

CHAPTER 3: THE ELEMENTS AT RISK AND THEIR VULNERABILITY

Ken Granger

In the first chapter we introduced the ‘five esses’ (shelter, sustenance, security, society and setting) into which we have organised our consideration of the elements at risk in the community and their vulnerability. The broader ‘setting’ elements were outlined in [Chapter 2](#). In this chapter we describe the key aspects of the remaining four groups.

Shelter

Buildings: The buildings that provide shelter to the community at home, at work and at play vary considerably in their vulnerability to different hazards, and hence the degree of protection they provide the community. A database containing details of the use and structural characteristics of around 20 700 individual buildings in Mackay has been developed. For convenience, this mass of detail has been summarised down to the suburb level in the [Tables 3.1 and 3.2](#). The format and content of the *BUILDING* database are described in [Appendix B](#).

[Table 3.1](#) provides the suburb-by-suburb tally of the uses to which buildings are put. It should be noted that the numbers relate to individual buildings. This differs from most published statistics. With census data, for example, the number of ‘flats’ relates to number of individual dwelling units (i.e. individual flats) rather than buildings; in industry statistics, figures typically relate to the complete enterprise or facility. Around 91% of the buildings in Mackay are residential (houses, flats and commercial accommodation), though the distribution is uneven across the study area, as shown in [Figure 3.1](#).

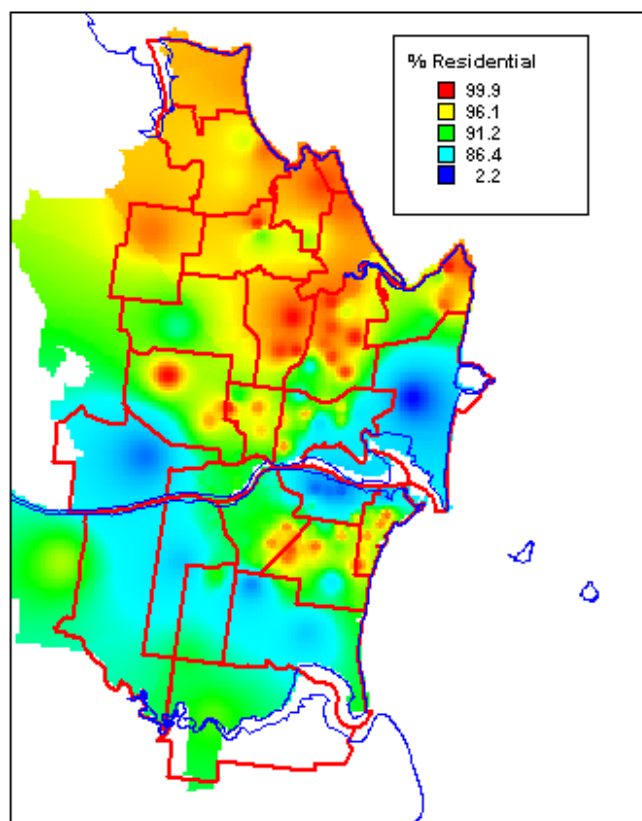


Figure 3.1: Proportion of residential buildings by CCD

Table 3.1: Mackay building use by suburb

Locality	Buildings	Houses	Flats	Motels, etc	Business ¹	Logistic ²	Safety ³	Community ⁴	Utility ⁵	Comms ⁶
Andergrove	2405	2228	105	2	8	5	1	54	2	0
Bakers Creek	267	245	2	2	9	1	0	7	1	0
Beaconsfield	1335	1309	16	0	2	1	1	6	0	0
Blacks Beach	282	244	5	29	1	0	0	3	0	0
Bucasia	890	826	32	10	2	3	3	13	0	1
Central Mackay	1633	770	179	30	470	32	29	108	4	11
Cremorne	23	14	1	0	8	0	0	0	0	0
Dolphin Heads	79	64	4	11	0	0	0	0	0	0
East Mackay	1117	993	86	2	11	1	3	21	0	0
Elmeo	619	595	16	1	3	0	0	3	1	0
Erakala	13	11	0	0	2	0	0	0	0	0
Foulden	1	1	0	0	0	0	0	0	0	0
Glenella	501	443	8	0	37	2	1	10	0	0
Mackay Harbour	121	1	0	1	30	74	1	8	3	3
Mount Pleasant	1233	1133	46	7	19	2	4	20	2	1
Nindaroo	54	53	0	0	0	0	0	0	0	0
North Mackay	2171	1831	114	5	109	19	5	84	3	1
Ooralea	578	546	2	0	12	9	0	9	0	0
Paget	244	82	3	2	130	22	1	3	0	1
Racecourse	57	43	0	0	10	2	0	2	0	0
Richmond	33	31	0	0	1	0	0	1	0	0
Rural View	376	363	2	0	4	1	0	6	0	0
Shoal Point	182	169	11	0	1	0	0	1	0	0
Slade Point	1303	1182	65	0	30	6	1	17	1	1
South Mackay	2634	2422	121	0	23	16	3	48	1	0
Te Kowai	46	43	0	0	2	1	0	0	0	0
West Mackay	2458	2184	55	60	53	12	34	52	8	0
Totals	20 672	17 844	873	162	976	209	87	476	26	19

1. Business includes industry
2. Logistic includes storage and transport
3. Safety includes public safety, and doctors and other health services
4. Community includes community, education, government and recreation
5. Utility includes power and water
6. Telecommunications ('Comms').

Table 3.2: Mackay building structural features by suburb

Locality	Source ¹	Walls Brick	Walls Block	Walls Timber	Walls Fibro	Walls Metal	Roof Metal	Roof Tile	Roof Fibro
Andergrove	820:49:1539	1332	121	40	891	12	2366	43	0
Bakers Creek	159:0:113	27	4	41	188	11	267	2	2
Beaconsfield	702:2:633	1000	36	34	265	1	1200	136	0
Blacks Beach	265:0:18	140	71	8	54	7	219	63	0
Bucasia	846:16:36	382	120	155	224	14	812	52	0
Central Mackay	1951:24:492	599	224	431	238	131	1572	64	4
Cremorne	23:0:0	1	1	5	9	6	22	0	1
Dolphin Heads	23:0:56	57	13	0	9	0	72	7	0
East Mackay	877:8:234	450	13	329	268	52	1066	52	1
Eimeo	278:0:346	434	38	81	57	6	603	19	2
Erakala	3:0:11	0	0	10	3	0	14	0	0
Foulden	1:0:1	0	0	2	0	0	2	0	0
Glenella	394:4:105	369	22	23	52	29	448	53	2
Mackay Harbour	99:17:2	1	5	2	3	87	103	0	0
Mount Pleasant	99:17:2	846	70	25	268	5	899	333	1
Nindaroo	0:0:54	53	0	0	1	0	54	0	0
North Mackay	1986:40:150	260	130	504	1143	106	2030	62	79
Ooralea	374:5:195	437	29	9	91	13	447	131	0
Paget	173:6:65	27	33	60	14	106	235	9	0
Racecourse	13:0:43	10	1	33	1	4	55	1	0
Richmond	0:0:33	0	0	31	2	0	33	0	0
Rural View	1:7:369	363	8	0	0	0	377	0	0
Shoal Point	176:0:9	90	28	36	26	4	156	27	2
Slade Point	1258:9:45	277	115	108	656	149	1228	58	26
South Mackay	1987:4:647	1069	19	952	571	22	2530	108	0
Te Kowai	7:0:41	2	0	40	2	1	48	0	0
West Mackay	2036:66:358	766	98	1097	427	66	2232	224	4
Totals²	14790:276:5652	8992	1199	4055	5457	832	19089	1443	172

Notes: 1. Source is a measure of the 'uncertainty' that exists with the building data and represents the following totals:

- building characteristics observed in the field : building characteristics and location identified from aerial photos : buildings characteristics estimated from field reconnaissance
- Totals will not necessarily balance. For example there are 57 buildings with reinforced or pre-cast concrete walls that are not included and 115 buildings for which no assessment of wall material has been made.
- Tallies include all buildings.

Floor height is seen as a strong indicator of building vulnerability, not only for inundation hazards, but also for earthquakes. The detailed data show that some 77.4% of all buildings are built on a slab (notionally 0.3 m above ground level); 8.0% have suspended floors of less than 1.0 m above the ground; and 14.6% have suspended floors that are 1.0 m or more above ground level. The high-set ‘Queenslander’-type houses are typically found in the older suburbs such as East Mackay, North Mackay, Slade Point and West Mackay. In these older suburbs, many high-set homes have had what was originally the under-floor area developed for additional living space and are now regarded as being multi-story on a slab. This type of house is referred to in [Chapter 4](#) as ‘soft story’.

The overall proportions of wall material are given in [Table 3.3](#).

Table 3.3: Wall materials of buildings in Mackay

Material	Houses %	Flats %	Other %
Brick	44.8	64.2	24.5
Concrete block	3.5	8.2	27.3
Timber	21.8	8.9	5.5
Fibro	28.2	18.0	14.4
Metal	1.7	0.7	28.2

Roof material for both houses and flats is overwhelmingly metal (typically the classic corrugated iron) at 92.1%, with tile (7.0%) and fibro (0.9%) making up the remainder.

The general style of housing contained in each suburb strongly reflects the period of development of each suburb. In the older suburbs the most common houses are elevated on stumps and have timber or fibro-clad walls. They also typically have high pitched hip ended roof shapes and small windows ([Plate 3.1](#) and [Plate 3.2](#)). In these older suburbs, however, there has been a significant degree of re-development with many of the original houses replaced by blocks of flats and other higher density developments.

This is in strong contrast to houses in the more recent suburbs which are almost universally on a slab, have walls of brick (or concrete block) and large areas of glass ([Plate 3.3](#) and [Plate 3.4](#)). Roof forms are predominantly gable ended and typically have a much lower pitch than those in the older suburbs. Brick walls are most common in suburbs developed since the 1960’s. The majority are likely to be of brick veneer construction, rather than ‘solid’ or cavity construction. Brick veneer became an accepted construction method in Queensland in the late 1950s and has been the predominant brick form since then.

Another distinct house type, probably constructed by the Housing Commission, is found mainly in the older parts of suburbs such as Andergrove and Beaconsfield. This type is high set, with fibro walls and low pitched metal clad gable roof and small windows ([Plate 3.5](#)). The lower level of these houses, which contains the garage and laundry, appear to have been enclosed by fibro-sheeted walls as standard, though the lower levels in some of these houses have subsequently been upgraded to provide living space. It is this style of house that accounts for the relatively large proportion of fibro-walled houses in Mackay.

The pattern of urban growth in Mackay over the past 80 years is reflected by the growth of the street network and can be seen in [Figure 3.2](#), [Figure 3.3](#), [Figure 3.4](#), [Figure 3.5](#), [Figure 3.6](#) and [Figure 3.7](#). These maps have been compiled from a range of sources including historic maps and aerial photography.

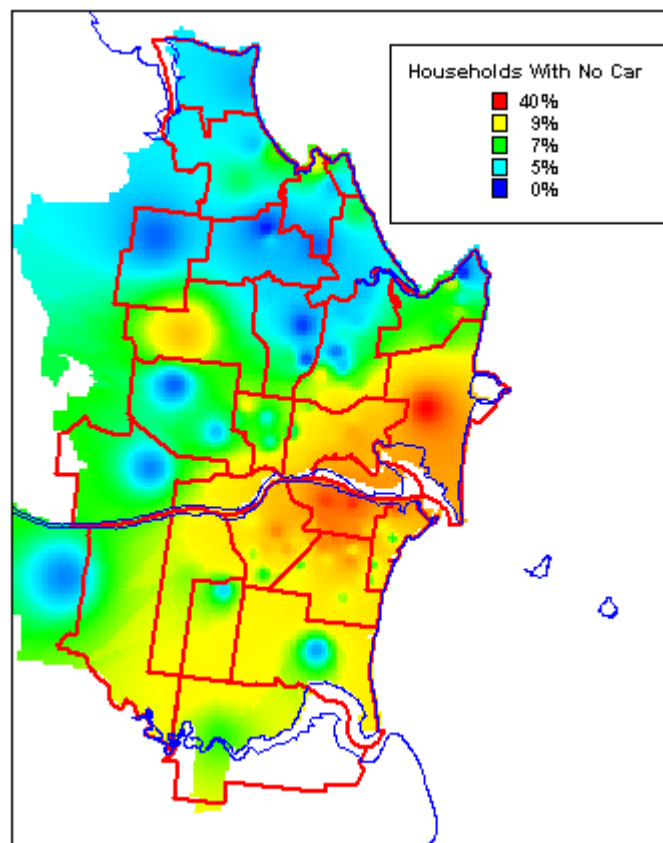
Engineered buildings constructed since 1975 have been subject to the Wind Loading provisions of the Australian Building Code, whilst domestic buildings have been covered since 1983. Earthquake Loading provisions were introduced in 1979 and upgraded (and extended to domestic construction) in 1993. The approximate proportions of buildings included in the Mackay *BUILDING* database, built before and after 1983, are as follows:

Pre 1983 66% Post 1983 34%

Current residential growth in Mackay is predominantly to the north in the Andergrove and Beaconsfield areas and along the northern beaches.

Mobility: The ability of people to get to and from shelter is almost as significant as the shelter itself. Mackay has a well developed urban road network. This network is mostly bitumen sealed and apart from potential flooding of low culverts, it is an all-weather network. In the study area there are 30.2 km of highway (Bruce Highway and Peak Downs Highway); 44.9 km of urban main roads; 30.5 km of suburban access roads, and 511.3 km of suburban roads. Maintenance of the roads in the study area is largely the responsibility of Mackay City Council from its depots in West Mackay and Andergrove. The Department of Main Roads, which is responsible for the Bruce and Peak Downs Highways, has depots at Bakers Creek and West Mackay.

Passenger transport in Mackay is based largely on the family car. Mobility is, consequentially, very heavily dependant on household access to private cars, of which there are an estimated 30 000 in the study area. Households without access to a car are consequently considered to be more vulnerable than those with access. [Figure 3.8](#) shows the distribution of households with no access to a car.



[Figure 3.8](#): Proportion of households with no car (ABS, 1998a)

The highest proportion of car-less households is 36 out of the 91 households (40%) in the CCD that covers the suburb of Mackay Harbour, whilst the lowest proportion is three households out of 311 (1%) in one of the CCDs in Beaconsfield.

This dependence on the private car is quantified in Table 3.4 which shows the proportions of travel mode used to get to work in Mackay on the day of the 1996 census. It clearly shows the dominance of the car, especially the use of the car by a single occupant.

Table 3.4: Mode of travel to work in Mackay (ABS, 1998a)

Mode	Number	Percent
Bus	133	0.5
Taxi	151	0.6
Car driver	15 716	62.2
Car passenger	2203	8.7
Motor bike	391	1.5
Bicycle	747	3.0
Walk	787	3.1
Worked at home	1127	4.5
Did not go to work	2933	11.6
Other modes (eg boat)	632	2.5
Not stated	427	1.7

Because Mackay serves as an entry point for tourists going to resorts in the Whitsunday Islands, the city has available large numbers of coaches, taxis, hire cars and other passenger vehicles. A scheduled bus service provides coverage of most suburbs.

Sustenance

The Mackay community is sustained by a well developed infrastructure of utility lifelines (power, water, sewerage, telecommunications, etc.) and logistic resources for the supply and distribution of food, clothing, fuel and other personal requisites. Each of these is important in their own right. There is, however, a very significant degree of interdependence as illustrated in Table 3.5. In this table the loss of the lifeline in the left-hand column will have an impact on the lifelines across the row to a significant (S) or moderate (M) degree.

	Power	Water	Sewer	Comms	Road	Rail	Bridge	AirFld	Port
Power		S	S	S	M	S		S	S
Water	M		S					M	M
Sewer		S						M	M
Comms	S	S	S		M	S		S	S
Road	M	M	M	M		M	M	M	M
Rail					M		M		M
Bridge	S	S	S	S	S	S			
AirFld									
Port									

Table 3.5: Interdependence of lifeline assets (developed from Granger, 1997, Table 2)

Power supply and telecommunications are overwhelmingly the most important of all lifeline assets in terms of what is dependant on them, followed closely by bridges, roads and water supply. Their significance to community sustainability, however, may be somewhat different - e.g. people can not survive for long without a safe water supply, but they can survive (albeit with some inconvenience) without the telephone, light and even power for some time.

Power supply: As described in Chapter 2, the main source of the Mackay power supply is from the power stations near Rockhampton and Gladstone, lying some 500 km to the south of Mackay. Transmission lines operated by Powerlink bring that supply to the city via three sub stations, at Beaconsfield, Central Mackay and West Mackay.

During the crushing season, the sugar mills in the Mackay area, such as the Racecourse Mill on the western outskirts of the study area, produce surplus power from their bagasse-fuelled steam generators. This surplus power is provided to the State grid. Outside the sugar-crushing season these generators would be available, however, they would need to be fuelled by very expensive oil.

Ergon Energy manages reticulation within the Mackay urban area. The Ergon depot is located in West Mackay. No details of the power reticulation infrastructure within the Mackay study area were available at the time of writing, though observation indicates that it is overwhelmingly above ground.

Water supply: The bulk of the Mackay water supply is drawn from the Dumbleton Weir and treated at the plant on Nebo Road, West Mackay.

Distribution to consumers is by gravity feed from at least ten reservoirs and water towers throughout the study area. Details of the water reticulation network were not available for this study; however, we estimate, given the history of urban growth, that more than half of the water reticulation network is constructed of brittle material (asbestos-cement or cast iron). This type of pipe is likely to be particularly prevalent in the older areas of the city and in the larger trunk mains. The more modern segments of the network probably employ ductile material such as PVC.

Sewer: Most of the Mackay study area is connected to the reticulated sewerage network. The main sewerage treatment plant is located on the southern slopes of Mount Bassett. There are at least three sewerage pumping stations throughout the study area to cope with the low-lying terrain. Sewage is aerated at each of these pumping stations using liquid oxygen. Again, details of the reticulation network were not available, however, like the water supply network, much of it would be of brittle material such as earthenware or cast iron.

Mackay City Council, from their depots in Andergrove and West Mackay, maintain both the water supply and sewerage systems.

Telecommunications: Much of the telecommunications network infrastructure operated by Telstra in the Mackay study area (both copper wire and optical fibre) is underground, though network details were not available for this study. A major microwave relay station/terminal operated by Telstra, is located on Mount Pleasant. Details of the infrastructure operated by Optus were also unavailable.

The key to telecommunications, regardless of whether it is by conventional telephone, mobile phone, fax or Internet and regardless of the service provider is the network of telephone exchanges. The main Telstra exchange is located on River Street in Central Mackay, with a second exchange on the Bruce Highway at Paget. The Telstra service depot is located in Prospect Street, East Mackay.

Both ABC and commercial broadcast radio and TV services covering the region are provided from studios in the city.

Dedicated telecommunications networks serving both public (e.g. police, emergency services, Council, etc) and private users (e.g. taxis, couriers, fishing fleet, etc) cover the study area, many of them using the Mount Pleasant site for their transmitters.

Logistic support: The supply and distribution of goods such as food, fuel and clothing are essential to the sustenance of the community. Of particular significance are those facilities that provide bulk or large scale storage and distribution services.

Food supply and distribution is obviously of great significance. Apart from small quantities of fruit and vegetables, meat and seafood, very little of the food consumed in Mackay is grown or processed locally. There is, consequently, a significant reliance on imported foodstuffs or raw materials such as flour. The bulk food storage, such as cold stores and grocery warehousing, and food processing facilities are concentrated in the suburbs of Central Mackay, Mackay Harbour, North Mackay and Paget. Regional shopping centres (Canelands Plaza in Central Mackay and Mount Pleasant Shopping Centre in Mount Pleasant), suburban shopping centres with smaller supermarkets or convenience stores, as well as smaller bakeries, butchers, green grocers, and so on, as well as local ‘corner stores’, service most suburbs. The levels of stock of basic foodstuffs held are not known.

Bulk fuel and gas storage facilities are also concentrated in Mackay Harbour (Plate 3.6), with secondary (essentially operational) storage of specialist products at facilities such as the airport (avgas and jet fuel) and some of the larger industrial and transport depot facilities (mostly diesel). Retail distribution of motor fuel is effected through more than 35 service stations, mostly located along the main access roads such as Nebo Road/Bruce Highway. There is no reticulation of gas in Mackay, so supply is provided in bottles or to bulk ‘bullet’ tanks. Distribution is, consequently, largely by dedicated tanker trucks. The capacity of bulk storage for most products is believed to be sufficient for approximately three weeks of normal usage. Tankers typically provide resupply by sea from Brisbane and/or Sydney.

Most other bulk storage and distribution centres for products as diverse as cement, agricultural chemicals, pharmaceuticals, raw sugar, molasses, ethanol, timber and hardware, as well as transport and handling equipment (fork lifts and cranes), are also concentrated either close to the port in Mackay Harbour, or the rail-freight facilities in Paget. Significant amounts of freight, including foodstuffs and goods such as pharmaceuticals, are also handled through the Mackay Airport in South Mackay.

Limitations: Due to the lack of adequately detailed data, it has not been possible to model lifeline vulnerability in this study. Further work is required to improve the detail on lifeline infrastructures and logistic resources to develop a better understanding of their vulnerability and their significance to the overall vulnerability of the community.

Security

In the context of our risk assessment methodology, ‘security’ relates to aspects of community health, wealth and the services and structures that provide for public safety. In addition to identifying the physical elements at risk that relate to these aspects, we have identified a range of factors (health, wealth, socio-economic disadvantage and protection) that will provide relative measures of community vulnerability and their distribution across Mackay.

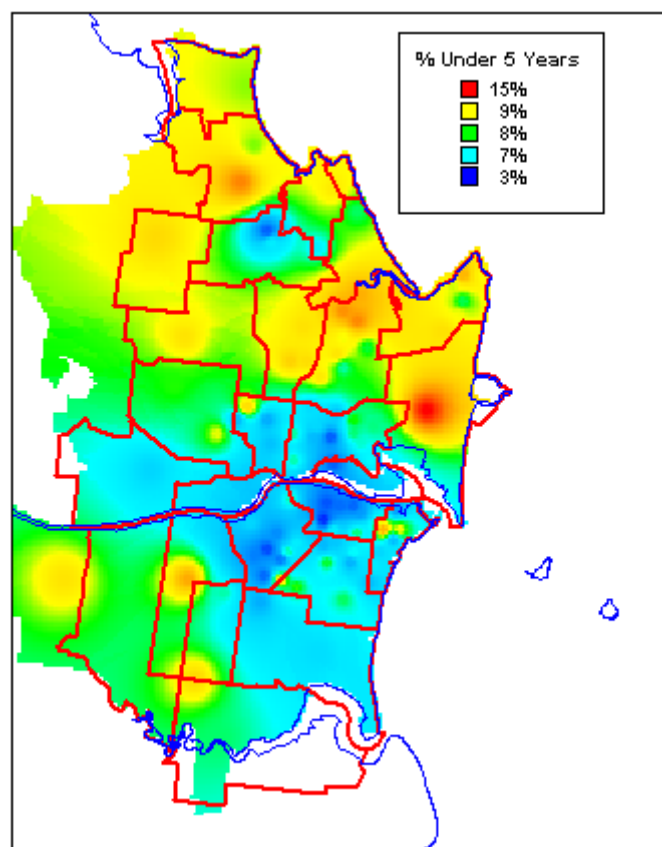
Health: The key health facilities in Mackay are the Mackay Base Hospital in West Mackay, the Mater Hospital in Central Mackay and the Pioneer Valley Hospital in Mount Pleasant. There are also four nursing homes. These include the Northern Heights Nursing Centre in Glenella, the Palliative Care Unit at the Mater Hospital in Central Mackay, Resthaven in North Mackay and the St Vincent de Paul Home in West Mackay. There are plans to relocate the Mater Hospital from its congested site in Central Mackay to a green-field site near the western end of the Ron Cam Bridge in North Mackay.

A wide range of private specialist medical practices, including pathology, surgery, and medical imaging are located within a few blocks of the Mater Hospital. Medical centres and individual general medical practices are spread throughout the city. Services such as physiotherapy, dental, podiatry, chiropractic, optometry and chemists are available throughout the study area. Community health services, such as Blue Nurses, which also operates a day respite care centre near the airport, are also available.

The age make-up of the population is a reasonable indicator of the health vulnerability of the community, with the very young (under five years) and elderly (over 65) considered to be the most vulnerable groups. The relative distribution of these age groups is shown in [Figure 3.9](#) and [Figure 3.10](#) respectively (see also [Figure 2.7](#)). These maps show the distribution at the CCD level.

The distribution of under five-year olds is clearly dominant in the newer suburbs such as Andergrove in the north, and Racecourse and Ooralea in the south. The CCD, which covers the suburb of Mackay Harbour, has the highest proportion of people less than five years (15.6%). The long-stay caravan park that is contained within the CCD probably accounts for this.

By contrast, the distribution of the elderly is concentrated in the central areas of East Mackay, Central Mackay, North Mackay and West Mackay, where the retirement villages and nursing homes are concentrated. The greatest proportion of elderly is 30% in the West Mackay CCD that contains the St Vincents Home.



[Figure 3.9](#): Mackay population aged under five years (ABS, 1998a)

We have no specific information on the numbers or distribution of the particularly vulnerable population with specific physical or mental disabilities, or of their carers.

Wealth: Whilst the economy of the Mackay district is undoubtedly dominated by sugar production, within the study area the service industries including retailing, manufacturing, health services and construction make the most significant contribution. The details are provided for the study area in [Table 3.6](#). This is a clear reflection of the service centre nature of the Mackay study area.

The spatial distribution of 'wealth' within the city can be gauged from indicators such as unemployment and rental accommodation. Such indicators are relevant to risk calculations because the less wealthy will have greater difficulty recovering from a disaster impact and are more likely to have no, or inadequate, insurance protection.

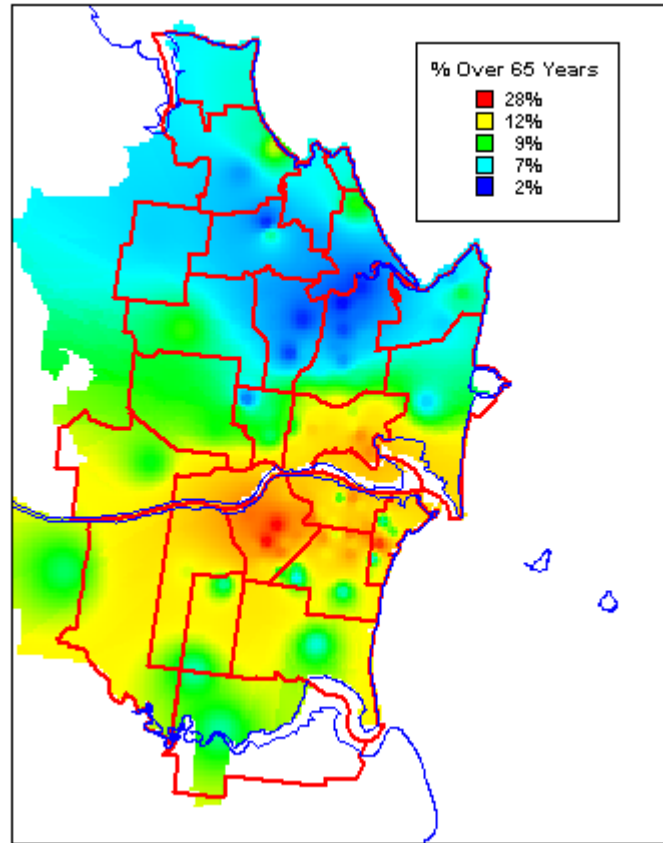


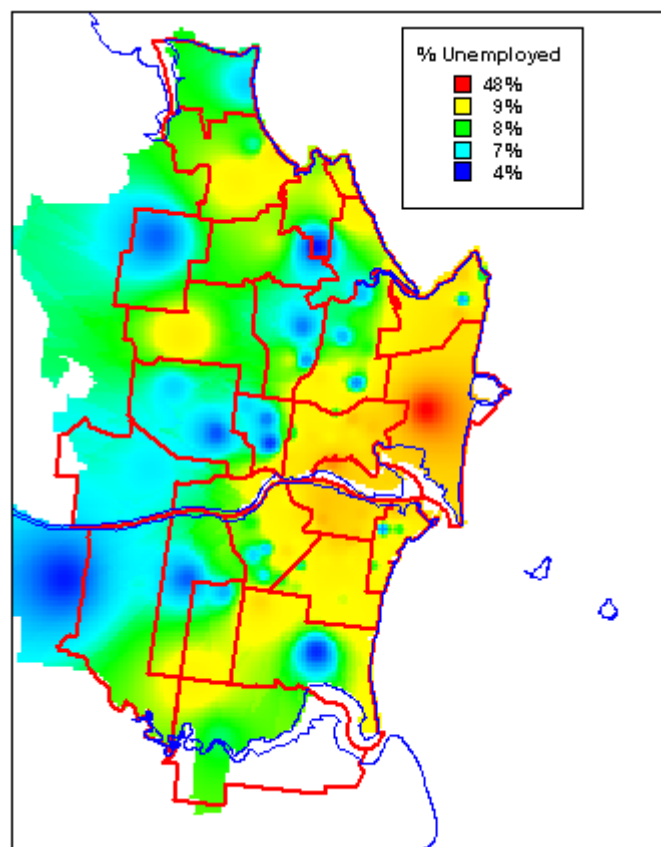
Figure 3.10: Mackay population aged over 65 years (ABS, 1998a)

Table 3.6: Mackay employment by industry (ABS, 1998a)

Industry group	Persons employed	Industry percent
Agriculture, forestry and fishing	724	2.9
Mining	457	1.8
Manufacturing	2819	11.1
Electricity, gas and water supply	299	1.2
Construction	2159	8.5
Wholesale trade	1945	7.7
Retail trade	4093	16.2
Accommodation, cafes and restaurants	1309	5.2
Transport and storage	1725	6.8
Communication services	360	1.4
Finance and insurance	758	3.0
Property and business services	2002	7.9
Government administration and defence	670	2.6
Education	1704	6.7
Health and community services	2219	8.8
Cultural and recreational services	483	1.9
Personal and other services	795	3.1
Non-classifiable economic units	355	1.4
Not stated	408	1.6
Total persons employed	25 284	

Unemployment rates of over 15%, recorded at the 1996 census, are concentrated in Central Mackay, East Mackay and Mackay Harbour, the latter having an extremely high unemployment rate of 49.3%. These are shown in [Figure 3.11](#). The spatial distribution of unemployment rates correlates very closely with the proportion of households that are in rented accommodation, as shown in [Figure 3.12](#). The highest proportion of households in rental accommodation (63.7% of all households) is in the north of East Mackay where there is a significant concentration of flats and units.

An *Index of Socio-Economic Disadvantage* has been compiled by the ABS by undertaking a principal components analysis on 20 weighted variables from the 1996 census. The attributes, such as low income, low educational attainment, high unemployment and jobs in relatively unskilled occupations, were selected to highlight disadvantage (see [Table C1](#) for a list of variables used). The resulting index has been standardised to have a mean of 1000 and a standard deviation of 100 across all CCDs in Australia (ABS, 1998b). For the Mackay study area, the mean CCD index value is 967.6, and ranges from a high (advantaged) value of 1079 in the essentially rural CCD that extends to the northwest of Andergrove, to a low (disadvantaged) value of 702 in Mackay Harbour. The spatial distribution is shown in [Figure 3.13](#).



[Figure 3.11](#): Mackay unemployment rate (ABS, 1998a)

A similar *Index of Economic Resources* is also available. This index is based on a profile of the economic resources of families. It is compiled from 22 weighted variables that reflect the income and expenditure of families, including measures of income, rent and home ownership (see [Table C2](#) for a list of variables used). This index is also standardised with a national mean of 1000 and a standard deviation of 100. The Mackay study areas mean index value is 976.8. The lowest value is 787.0, more than two standard deviations below the national mean, in Mackay Harbour, whilst the highest value of 1112.5 is the rural area between Bakers Creek and Ooralea. The spatial distribution is shown in [Figure 3.14](#).

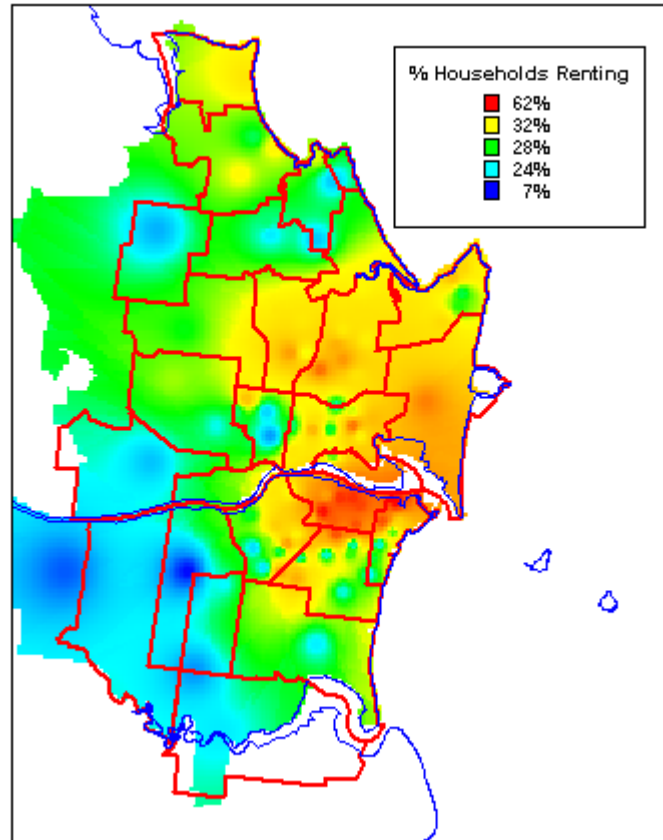


Figure 3.12: Mackay percentage of households renting (ABS, 1998a)

Protection: The full range of public safety services is provided in Mackay. The city is headquarters for the Queensland Police Service (QPS) Mackay Police District. QPS establishments are located at 59 Sydney Street in Central Mackay. The Mackay Police Station, the only police station within the study area, is co-located with the District Headquarters (HQ) with its entrance on Brisbane Street.

The Mackay District Disaster Coordination Centre, when activated, is located in the QPS District HQ building. District-level disaster control is vested in the District Police Superintendent in his (non-police) role as District Disaster Coordinator (DDC). The DDC is responsible for maintaining the district disaster plan.

There are two ambulance stations in the study area located at:

- | | |
|----------------|--|
| Mackay | corner of Sydney and Alfred Streets, Central Mackay |
| Mount Pleasant | corner of Phillip and Lauchlan Streets, Mount Pleasant |

There are three fire stations in the study area located at:

- | | |
|------------------|---|
| Mackay | corner of Sydney and Alfred Streets, Central Mackay |
| North Mackay | Harbour Road, North Mackay |
| Northern Beaches | McHugh Street, Bucasia |

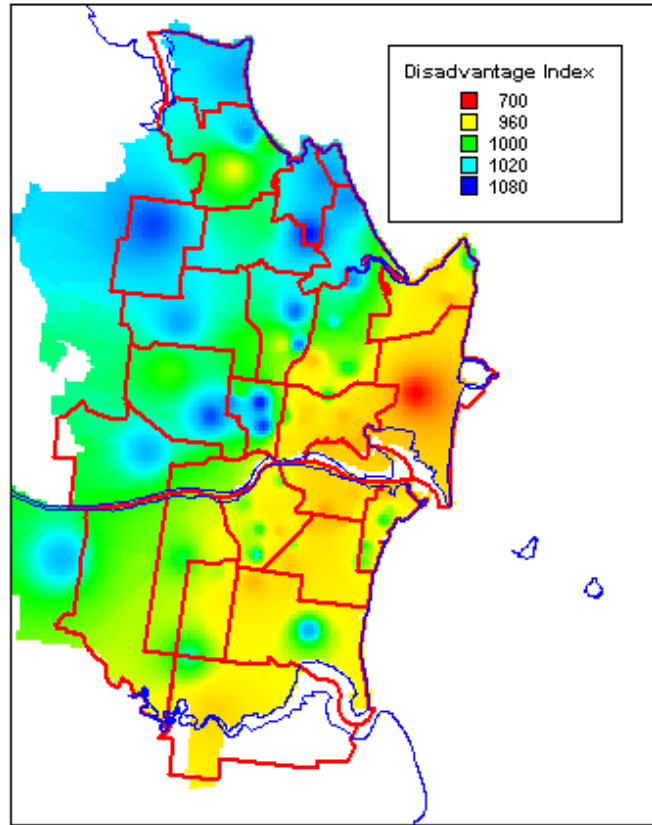


Figure 3.13: Mackay - areas of relative socio-economic disadvantage (ABS, 1998b)

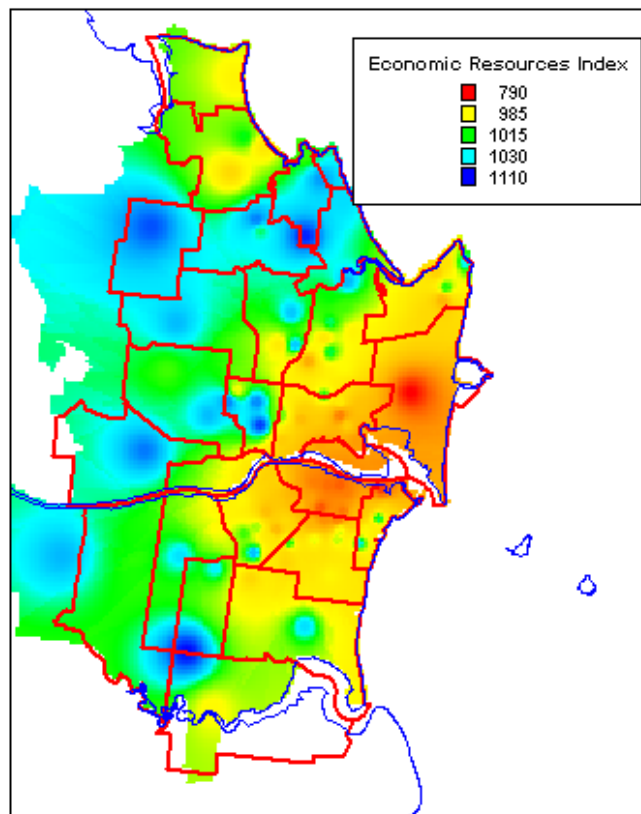


Figure 3.14: Mackay - areas of relative abundance of economic resources (ABS, 1998b)

The specialised Airport Rescue and Fire Service protects the airport. It is located on the airfield, off Milton Street, South Mackay.

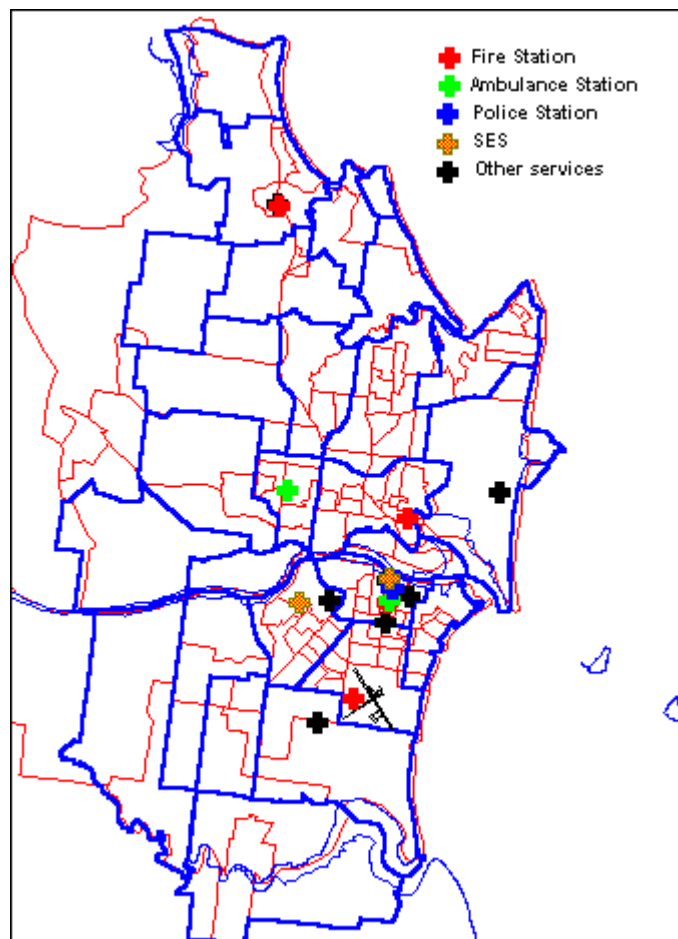
Training and administration of State Emergency Service (SES) units in the Mackay District is coordinated by the DES Disaster and Rescue Services Division's District Manager, whose office is located in River Street, Central Mackay. Local SES units are the responsibility of the Mackay City Council, as is the coordination of the Local Disaster Committee (LDC). The LDC, chaired by the Mayor and supported by a full time executive officer, is responsible for the local disaster plan. Mackay City SES headquarters is located at 23 Cemetery Road, West Mackay.

The Queensland Mine Rescue Service has a base at 177 Boundary Road East in Paget, near the airport.

There are no permanent Australian Defence Force units in Mackay, though a Defence Force Reserve establishment is located at the Drill Hall at 400 Shakespeare Street, West Mackay.

The Bureau of Meteorology's weather station on Mount Bassett is a key link in the Bureau's severe weather and flood warning system and can be considered to be a key public safety facility.

The locations of the major public safety service facilities are shown on [Figure 3.15](#).



[Figure 3.15](#): Mackay public safety services

A system of levees, training walls and bank protection works has been constructed to provide a degree of protection from flooding of the Pioneer River. These are described in [Chapter 5](#).

The Australian Building Code, with its guidance for both earthquake and wind loads, is administered by Mackay City Council.

Society

The capacity of individuals, families, households and neighbourhoods to withstand the impact of disaster has much to do with the cohesiveness and resilience of those communities. Social cohesion is a very complex thing and difficult to measure, especially in a population as mobile as that found in Mackay. The development of indices of social vulnerability has still a long way to go, however, the measures discussed below, including family structure, language and ethnicity, religion, length of residence, education and community services, appear to be amongst the most relevant.

Family structure: The literature on community vulnerability has identified the structure of families as having a significant bearing on susceptibility or resilience to disaster impact. Single parent families, especially ‘women-led’ families with younger children, and large families, for example, have been shown to be particularly susceptible. Morrow (1999), for example, identifies those types of family as having been amongst the most adversely affected by the 1992 impact of Hurricane *Andrew* in Florida.

[Table 3.7](#) summarises the number of households in the Mackay study area according to their size and structure. There are 7412 households made up of a couple plus their children, of which almost 30% contain five or more people (i.e. notionally three or more children). There are 2217 households made up of a single parent and their children, of which 20% contain four or more people (likewise three or more children). Group or lone-person households are not included in the table.

[Table 3.7:](#) Number of households by type and size (ABS, 1998a).

	Number of people usually resident					Total
	2	3	4	5	6+	
Couple with children		2247	2984	1540	641	7412
One parent family	1035	744	289	92	57	2217
Totals	1035	2991	3273	1632	698	9629

The spatial distribution of large families and single parent families is shown in [Figure 3.16](#) and [Figure 3.17](#). As a broad generalisation, the larger families tend to be located in the rural fringe and areas of recent urban growth, whilst the single parent families tend to be concentrated in the inner and older urban areas.

Language and ethnicity: One of the strongest social links in a community is derived from language and ethnicity. For the resident population, English is overwhelmingly the most common language spoken, with 93.6% of the study area population over five speaking English at home. The next largest groups are Italian, Maltese, German and ‘other’ (each of which comprise less than 1.0% of the total). The ‘other’ group appears to include mainly Asian languages such as Japanese and possibly Korean.

The only significant concentration of any particular ethnic group is the proportion of Aboriginal and Torres Strait Islander people in the Mackay Harbour-Slade Point area, where between 10 and 25% of the population in each CCD is of indigenous origin.

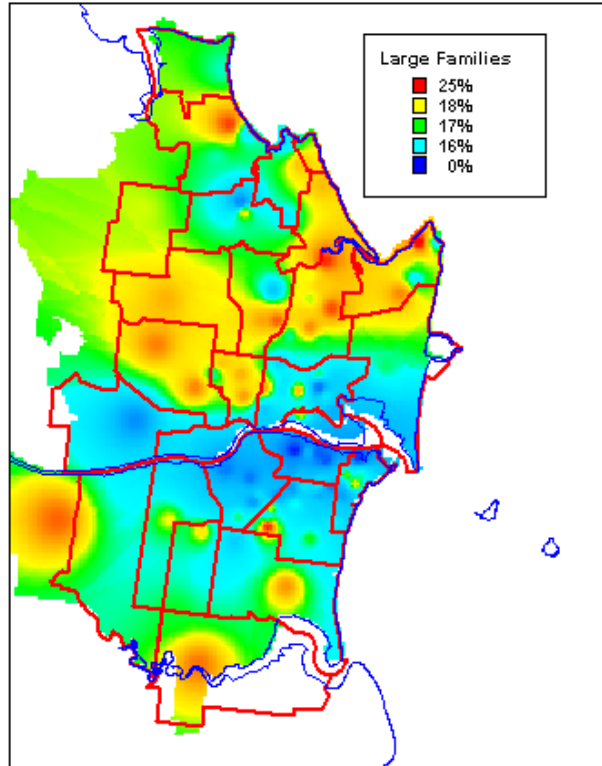


Figure 3.16: Percent of all family households with three or more children at home (ABS, 1998a)

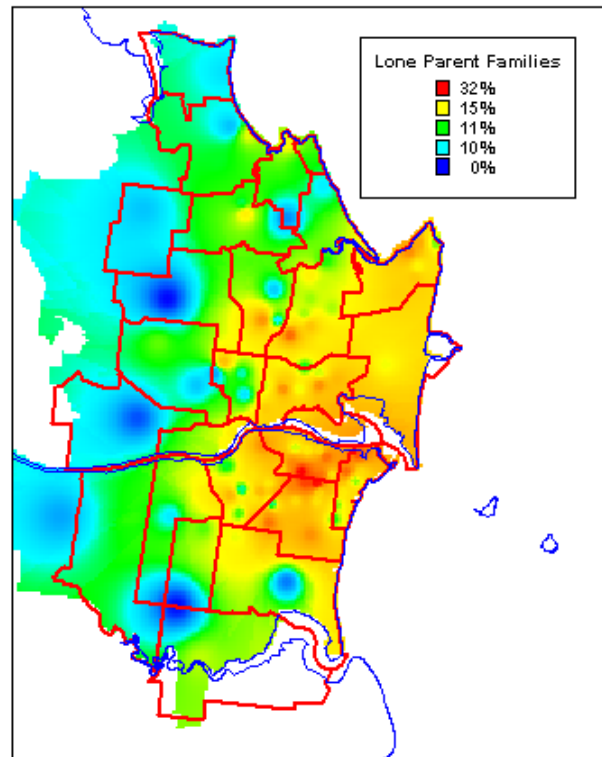


Figure 3.17: Percent of all family households with only one parent present (ABS, 1998a)

Religion: One of the more significant linkages that tend to span social cleavages such as ethnicity, is religion. In Mackay, the majority (77.4%) of people who provided answers to the questions on religion in the 1996 census were Christian. Of the remainder, 0.5% was divided between Buddhism,

Islam, Hindu and Judaism (in that order), whilst 13.5% said they had no religion. Of the Christian faiths, Catholic (38.8% of all Christians), Anglican (27.5%), Uniting (16.4%) and Presbyterian (5.6%) have the largest congregations. Distribution across the city is quite even, though localised concentrations are obviously found where there are institutions such as convents, boarding schools and church-run nursing homes.

Length of residence: Awareness of the local hazard history, environment and how to cope with disaster, as well as the level of integration into the local community, can be measured by the length of time people have lived in the area. The population of the Mackay study area is clearly a mobile one, with only 40% of the population at the 1996 census living at the same address that they were living at five years previously. This change is overwhelmingly based on in-migration. Figure 3.18 shows the proportion of the total population that was living at a different address at the 1991 census and reflects the recent growth of Mackay to the north of the Pioneer River.

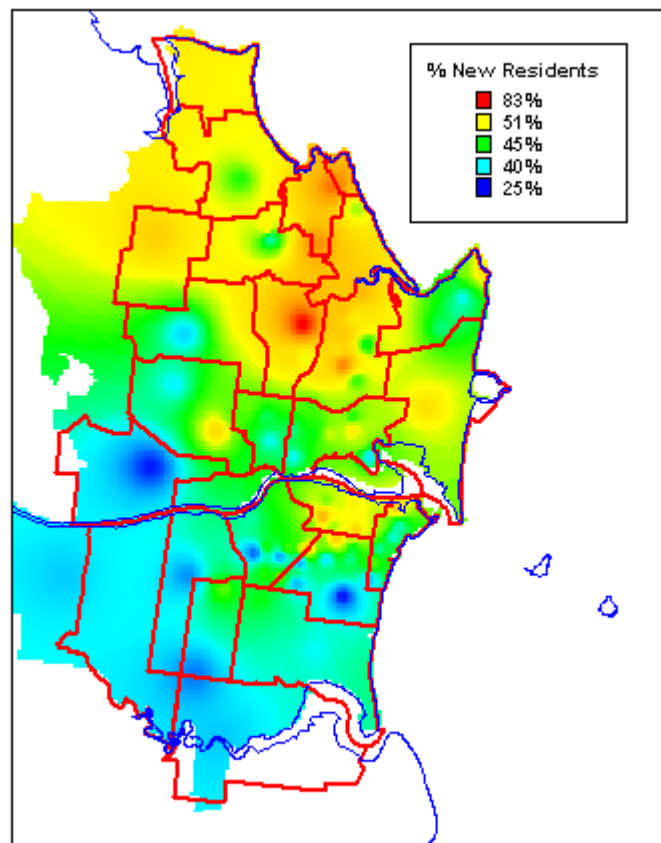


Figure 3.18: Proportion of population at census address for less than five years (ABS, 1998a)

Education: The disaster management literature suggests that the capacity of the community to understand and respond to information on risk or hazard potential is, to some degree, dependant on education and literacy. Much of the research reported in this literature, however, relates to developing countries where levels of literacy and access to information are typically poor. In a developed country such as Australia, basic levels of education and literacy are comparatively high across the community. In Mackay, for example, some 38% of people over 15 have gained some form of post-secondary qualification. In this community, therefore, education levels are unlikely to make a particularly significant contribution to community vulnerability.

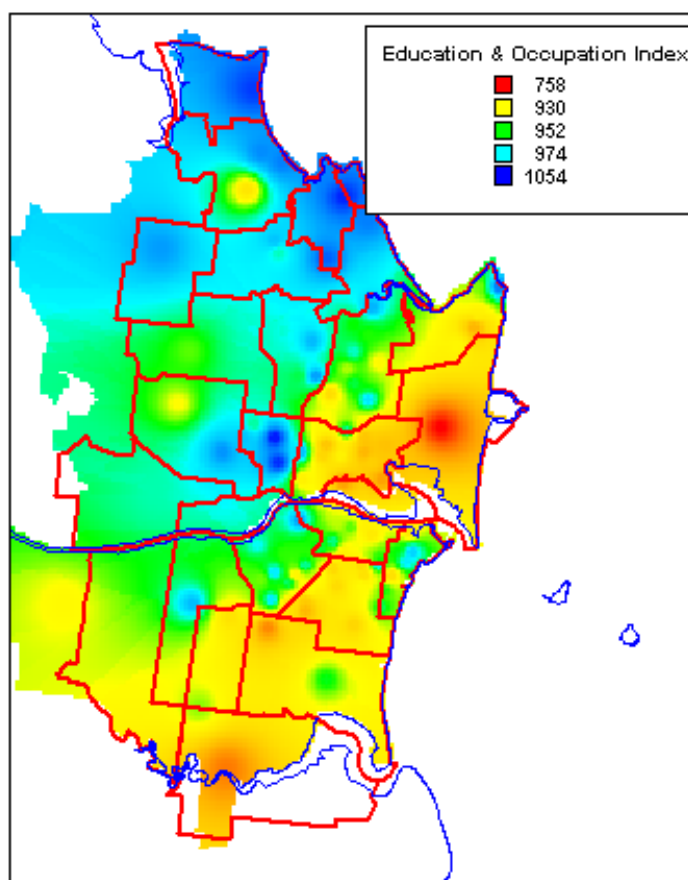
Educational facilities are typically identified in disaster plans as shelters or evacuation centres following disaster because they have ample space and facilities such as toilets and canteens. Table C3 lists the locations of the 29 primary and secondary schools in Mackay. Schools are also centres in

which there are concentrations of more vulnerable people for significant parts of the day. The table also includes statistics for the numbers of enrolments and teaching staff at government (State) schools where available.

A campus of the Central Queensland University (CQU) is located in Ooralea, whilst the Central Queensland Conservatorium of Music, which is also part of CQU, is located in West Mackay. These centres, together with the Mackay TAFE located in Central Mackay, provide tertiary-level education and training. Other post-secondary training institutions include Skillshare (in River Street, Central Mackay), the Indigenous Education Unit (in Wood Street, Central Mackay) and CQMS Training in Glenella.

At the other end of the educational process are at least 17 child care centres and kindergartens that serve areas of employment and the suburbs, such as Bucasia, in which young families predominate. These centres are listed in [Table C4](#). Given the very young age and vulnerability of children at these centres, they deserve particular attention.

The SEIFA *Index of Education and Occupation* also provides an overview of the distribution of population with an educational 'advantage'. As with the two SEIFA indexes already discussed, this index is also standardised with a national mean of 1000 and a standard deviation of 100. The Mackay study area mean value is 943.98 and ranges from a high (high educational levels and high occupation status) of 1054.09 in Mount Pleasant to a low (low education levels and job status) of 754.37 (more than two standard deviations below the national average) in Mackay Harbour. The spatial distribution is shown in [Figure 3.19](#). [Table C5](#) lists the variables used to build this index.



[Figure 3.19](#): Mackay index of education and occupation (ABS, 1998b)

Community services: Community based groups provide a significant level of social resilience and effective networks for the dissemination of information. Mackay is extremely well served by these groups, which include those based on schools (e.g. Parents and Citizens Associations), churches (e.g. youth groups, fellowships, etc), sporting activities and community service clubs (e.g. Apex, Rotary, Boy Scouts, etc). It is likely that there is a significant degree of cross membership between these various groups, a situation that has been observed in other communities and which greatly enhances community resilience and cohesion.

A detailed community service guide for Mackay was published in 1999 (Mackay City Council, 1999). A summary of the types of community services available in the study area is contained in [Table C6](#). This provides an impression of the broad extent of interests covered.

Critical, High Risk and Hazardous Facilities

The distribution of facilities that are critical to the safety and sustenance of the community provides a strong indicator of community vulnerability, particularly in the aftermath of a disaster impact. A total of 51 such facilities have been selected as representing those facilities which are the most critical to the overall vulnerability of the Mackay community. These are listed in [Table C7](#).

Some of these facilities could, under certain circumstances, exacerbate the impact of a hazard event by adding to the danger. The loss of containment of hazardous materials such as chemicals or flammable substances as the result of a hazard impact would magnify the danger because of toxic contamination, fire or explosion. The facilities that are considered to contain secondary hazards are annotated in [Table C7](#). The hazards contained at some of these facilities are not always obvious. For example, large commercial cold storage facilities would not usually be considered to be dangerous, however, they typically use large quantities of ammonia as their refrigerant (as much as three tonnes in some facilities). Apart from its noxious properties as a gas, ammonia is highly flammable.

A wide range of essentially incompatible chemicals may be stored on the same premises. Supermarkets, garden supply nurseries, pool supply shops, hardware stores, school chemistry laboratories, pharmacies and so on, store a wide range of chemicals (generally in small quantities) that can become dangerous if not properly contained and stored. Some chemicals, such as the various forms of cyanide, can be extremely dangerous, even in very small quantities. Some of these are used in a wide range of processes and can be found in the most obscure businesses such as fibreglass manufacture, electro-plating, jewellery manufacture and the manufacture of dental prostheses. Most facilities that store quantities of hazardous substances over certain thresholds, however, must display safety placards that identify the chemicals and the nature of the hazard they represent.

Facilities in which people concentrate at various times can also be considered to be high risk facilities (in terms of people exposed), especially for hazards such as earthquakes which can strike without warning at any time of day. Such facilities are too numerous to list individually, but would include the following groups of facility:

- schools, preschools and other educational facilities;
- entertainment, recreational and sporting facilities;
- transport terminals;
- tourist accommodation such as hotels, resorts and hostels;
- shopping, commercial and professional centres; and,
- hospitals and nursing homes.

The significance of a facility may extend beyond the community in which it is located if a wider community of interest depends on it for services or supply. The bulk fuel and gas depots that are

concentrated in Mackay Harbour, for example, supply consumers throughout a region that extends well beyond the study area. Clearly, the loss or isolation of those facilities would have a proportionately greater impact overall than would the loss of a neighbourhood service station, for example. Likewise, the TAFE and CQU campuses attract students from a much wider catchment than does the suburban primary school. The bulk sugar and grain terminals in Mackay Harbour are significant at a national level given their importance in the export of those commodities, and consequently to the national, as well as local and State economies.

In this study we have not attempted to track the consequences beyond the study area of the loss or isolation of facilities, or to weight the significance of individual facilities.

A Composite Community Vulnerability Profile

In this chapter we have described a broad range of the elements at risk within the Mackay community and identified some of the key aspects that contribute to their vulnerability. These have been drawn from the large amount of high resolution data accumulated on the hazard phenomena, people, buildings and infrastructure of Mackay since 1993. Whilst these data provide a detailed quantitative description of specific aspects of the city's risk environment, they do not, of themselves, provide an adequate measure of overall community vulnerability. Nor do they individually reflect the relative levels of vulnerability across the city.

We consider that it is highly desirable to be able to identify those parts of the study area that would provide a potentially disproportionate contribution to community risk because of the number and nature of the elements at risk they contained. Given that most people tend to identify themselves with the suburb in which they live and/or work, we have aggregated these data, from the CCD level at which they have been compiled, to the suburb level.

There is little in the risk or disaster management literature to provide a guide for this task so we created our own methodology for the Cairns study (Granger and others, 1999) based on the 'five esses' and a composite, or combined community vulnerability assessment. We have modified that methodology slightly for Mackay, in part because of the difficulties we have experienced in linking the census data to suburb boundaries and partly because of our ongoing efforts to enhance our methods. [Appendix D](#) provides a detailed explanation of the methodology and the logic behind the selection of the variables included in this study.

It is emphasised that the values in the 'overall' column in [Table 3.8](#) do **not** equate to a risk rating. They simply provide an indication of the **relative contribution** made to overall community risk by each suburb. A number of one indicates that a suburb contributes relatively the most individually to overall community vulnerability and a number of 27 the least. This assumes that an even and equal exposure to the impact of all hazards exists. This is clearly not the case, as will be explored in the following chapters.

The relative suburb contributions to setting ([Figure 3.20](#) and [Table 3.9](#)), shelter ([Figure 3.21](#) and [Table 3.10](#)), sustenance ([Figure 3.22](#) and [Table 3.11](#)), security ([Figure 3.23](#) and [Table 3.12](#)), social ([Figure 3.24](#) and [Table 3.13](#)) and overall community ([Figure 3.25](#) and [Table 3.14](#)) vulnerability are also shown below.

In the following chapters, we bring together an analysis of the earthquake ([Chapter 4](#)), flood ([Chapter 5](#)) and cyclone ([Chapter 6](#)) hazards, and their threat to the Mackay community. In [Chapter 7](#) we draw these together into an assessment of the total multi-hazard risk faced by the Mackay community and link that assessment to a consideration of some risk mitigation strategies.

Table 3.8: Ranking of each suburb’s contribution to overall community vulnerability

Suburb	Setting	Shelter	Sustain	Security	Society	Overall
Andergrove	4	1	5	14	5	3
Bakers Creek	20	19	13	12	16	16
Beaconsfield	5	6	11	16	14	10
Blacks Beach	18	12	24	19	7	19
Bucasia	12	7	10	9	10	8
Central Mackay	6	10	1	1	2	2
Cremorne	24	22	27	6	3	18
Dolphin Heads	13	16	25	26	8	20
East Mackay	7	4	16	4	9	7
Eimeo	7	11	18	23	13	15
Erakala	26	26	21	20	27	26
Foulden	27	27	26	27	26	27
Glenella	15	13	12	15	12	14
Mackay Harbour	19	21	9	2	1	9
Mount Pleasant	3	2	7	18	21	11
Nindaroo	22	18	22	25	24	23
North Mackay	11	5	3	5	6	4
Ooralea	9	14	15	11	15	12
Paget	16	20	8	7	18	13
Racecourse	25	25	19	17	25	25
Richmond	23	23	20	21	22	22
Rural View	14	17	17	22	20	21
Shoal Point	16	15	23	13	19	17
Slade Point	9	8	6	8	4	6
South Mackay	1	3	4	3	11	1
Te Kowai	21	24	14	24	23	24
West Mackay	2	9	2	10	17	5

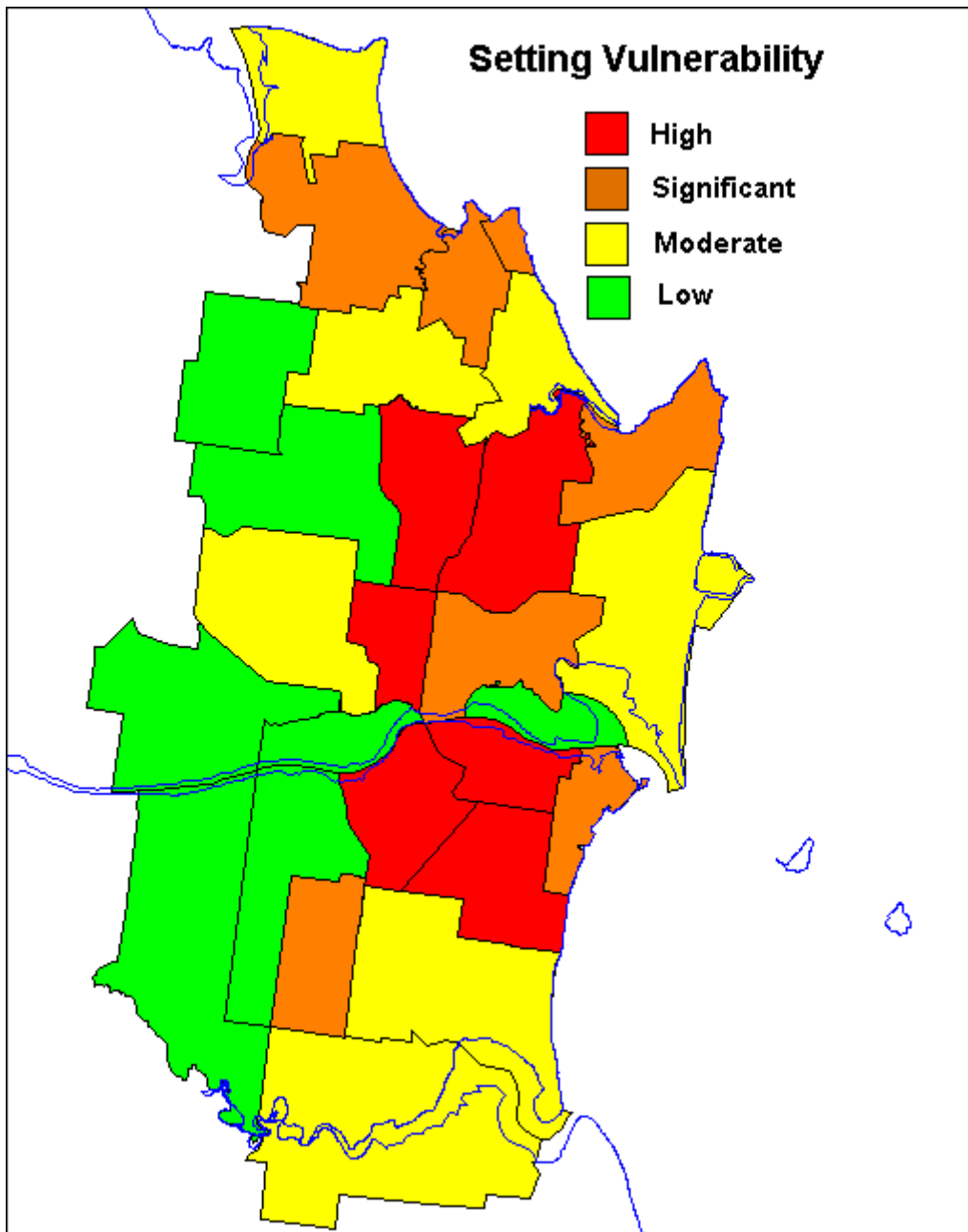


Figure 3.20: Relative suburb contribution to setting group vulnerability

Table 3.9: Relative suburb contribution to setting group vulnerability

Rank group	Suburbs (in rank order)
High	South Mackay, West Mackay, Mount Pleasant, Andergrove, Beaconsfield, Central Mackay,
Significant	East Mackay, Eimeo, Slade Point, Oralea, North Mackay, Bucasia, Dolphin Heads
Moderate	Rural View, Glenella, Shoal Point, Paget, Blacks Beach, Mackay Harbour, Bakers Creek,
Low	Te Kowai, Nindaroo, Richmond, Cremorne, Racecourse, Erakala, Foulden

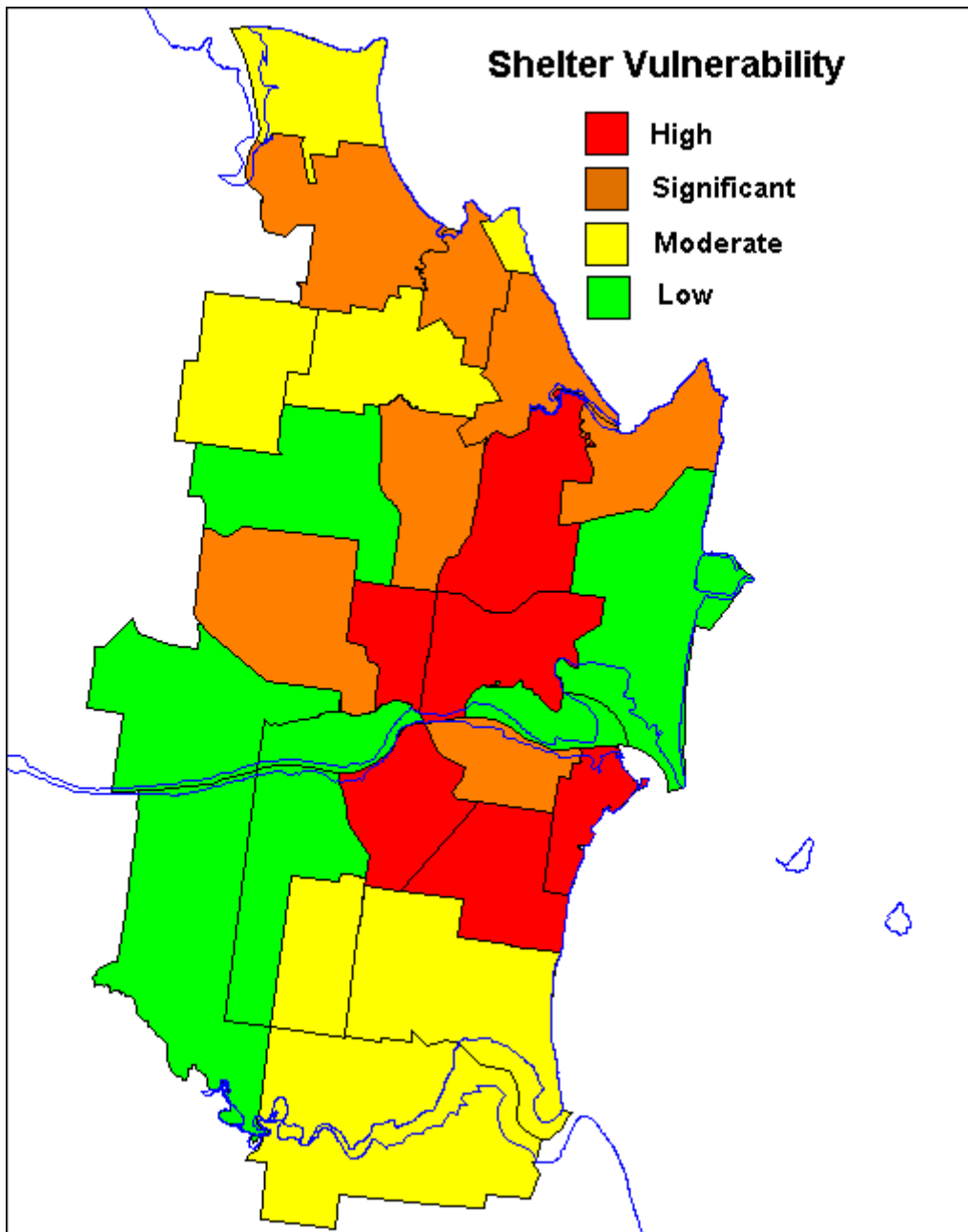


Figure 3.21: Relative suburb contribution to shelter group vulnerability

Table 3.10: Relative suburb contribution to shelter group vulnerability

Rank group	Suburbs (in rank order)
High	Andergrove, South Mackay, Mount Pleasant, East Mackay, North Mackay, West Mackay.
Significant	Beaconsfield, Bucasia, Central Mackay, Slade Point, Eimeo, Glenella, Blacks Beach.
Moderate	Ooralea, Shoal Point, Rural View, Bakers Creek, Nindaroo, Dolphin Heads, Paget.
Low	Mackay Harbour, Richmond, Te Kowai, Cremorne, Racecourse, Erakala, Foulden.

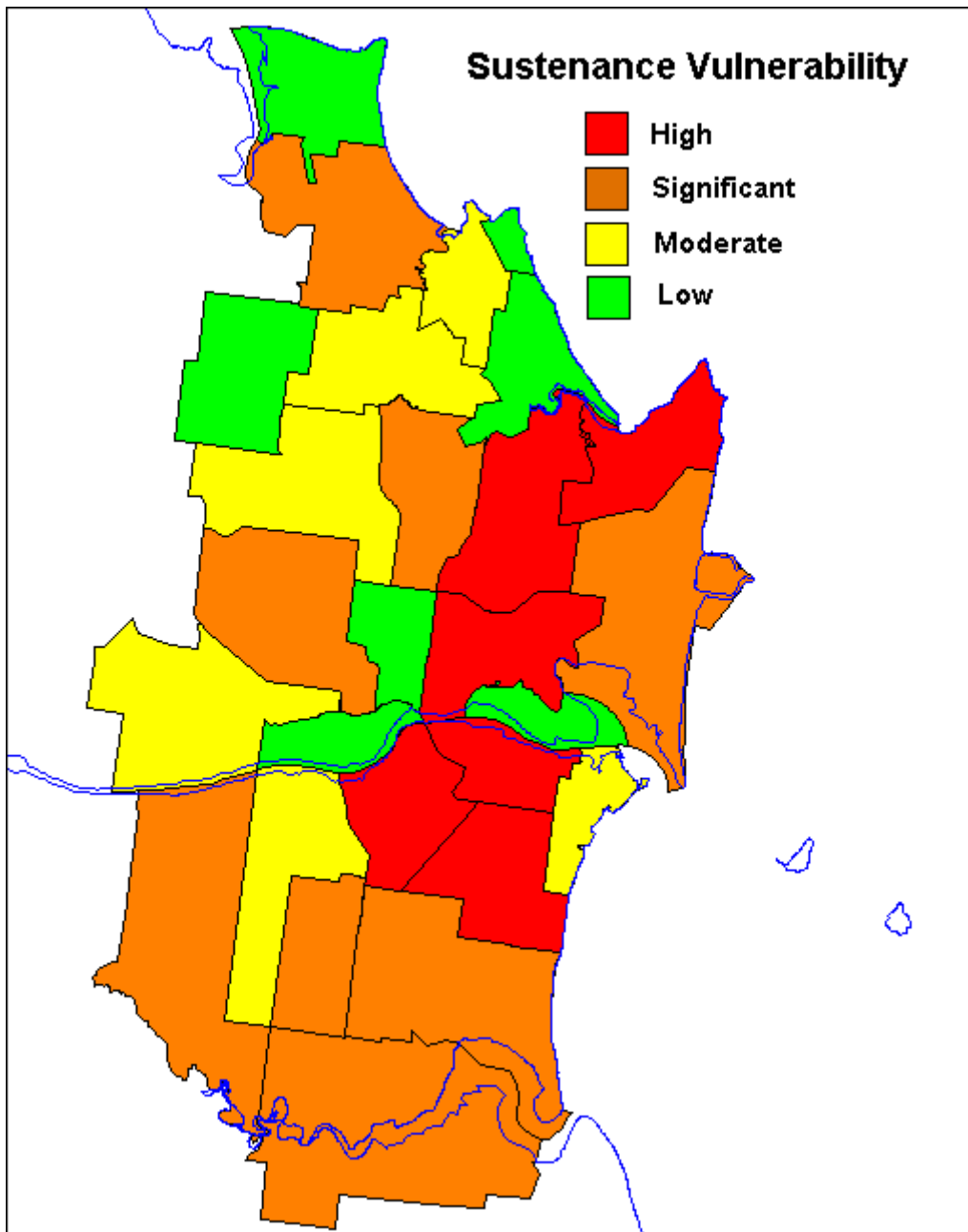


Figure 3.22: Relative suburb contribution to sustenance group vulnerability

Table 3.11: Relative suburb contribution to sustenance group vulnerability

Rank group	Suburbs (in rank order)
High	Central Mackay, West Mackay, North Mackay, South Mackay, Andergrove, Slade Point.
Significant	Paget, Mackay Harbour, Bucasia, Beaconsfield, Glenella, Bakers Creek, Ooralea, Te Kowai.
Moderate	East Mackay, Rural View, Eimeo, Racecourse, Richmond, Erakala.
Low	Nindaroo, Mount Pleasant, Shoal Point, Blacks Beach, Dolphin Heads, Foulden, Cremorne.

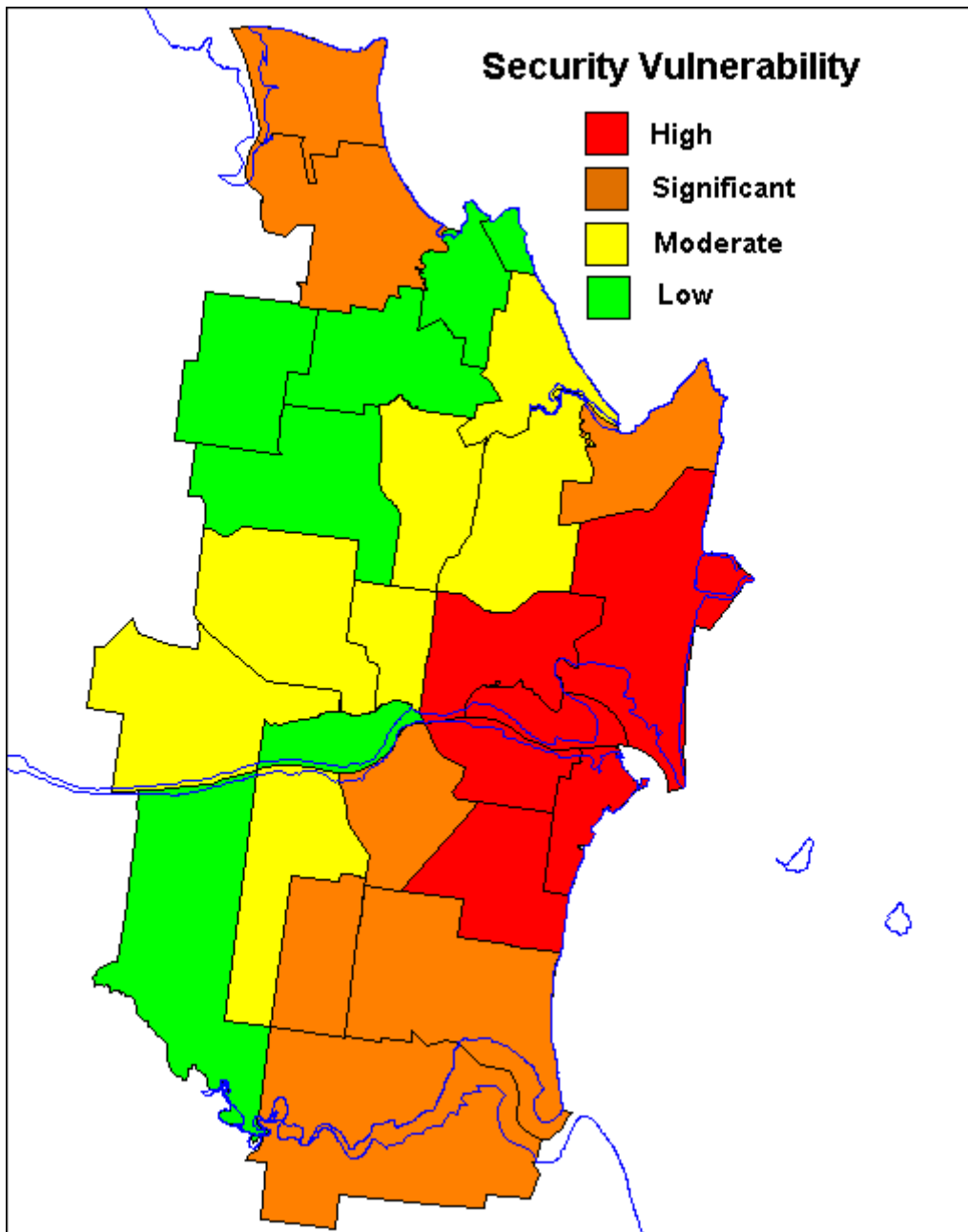


Figure 3.23: Relative suburb contribution to security group vulnerability

Table 3.12: Relative suburb contribution to security group vulnerability

Rank group	Suburbs (in rank order)
High	Central Mackay, Mackay Harbour, South Mackay, East Mackay, North Mackay, Cremorne.
Significant	Paget, Slade Point, Bucasia, West Mackay, Ooralea, Bakers Creek, Shoal Point.
Moderate	Andergrove, Glenella, Beaconsfield, Racecourse, Mount Pleasant, Blacks Beach, Erakala.
Low	Richmond, Rural View, Eimeo, Te Kowai, Nindaroo, Dolphin Heads, Foulden

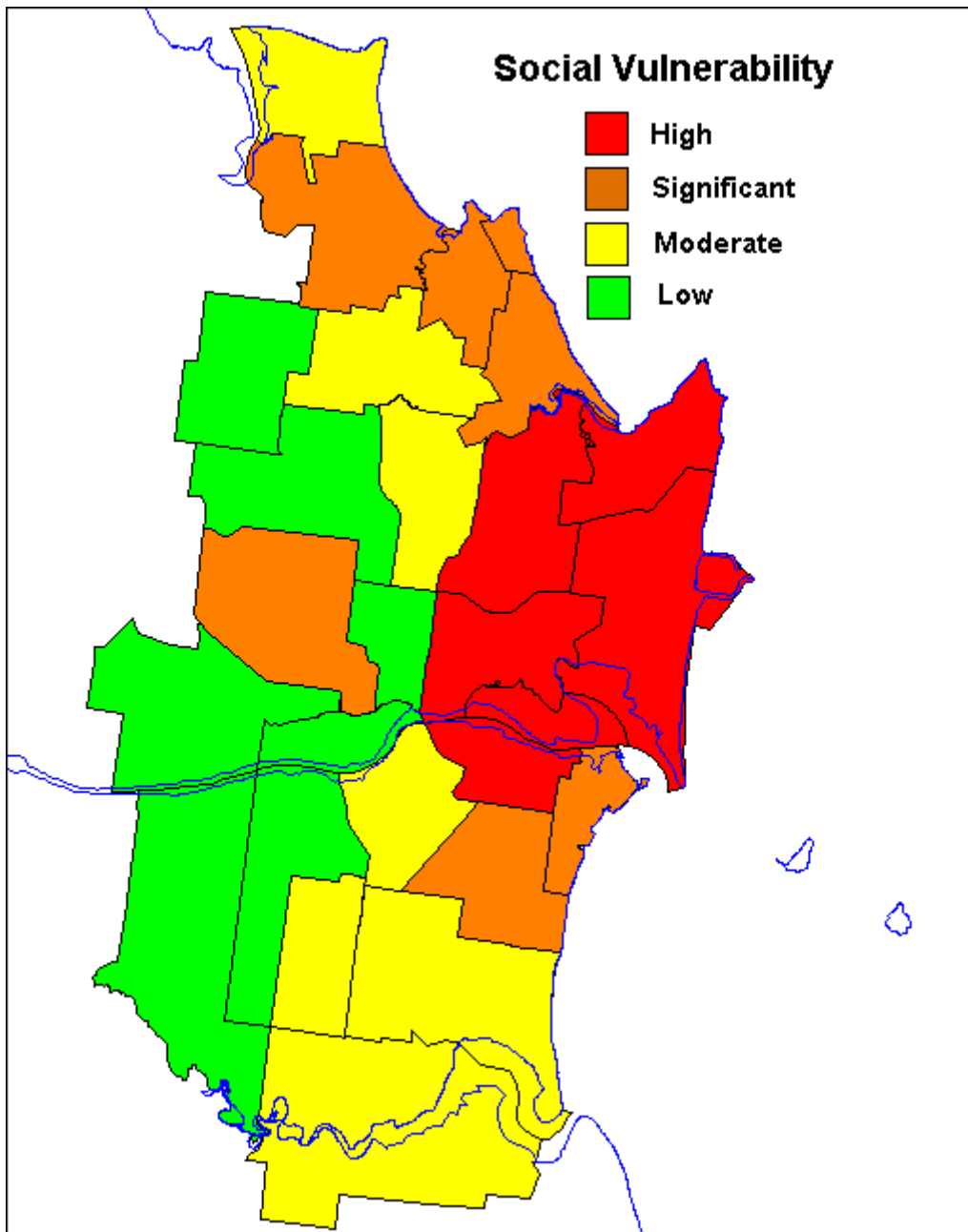


Figure 3.24: Relative suburb contribution to social group vulnerability

Table 3.13: Relative suburb contribution to social group vulnerability

Rank group	Suburbs (in rank order)
High	Mackay Harbour, Central Mackay, Cremorne, Slade Point, Andergrove, North Mackay.
Significant	Blacks Beach, Dolphin Heads, East Mackay, Bucasia, South Mackay, Glenella, Eimeo.
Moderate	Beaconsfield, Ooralea, Bakers Creek, West Mackay, Paget, Shoal Point, Rural View.
Low	Mount Pleasant, Richmond, Te Kowai, Nindaroo, Racecourse, Foulden, Erakala.

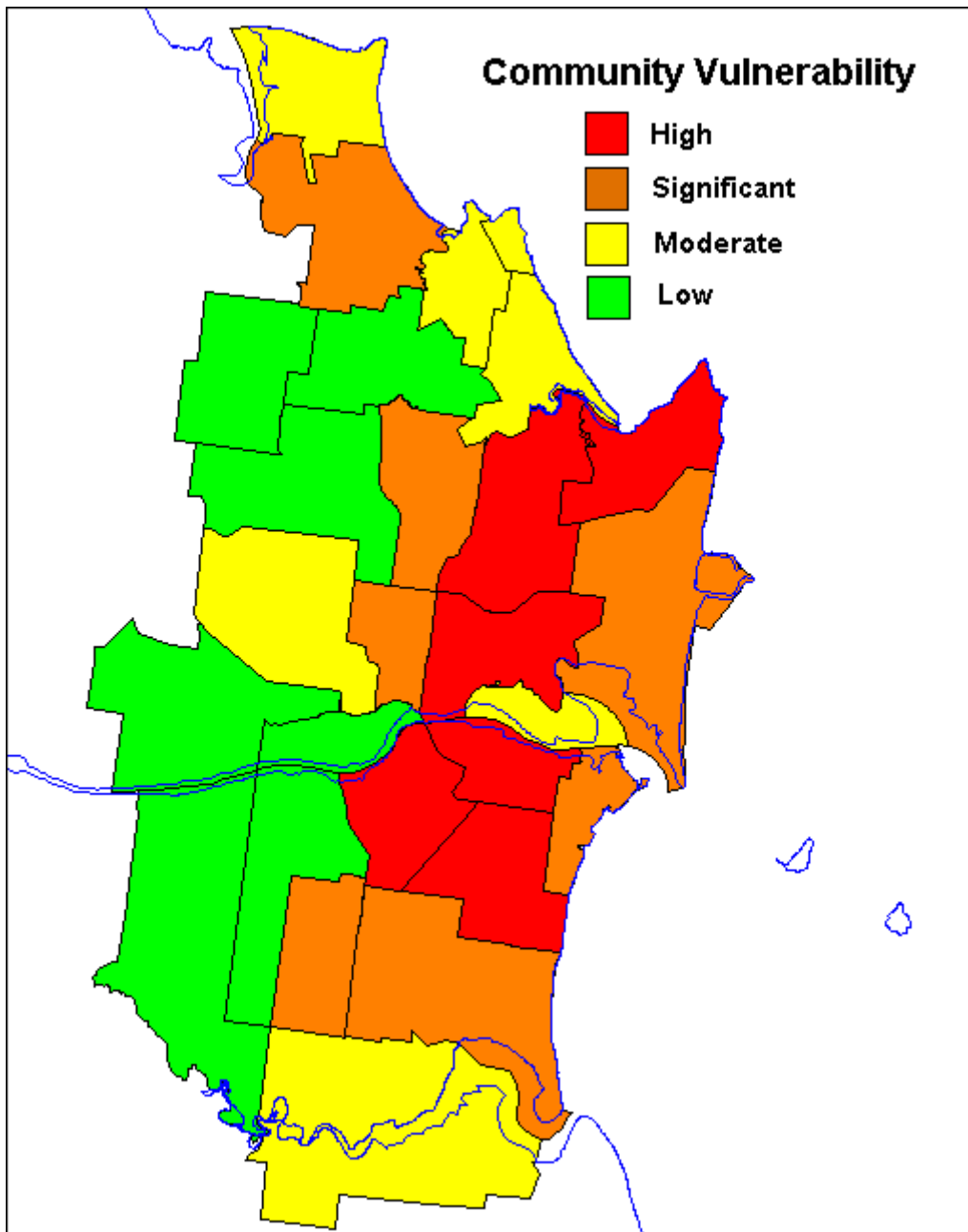


Figure 3.25: Relative suburb contribution to overall community vulnerability

Table 3.14: Relative suburb contribution to overall community vulnerability

Rank group	Suburbs (in rank order)
High	South Mackay, Central Mackay, Andergrove, North Mackay, Slade Point, West Mackay.
Significant	East Mackay, Bucasia, Mackay Harbour, Beaconsfield, Mount Pleasant, Ooralea, Paget.
Moderate	Glenella, Eimeo, Bakers Creek, Shoal Point, Cremorne, Blacks Beach, Dolphin Heads.
Low	Rural View, Richmond, Nindaroo, Te Kowai, Racecourse, Erakala, Foulden.