queensland. Accessed 26/10/2006 from www.epa.qld.gov.au/about_the_epa/media_room/archived_issues/cyclone_larry/media__wave_and_tide_graphs_of_cyclone_larry/

Handmer, J. (2003) *We are all vulnerable*. The Australian Journal of Emergency Management, Vol. 18 No 3., August 2003, pp.55-60.

Handmer, J. (2006) *American exceptionalism or universal lesson? The implications of Hurricane Katrina for Australia.* The Australian Journal of Emergency Management, Vol. 21 No. 1, February 2006, pp. 29-42.

Hayne, M. and Schneider, J. (2002) *Minimising the Impacts of Natural Hazards on our Urban Coastal Communities.* Coast to Coast pp.153-156. www.coastal.crc.org.au/coast2coast2002/proceedings/Theme3/Minimising-impacts-natural-hazards.pdf

Henderson, D.Ginger, J. Leitch, G. and Falck, D. (2006) *Technical Report No. 51 – Tropical Cyclone Larry: Damage to buildings in the Innisfail area*. Cyclone Testing Ststion, School of Engineering, James Cook University, Townsville. Accessed 5/11/2006 from http://www.abcb.gov.au/index.cfm?fuseaction=Publications

Henderson, D. and Harper, B. (2003) *Queensland Climate Change and Community Vulnerability to Tropical Cyclones: Development of a Cyclone Wind Damage Model for use in Cairns, Townsville and Mackay*. Department of Natural Resources & Mines, Queensland State Government. Accessed 22/09/2006 from www.longpaddock.qld.gov.au/ClimateChanges/pub/OceanHazardsMenu.html

Jenner, T. (2006) *Notes from the Field: Emergency Management Liaison in the aftermath of Severe Tropical Cyclone Larry.* The Australian Journal of Emergency Management, Vol. 21 No. 2, May 2006 p. 64.

King, D. (2001) *Uses and Limitations of Socioeconomic Indicators of Community Vulnerability to Natural Hazards: Data and Disasters in Northern Australia.* Natural Hazards 24: 147–156, 2001, Kluwer Academic Publishers, the Netherlands.

King, D and Gurtner, Y. (2005) *After the Wave: a wake up warning for Australian coastal locations.* The Australian Journal of Emergency Management, Vol.20 No.1, February 2005 pp. 4-9.

King, D and Goudie, D. (2006) *Cyclone Larry Post Disaster Residents Survey*. Centre for Disaster Studies, James Cook University & Australian Bureau of Meteorology.

McInnes, K. L., Walsh, K. J. E., Hubbert, G. D. and Beer, T. (2003) *Impact of Sea-level Rise and Storm Surges on a Coastal Community*. Natural Hazards 30: 187–207, 2003. Kluwer Academic Publishers. Printed in the Netherlands.

Stern, N. (2006) *Stern Review on the Economics of Climate Change*. HM Treasury, British Government, London. Accessed 1/11/2006 from
www.hm-treasury.gov.uk/Independent_Reviews/stern_review_economics_climate_change/sternreview_index.cfm

Walsh, K., Cai, W., Hennessy, K., Jones, R., McInnes, K., Nguyen, K., Page, C. and Whetton, P. (2002) *Climate Change in Queensland under Enhanced Greenhouse Conditions Final Report, 1997-2002*. CSIRO Atmospheric Research & Queensland Department of Natural Resources. Accessed 23/10/2006 from www.longpaddock.qld.gov.au/ClimateChanges/pub/CSIRO2002.html#end

Walsh, K. (2004) *Climate change and coastal response*. Cooperative Research Centre for Coastal Zone Estuary and Waterway Management (Coastal CRC), Indooroopilly Sciences Centre, Brisbane. Accessed 23/10/2006 from www.coastal.crc.org.au/pdf/coast2coast2002papers/climate.pdf

Webster, P.J., Holland, G.J., Curry, J.A., & Chang, H.R. (2005) *Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment*. Science, 16 September 2005, Vol. 309, pp.1844-1846.

Innisfail after Cyclone Larry (King and Goudie 2006:74)

Appendix I. Method

The following appendices are from the *Cyclone Larry Post Disaster Residents Survey*, adapted for this report. This section is verbatim from page 4-5 (King and Goudie 2006).

The survey was conducted by short answer questionnaire. One respondent from each household answered the questions that were put to them by the interviewer. The interview team worked closely together, both as a team but also geographically. A random point was selected in the community and a cluster of houses was approached by the team. It was clear from examination of the initial photographs of the cyclone impact that damage had occurred in quite a random way, such that a house may have been destroyed while its neighbours were virtually intact. Thus the cluster selection did not necessarily result in a concentration of damage. The advantages of the team working in clusters included security, mutual support, group feedback and access to transport. Early estimates of the cyclone impact suggested that about 5% of residential dwellings had been totally destroyed. The survey recorded less than this estimate because places that had been totally destroyed were less likely to have any household members present at the wreckage at the time of the survey. However the intention of the survey was less about damage, than about behaviour, preparation and warnings.

The survey instrument was based upon earlier post disaster studies, especially Steve which hit Cairns in 2000, but in undergoing a rapid review before being conducted, some repetition of questions resulted. There was however an advantage to this when coding the questionnaires for-data entry, in that answers could be cross referenced for greater detail. The questions were open-ended rather than being pre-coded, but limited space was made available on the questionnaire form for answers. Additional notes were recorded by the interviewers where the respondents expanded on their answers or gave additional information. These notes have been incorporated into the text of this report. Because the questions were open-ended there was a diversity of responses. All answers were therefore coded and defined by one person. Notes on questions, answers and coding of responses are given as Appendix 1.

The questions in the survey followed a roughly chronological or logical order in terms of actions and preparedness following a series of different types of warnings and information. The responses have been organized into categories of questions which are presented as tables and figures with annotation and discussion.

The transcriptions reflect general responses verbatim, not easily reduced to one of the standard array of coded answers. They also capture ‘the outliers’, or the unusual. With so many open-ended questions and prompts, the transcriptions show the merit of such questions, to capture a complete and accurate record of how people reacted to safety weather warnings, what happened, what lessons the Bureau, the media, various authorities and residents in threat zones can learn from impact residents’ often frightening experiences. The transcribed responses to questions were variously obvious, detailed, thorough, telling, insightful or illuminating.

Appendix II. Notes on questions, answers and coding of responses

The numbers relate to the original 42 questions asked by the researchers (King and Goudie 2006:54-59). I have only included those 20 questions relevant to this report, but kept the original numbers for ease of cross-referencing. The section of the survey instrument used for this report is included as Appendix III.

3. What did you do to prepare for this cyclone season?
Many people's little responses to questions two and three were no or didn't do anything etc. For single people and even couples this is a rational response, but many people indicated that they maintain a level of preparedness without necessarily having a formal plan or taking specific action.

4. At what time (and day) did you first become aware cyclone Larry was heading your way?
While Sunday was the warning period the development of the low was watched much earlier in the week. There was plenty of time on Sunday from people to prepare for the cyclone and as it was a glorious sunny day many respondents indicated that they participated in other activities.

6. What further preparations did the warnings prompt you to carry out?
This question sought information of the actual actions of people. Some gave a single action, when others indicated a number of activities. Coding has attempted to summarise knees into groups of separate actions.

7. Can you remember how you felt when you heard the cyclone advice messages for cyclone Larry?
Frightened has been coded under scared. A few people said they prayed (these responses appeared genuine) and these have been coded along with feeling calm, although the intent may have been more oriented to action rather than to personal self-control.

8. Can you recall how you acted on this feeling?
A dominant response was that people got on with preparations with a sense of increased urgency and importance. This question was looking for the type of response rather than the specific actions as these have already been recorded in question six.

9. Who was in your household on Sunday March 19th as Cyclone Larry approached the coast (ie were all the family at home? did others come to your household?) (List ages and gender)
A number of data columns were generated from this question. The interviewers generally did not record whether others have come to the household but this information is implicit in various other answers. The total number of people and householders recorded, and a list of ages and genders. From this an approximate definition of the family type or group of people present in the house has been attempted and from this information the classification of vulnerability categories may be added. However we did not ask people their relationships to other members of the household, so that the family type variable is indicative only. An additional variable was generated from a combination of age, family type and the special needs question. Households were classified as elderly if the members, or the mean age of a couple, were over 65 years of age. Single parents with children under twelve were selected next, then additional households containing someone with special needs. Some of these had already been classified as elderly, or single parent with young kids in which case the initial classification was left. All other households are thus deemed less vulnerable.

12. Were any of your family or relatives (that do not live with you) also in the Cyclone Larry warning area? If yes, did you have contact with them?

13. Did members of your household talk to / visit / stay with, neighbours during the Cyclone Larry warning period on Sunday March 19th? If yes, when or how often?

To both questions 12 and 13 people responded with words like lots or often had contact etc. They also indicated contact by mobile and landline telephone. Where the answer was given as lots of contact it may have been by telephone. Some people also indicated the different periods of time when they had contact with relatives or neighbours, and there is a significant number who mentioned visiting neighbours during the passage of the eye of the cyclone (principally in Innisfail, but not communities to the north and south). Therefore this response has been coded even though it is not technically an answer to the question that they were asked.

18. Did you expect there to be a storm surge associated with Cyclone Larry crossing the coast at or near Innisfail?

The answer to this question should have been a universal yes as it was contained within warnings. It is uncertain whether or not it was the interviewer or the respondent who gave the impression that this referred to the local community in which the interview was taking place. However many people interpreted this question in that way, such that Babinda residents strongly answered in the negative

20. When did you begin to be concerned about cyclone Larry?

The category of Monday a.m. was generally stated as between 4.30 and 7.30, presumably when destructive winds were at their strongest.

21. When did you begin to make preparations for Cyclone Larry?

This question was repetitive and used the same time categories as other questions, but was additionally useful for qualifying some of the other answers.

22. When the cyclone warning was in force, what preparations, including purchases, did you make?

This question was repetitive but emphasised purchases as well as other preparatory actions.

23. How adequate do you think your household's preparations were for Cyclone Larry?

Most people had answered yes which was interpreted as good.

24. Did you stay in your own residence while cyclone Larry impacted the Innisfail area on Sunday and Monday and where in the house did you shelter? If no, where did you go?

All households are moved elsewhere were classified as evacuated, but those from the three beachside communities were told to evacuate, whereas other households chose to shelter with family, relatives or friends and neighbours.

25. What was the effect of Cyclone Larry on your property (or properties)?

Answers to this question gave a list of major damage from the point of view of the respondent. Question 42 required the interviewer to record a visual observation of damage. Clearly some things could have been fixed up by the time the interview took place. Actual items of damage were transferred from this question to question 42, and a combination of both questions was used to code the level of damage under this variable

26. About how old is/was your home?

The answer is in years.

27. Is your property insured for cyclone damage? a) Yes, House only b) Yes, Contents only c) Yes, House and contents d) No

There were some respondents who answered no, and made a comment that the dwelling was rented and that the landlord probably had insurance.

37. What was the effect of Cyclone Larry on you personally?

Responses to question 37 will not on a continuum scale but tended to be quite diverse, such that coding has attempted to reflect the diversity but with some compression of emotional responses.

40. Is there anyone in this household who has special needs?

If yes how were their needs met during the passage of the cyclone?

This question was a broad self definition. If somebody answered yes their responses have been coded. Thus some babies had special needs while others did not, and some eighty-year-olds had special needs while others did not.

42. Visual observation of damage

See question 25. Items from both of these questions have been recorded within a 50 character limit.

Appendix III. Survey Instrument

The following is from the *Cyclone Larry Post Disaster Residents Survey* (King and Goudie 2006:64-66) As noted in Appendix II, I have only included those 20 questions relevant to this report but kept the original numbers for ease of cross-referencing

Number:
3. What did you do to prepare for this cyclone season?
4. At what time (and day) did you first become aware cyclone Larry was heading your way?
6. What further preparations did the warnings prompt you to carry out?
7. Can you remember how you *felt* when you heard the cyclone advice messages for cyclone Larry?
8. Can you recall how you acted on this feeling?
9. Who was in your household on Sunday March 19th as Cyclone Larry approached the coast (ie were all the family at home? did others come to your household?) (List ages and gender)
12. Were any of your family or relatives (that do not live with you) also in the Cyclone Larry warning area? If **yes**, did you have contact with them?
13. Did members of your household talk to / visit / stay with, neighbours during the Cyclone Larry warning period on Sunday March 19th? If **yes**, when or how often?
18. Did you expect there to be a storm surge associated with Cyclone Larry crossing the coast at or near Innisfail?
20. When did you begin to be concerned about cyclone Larry?
21. When did you begin to make preparations for Cyclone Larry?
22. When the cyclone warning was in force, what preparations, including purchases, did you make?
23. How adequate do you think your household's preparations were for Cyclone Larry?
24. Did you stay in your own residence while cyclone Larry impacted the Innisfail area on Sunday and Monday and where in the house did you shelter? If **no**, where did you go?
25. What was the effect of Cyclone Larry on your property (or properties)?
26. About how old is/was your home?
27. Is your property insured for cyclone damage? a) Yes, House only b) Yes, Contents only c) Yes, House and contents d) No
37. What was the effect of Cyclone Larry on you personally?
40. Is there anyone in this household who has special needs? If yes how were their needs met during the passage of the cyclone?
42. Visual observation of damage