EVALUATING TROPICAL CYCLONE WINIFRED, 1986 AS AN ENVIRONMENTAL THREAT.

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THE EVENT

Cyclone Winifred crossed the North Queensland coast and ravaged the area north and south of Innisfail on February 1, 1986. The official forecast central pressure was 960 mb, although unofficial and uncorrected records for Flying Fish Point and for Croquet Point were respectively 952.4 mb and 956 mb. This would place the cyclone just in level 3 of the 5 level Saffir-Simpson hurricane intensity scale.

Many people in the affected area had held a view that cyclones tended to pass them by or crossed the coast well north. The last severe cyclone to affect the Innisfail area was in March 1918. This crossed the coast south of Cairns (Lourensz, 1981), and records show a central pressure 928 mb. The area suffered moderately badly when on March 6, 1956 a cyclone crossed the coast north of Townsville and moved inland on a north-west track. Memories of these earlier events had faded; older residents had died, and others had moved into the area.

The database is limited and often inaccurate. The earliest printed record (back to 1867) is sketchy, not always reliable and lacks firm data. The Bureau of Meteorology, using its own records and some of the early summaries, has published data from June 1909 to the present. (Lourensz, 1981: annual updates of the Australian Meteorological Magazine). To about 1960, there are probably omissions either of measured or interpolated values of central pressures, and even of cyclones that remained out at sea. Without cyclone reconnaissance aircraft, measured data for cyclones at sea are limited to chance information from ships caught in the storm (or nearer the coast from automatic weather stations on reefs or cays).

It is difficult, considering the length of coastline involved, to calculate probable return periods for cyclone occurrence, let alone differentiate the individual cases on an intensity basis. Table 1 shows the cyclones that crossed the coast (or came within 100 km of the coast with cyclonic intensity) between Thursday Island and Gladstone. Before 1954, no reliable pressure is available for many cyclones so the totals are probably too low.

Table 1. Cyclones crossing (sea to land or vice versa) or coming close to the coast. Thursday Island to Gladstone. Central pressure on crossing (mb); may have been lower at sea. 1909/10-1984/85 seasons.

Central Pressure	990-980 mb	980-960 mb	less than 960 mb
	18	10	4

Table 2. All cyclones crossing sectors of the coast (100 km) between 1909 and 1985.

Sector	Town within sector	Sea-land	Land-sea*
80	Mossman	11	4
81	Cairns	4	2
82	Innisfail	5	1
83	Ingham	2	4
84	Townsville	6	1
85	Bowen	2	1
86	Proserpine	4	3

*Note: Cyclones crossing from land to sea are generally less intense.

Generalisations about the potential impact of tropical cyclones are dangerous. No two cyclones behave identically even though they may have similar central pressures or even maximum, or mean wind velocities (further details about the structure and behaviour of cyclones may be found in Bureau of Meteorology, 1978, and in Oliver, 1985). As a consequence, evaluations of their environmental effects must be related to the particular case in question. It is this same diversity in characteristics or behaviour that makes their forecasting a difficult task. A number of the possible differences are briefly referred to below.

Differences between different cyclone prone regions

Although basically the same sort of physical system differences appear between the cyclones of the North Atlantic or north-west Pacific, or for that matter between north-west Australian, Gulf of Carpentaria and Coral Sea cyclones.

Cyclones as severe wind threats

Although there is a relationship between the central pressure and gust or mean, one or 10 minute wind velocities (10 m above surface) there is a considerable divergence in individual cases (perhaps 20 km/hr at 75 percent confidence) from indicative values.

There are other complications because the gust/mean value varies with the nature of the surface (roughness of the sea, or the nature of the terrain, vegetation, relief, buildings). Even surface temperature may affect the turbulence pattern.

Wind speeds are greatest in a ring of which the eye wall is the inner circumference. This maximum wind ring varies in width. Wind speed isopleths usually show asymmetries between different sides of the centre (often fastest on the left of the track).

Table 3. Relationships between central pressure and wind speed. The figures given are broad estimates only for one minute mean wind speeds.

Central pressure 990 to 980 mb :	100 to 130 km/hr
Central pressure 980 to 960 mb :	130 to 170 km/hr
Central pressure 960 to 940 mb :	170 to 220 km/hr

Cyclones as rain producers

There is little correlation between the central pressure and the total rainfall from a given cyclone. Some cyclones, though intense, yield relatively small totals (50 mm or less); others up to 300 mm. It is often their declining phase, when they can become "rain depressions", that the totals (especially where high ground is involved) can attain 800 to 900 mm (1 947 mm in the case of former cyclone Peter, as recorded at Bellenden Ker on January 4 and 5, 1979). Over the sea or small islands rainfall is usually lower. The rainfall tends, but not always, to be most to the left front of the cyclone. It may continue as heavy showers for some hours after the cyclone has passed.

The rate of passage of the cyclone, as well as rate of rainfall are significant factors. Over land, local convergence may add to local falls.

Cyclone storm tides

A rough and ready rule equates a pressure drop of 1 mb with a rise of 10 mm in sea level. The general sea level (or that around small islands) is little affected. The rise in sea level is greatly enhanced by the onward impulsion of the sea by the wind nearer land on the left of the track. Shallowing of the sea floor, coastal embayments, and the relationship between cyclone track and coastal orientation will all have varying and important effects. Particularly critical is the relationship between the pattern and timing regime and the arrival time of the surge. The generation of waves by the cyclonic winds adds a further complication which affects both the inundation level and the erosive energy of the waves.

The varying behaviour of the individual cyclone

Not only do different cyclones vary in behaviour, but so does an individual cyclone - its track varies, often erratically, in direction, while its speed of movement changes from being virtually static to a fast advance, possibly on more than one occasion. Rate of movement tends to be slower in the developing stage and increase as the cyclone becomes mature or declining. In many cases, the most destructive conditions last six to eight hours, but it can in some slow moving cyclones be much longer. The area affected by hurricane force (in excess of 117 km/hr) or gale force (greater than 63 km/hr) in different cyclones (or even in the same one) shows marked differences, although the central pressures may not differ. The shape of the area affected may well be asymmetrical, especially as the cyclone gets closer to land. The diameter of the eye is similarly variable and the duration of calm in a locality over which it passes will vary with the eye diameter and speed of cyclone travel.

CYCLONE WINIFRED

Cyclone Winifred demonstrated its own individuality.

It caused an abnormally wide band of wind damage north of its track to north of Cairns and on to the southern Atherton Tablelands. Over land, although building damage was considerable, the most dramatic effect of the wind was upon the rainforest and also on fruit trees, the banana crop, and some areas of sugar cane.

It was intense, but had a large eye (approximately 50 km in diameter over the sea) but the eye decreased rapidly as the cyclone moved inland declining to 22 km in diameter north of Tully, becoming diffuse by 60 km inland.

It showed varying rates of movement, being almost stationary for much of its earlier life, then advancing at varying rates (15 km/hr in the later stages up to landfall), showing small but difficult to interpret changes in direction until it quickly changed to a westward direction about mid-morning on February 1.

It was a significant rain producer. Many areas in the general Innisfail area received between 200 and 250 mm, and Cardstone, north of Tully, 400 mm. Rivers and creeks rose rapidly, especially the South and North Johnstone Rivers and the Herbert. Large amounts of sediment were carried out to sea.

Fortunately the surge coincided with low tide and coastal flooding and erosion was small.

Over the coastal areas, severe effects lasted about seven hours.

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