CHAPTER 10: HEAT WAVE RISKS

Ken Granger and Michael Berechree

The Heat Wave Threat

According to Coates (1996), heat waves kill more people than any other natural hazard experienced in Australia. She reported that in the period between 1803 and 1992 at least 4287 people had died in Australia as a direct result of heat waves. This was almost twice the number of fatalities attributed to either tropical cyclones or floods over much the same time-frame. Coates' figures are not broken down according to the state or territory in which the deaths occurred, however, a database developed by her colleague at the Natural Hazards Research Centre (NHRC) at Macquarie University, Kylie Andrews, based on press reports covering the period between 1907 and 1992, indicated that about 18% of the national heat wave deaths occurred in Queensland – 681 deaths in Queensland out of a national total of 3843 - (Russell Blong, NHRC, personal communication, 2000). NSW, with 33% of the total, suffered the greatest number of deaths. Interestingly, the Andrews data indicates that males were significantly more at risk than females (449 males deaths to 222 female deaths) though this trend has been significantly less marked in the past few decades as the number of men engaging in hard physical labour out of doors has decreased.

As well as significant loss of life, heat waves can also cause significant economic losses through livestock/crop losses and damage to roads, railways, bridges, power reticulation infrastructure, electrical equipment, and so on (EMA, 1998). Heat wave conditions also lead directly to significant increases in demand for electricity to power domestic air conditioners. This demand can exceed the available capacity of the generating system, leading to load shedding – which in turn exacerbates the heat wave impact on people.

Regardless of these statistics, heat wave is probably the most under-rated of all natural hazards.

The Heat Wave Phenomenon

There appears to be no official Australian definition of a heat wave, however, the American Red Cross (*www.redcross.org/disaster/safety/heat.html*) define it simply as a 'prolonged period of excessive heat and humidity'. This is a useful definition because it emphasizes the combined effects of both air temperature and humidity.

Temperatures that would indicate whether a specific location was under the effect of a heat wave would be in the top 5% for a continuous three-day period. In South-East Queensland, heat waves typically occur between November and February, but days of excessive heat can occur between October and March. During these events the predominant wind is generally from the south-west to the north-west, i.e. from the interior of the Continent. Winds from these quarters have the potential to nullify the cooling effects of any sea breeze.

The difficulty in defining a heat wave in Australia has been in establishing an acceptable threshold and duration of an event, and relating it to the climatology of the area under investigation. The United States National Weather Service uses the measure of *apparent temperature*, T_a, which is based on the work of Steadman (1979, 1984), to produce a *heat index*. The Steadman heat index is summarised in Table 10.1. Similar indexes have also been published by Henderson-Sellers and Robinson (1986), for example.

The use of apparent temperature for an individual day can assist in the evaluation of heat related stress associated with outdoor activities. It should also be noted that the atmospheric temperature within an enclosed space, such as a house with all of its doors and windows closed, or a motor vehicle, will be significantly higher than the 'screen' temperature quoted on the evening weather report.

Table 10. 1 Apparent temperature heat index (based on Steadman, 1979 and 1984)

Relative Humidity(%)	Atmospheric temperature (°C)									
	26	**28**	**30**	**32**	**34**	**36**	**38**	**40**	**42**	**44**
0%	25	27	28	30	32	33	35	36	37	38
10%	25	27	28	30	32	33	35	37	39	41
20%	26	27	28	30	32	34	37	39	42	46
30%	26	27	29	31	33	36	39	43	47	52
40%	26	28	30	32	35	39	43	48	54	60
50%	27	28	31	34	38	43	49	55	62	
60%	27	29	33	37	42	48	55	62		
70%	27	31	35	40	47	54	63			
80%	28	32	38	44	52	61				
90%	28	34	41	49	58					
100%	28	36	44	56						

At an apparent temperature, T_a of:

32-40	Heat cramps or heat exhaustion possible
41-54	Heat cramps or heat exhaustion likely, heat stroke possible
54-more	Heat stroke highly likely

. Exposure to full sunshine can increase the heat index value by up to 8°C.

The South-East Queensland Heat Wave Experience

The records of fatalities caused directly or indirectly by heat wave are, at best, fragmentary for South-East Queensland. They have, none-the-less, been recorded in the region since at least 1899. Perhaps the most severe heat wave, in terms of fatalities, occurred in late January 1940, when at least 80 people died (51 males and 29 females). Most recently, between 19 and 21 January 2000, a heat wave reportedly killed 22 people in the region. The victims died of heat associated stress, with most of the victims being elderly residents of Brisbane, many of whom lived alone and had closed themselves away inside their homes for ‘security’.

Using a threshold for temperature that is within the top 5% of daily maximum temperatures for a continuous three-day period in the South-East Queensland area, at least 18 heat wave events have been identified since 1899 giving an ARI of, at most, 5 to 6 years. January is clearly the most common month in which to experience a heat wave episode.

The episodes identified from this analysis were:

1-3 January 1899	4-6 March 1929	6-8 February 1978
1-7 January 1903	24-26 January 1940	18-21 December 1985
1-5 January 1905	3-6 January 1942	14-16 January 1987
5-7 March 1919	5-8 December 1952	6-9 January 1994
9-12 January 1924	18-21 November 1968	6-8 November 1994
16-18 January 1929	23-25 December 1972	19-21 January 2000

Heat Wave Risks

The level of discomfort experienced in warm, moist tropical and sub-tropical conditions is determined by a range of climatic variables, principally air temperature, humidity and wind; as well as cultural variables including clothing, occupation and accommodation; and physiological variables such as health, fitness, age and the level of acclimatisation. The main factor involved in the degree to which we feel uncomfortable in such conditions is not so much because we feel hot, but rather we sense how difficult it has become for us to lose body heat at the rate necessary to keep our inner body temperature close to 37^{o}C. Put simply, in still air the higher the humidity, the less effective are the body's mechanisms for evaporative cooling through sweat.

The body responds to this stress progressively through three stages:

- **heat cramps** – muscular pains and spasms caused by heavy exertion. Although heat cramps are the least severe stage they are an early signal that the body is having trouble with the heat;
- **heat exhaustion** – typically occurs when people exercise heavily or work in a hot, humid place where body fluids are lost through heavy sweating. Blood flow to the skin increases causing a decrease of flow to vital organs. This results in mild shock with the symptoms of cold, clammy and pale skin together with fainting and vomiting. If not treated the victim may suffer heat stroke;
- **heat stroke** – is life threatening. The victims temperature control system, which produces sweating to cool the body, stops working. The body temperature may exceed 40.6^{o}C potentially causing brain damage and death if the body is not cooled quickly.

(based on material from the American Red Cross web site)

The suggested responses to heat wave conditions include:

- slow down – avoid strenuous activity. If this can not be avoided, do it during the cooler parts of the day e.g. between 4.00 and 7.00 am;
- stay indoors as much as possible and stay out of the sun. If air conditioning is not available, stay on the lowest floor. Try to go to a public building with air conditioning, such as a shopping centre, each day for several hours. Whilst electric fans do not cool the air, they do help sweat to evaporate, which in turn cools the body. Ensure that the building you are in has adequate ventilation;
- wear lightweight, loose fitting, light coloured clothes;
- drink plenty of water regularly. Avoid drinks with alcohol or caffeine in them. They may make you feel good briefly, but they make the effects of the heat on the body worse. This is especially true of beer which dehydrates the body;
- eat small meals and eat more often. Avoid foods that are high in protein which increase metabolic heat; and,
- check on elderly relatives or neighbours, especially if they are living alone, and ensure that they also follow these risk mitigation measures.

(also based on material from the American Red Cross web site)

The anecdotal evidence of the heat wave event of January 2000 indicates that many elderly people, and indeed many people in other susceptible groups of the population, are largely ignorant of the risks posed by heat waves, or of the simple steps that can be taken to reduce those risks. There is clearly a need to improve public awareness of the risks associated with heat wave and possibly to adopt the US warning methods using a heat index. There is absolutely no reason why such an index could not be introduced and accepted in Queensland given that its cold climate equivalent, the wind chill factor index, is already widely accepted in the southern states. There is also a need to actively involve those community agencies, such as Meals on Wheels and Blue Nurses, that have regular contact with some of the more susceptible individuals, to promote the awareness message.

Total Risk Assessment

It is clear that whilst a heat wave weather sequence will be felt more-or-less equally across the entire area, its impact will be greatest on those who are most susceptible. The elderly, especially those living alone, would seem to be the most susceptible group. Whilst a good number of elderly people who are living alone may reside in 'managed' communities such as retirement villages, and consequently have a degree of regular contact, a very large number remain isolated in their homes within the general community.

The very young also constitute a susceptible group, however, it is likely that they will have a parent or other carer to look after their well being. We do not have any information on the distribution or numbers of other susceptible groups such as the homeless and the physically or mentally disabled, so have adopted the over 65 years living alone group as our measure of risk exposure.

The distribution of people over 65 years and living alone, based on the proportion they represent of the total population in 1996, is shown in Figure 3.20. In absolute terms, however, it should be noted that in South-East Queensland there were 51 784 people that were within this group in 1996. The suburbs in which the top 1% of CCD with this group of people present (i.e. the highest heat wave exposure) are located are (in alphabetical order):

As has been shown in earlier chapters, by relating the level of exposure (in this case the number of elderly who are living alone) to the respective hazards at the CCD level to the level of the CCD's contribution to overall community vulnerability (the vulnerability index detailed in Chapter 3), it is possible to derive an index of risk. The urban heat wave risk surface derived from that index is shown in Figure 10.1. As described in earlier chapters, the higher the index number the greater is the overall risk posed by heat wave.

The top 1% of urban CCDs by heat wave risk index are located in (alphabetical order):

> Ashmore, Aspley, Benowa, Bongaree, Caboolture, Chermside, Cleveland, Coombabah (2), Deception Bay, Durack, Elanora, Fitzgibbon, Greenslopes. Keperra (2), Lawnton, Mount Gravatt, Mount Warren Park, Nerang, New Farm, Ormiston, Robertson, Runaway Bay, Sandgate, Scarborough (2), Southport, Thornlands and Upper Mount Gravatt.

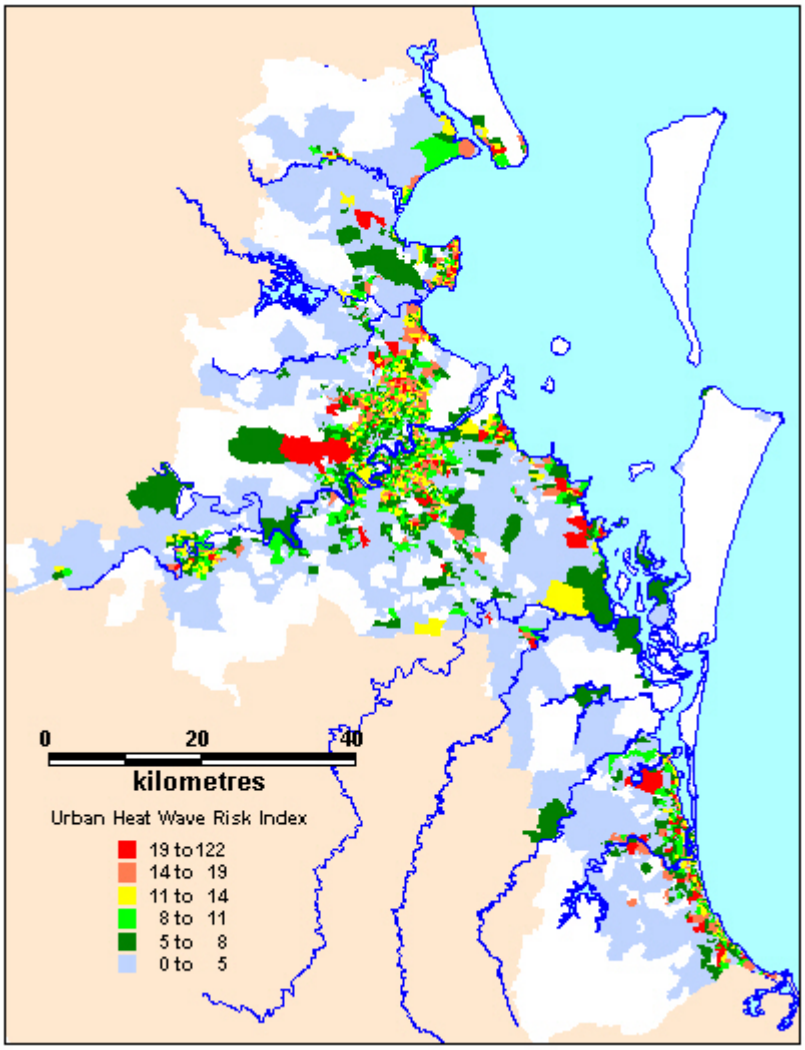

Figure 10.1 Heat wave total risk distribution

Community Awareness

As with other hazards dealt with in this study, there appears to be a significant lack of community awareness of the risks associated with heat wave, even though the region experiences such events with some regularity. In briefings and presentations given during the South-East Queensland research, even experienced disaster managers expressed surprise at the rate of fatalities attributed to heat waves compared with cyclones and floods. It is clearly a widely overlooked, even unknown, killer.

There are, however, various Workplace Health and Safety requirements in place aimed at protecting workers, school children and so on from the stress of high temperatures in the workplace, school and so on. The general public, in particular the elderly lady closed up by herself in her home in the suburbs, does not have the same degree of oversight or protection.

Forecasting and Warnings

Unlike their US counterparts, the Bureau of Meteorology does not issue specific 'heat wave warnings', though at times of extended hot weather, advice will be included in normal weather forecasts advising of the dangers of heat stress. The use of a 'heat index' has yet to be established in Australia.