

Tropical Cyclone Karen 02/03/1977 to 09/03/1977

(i) General

Tropical cyclone "Karen" was the fourth cyclone of the season and the second to operate near the Northwest coast. It was a severe storm and although it caused mostly minor damage its track was so close to the coast that it caused gales along the whole of the Northwest coast from Cape Leveque to Northwest Cape.

"Karen" was a slowly developing storm which reached maturity on 7 March. Its estimated central pressure at that time was 970 mb and the eye diameter varied between 25 km and 55 km. It is estimated that the maximum mean wind generated at the surface was 150 km/h. The lowest pressure reported was 980 mb from a tug in Flying Foam Passage at 062230 GMT and from Exmouth at 072000 GMT.

All centres along and close to the Northwest coast suffered damage because of the strong winds. Mostly the damage was minor, such as shrubs and trees being uprooted, power supplies and shipping schedules disrupted. The main damage occurred at Exmouth where some roofs of houses were damaged, trees uprooted and power lines broken. One woman suffered a badly gashed leg. A yacht was wrecked at East Intercourse Island by the heavy seas.

(ii) Development

Cyclone "Karen" was first identified as a closed circulation on 2 March. It was then located 100 km to the east of Browse Island with a central pressure of about 1002 mb. This circulation was part of a broad trough which was active over the northern part of Australia and the adjacent seas east of longitude 117°E.

Reports from the Automatic Weather Stations off the West Kimberley coast indicated on 3 March that the low pressure system was drifting southwestward and had deepened to 996 mb. During the next four days "Karen" developed slowly becoming an intense storm on 7 March with an estimated central pressure of 970 mb. Late on 7 March "Karen" crossed the coast near Exmouth and then moved out to sea again near Ningaloo on 8 March. The weakening process was well under way by this time and redevelopment did not occur. By 9 March only a weak low level circulation with a central pressure of 1006 mb remained 370 km northwest of Carnarvon.

The lowest pressure reported in the vicinity of "Karen" was 988 mb from a tug sheltering in Flying Foam Passage. This pressure was reported at 062230 GMT when the cyclone centre was about 50 km to the northeast. At this time "Karen" was approaching its maximum development. A pressure of 988 mb read from an aneroid barometer was also reported from Exmouth at 072000 GMT as the cyclone was passing over that township. At this time "Karen" was beginning to weaken.

(iii) Features of the Track

During its lifetime of 7 days "Karen" travelled 1900 km. Apart from a brief period when it crossed Northwest Cape "Karen" remained over tropical waters. The track is unusual in that after an early change of direction from southwest to south, the cyclone resumed a southwesterly movement when it was 90 km north of Broome.

Thereafter the cyclone travelled on a path only slightly convergent with the Northwest coast. The cyclone made landfall at Exmouth and then crossed out to sea again at Ningaloo. Within 24 hours of passing out to sea the system had degenerated almost completely as it moved northwestward away from the Continent.

For the first three days "Karen" travelled quite slowly at about 5-8 km/h. It then gradually increased in speed and on 6 March was travelling southwestward at 18 km/h. On 7 March its speed began to decrease to about 15 km/h and after "Karen" had crossed Northwest Cape its speed decreased still further to 9 km/h. When the weakening storm began moving northwestward its speed increased to 18 km/h.

During the early part of "Karen's" development, a ridge of high pressure located in the Bight moved slowly eastward and weakened. A new high pressure ridge surged over Western Australia on 5 March bringing a moderate easterly flow to all areas. The arrival of the easterly surge in the Broome area coincided with the recurvature of cyclone "Karen" to the southwest. This new high pressure system maintained a ridge over the whole of Western Australia until 8 March when a weak low pressure trough moved across the State causing a breakdown of the easterly flow. By this time however "Karen" was dissipating. On 9 March a new ridge of high pressure began moving across the southwestern part of the State coinciding with the rapid movement of the weakening depression to the northwest.

(iv) Rainfall, Flooding and Flood Damage

Tropical cyclone "Karen" brought good rains to the coastal and adjacent areas of Northwestern Australia. Isohyets of the cumulative rainfall for the 96 hour period 0900 WST 5 March 1977 to 0900 WST 9 March 1977 are shown in Figure 4.2. The greatest totals occurred in those parts which were most exposed to onshore winds circulation about the storm.

Cape Leveque recorded the highest 24 hour fall 160 mm to 0900 WST 6 March 1977. In the same period Derby recorded 122 mm while Broome recorded only 15 mm.

Heavy rain also occurred between Mandora and Pardoo where falls occasioned by "Karen" exceeded 150 mm. Further south the only other station to record more than 100 mm during the passage of "Karen" was Onslow with 106 mm.

Flooding occurred in the Onslow area but was of a minor nature.

(v) Winds and Wind Damage

"Karen" was a severe storm and at maturity generated winds estimated at about 150 km/h.

Winds exceeding gale force were first reported from the Automatic Weather Station at Scott Reef. The report of wind at 83 km/h at 032200 GMT was the first indication that the tropical depression off the Kimberley coast had deepened to tropical cyclone intensity. Each report from Scott Reef until 040600 GMT indicated gales occurring at that station.

By 041600 GMT gale force winds were being caused at Cape Leveque and these persisted until about 060100 GMT. For most of that period, from 041800 to 051600 GMT winds exceeded 93 km/h. The maximum wind was estimated to be northwesterly at 111 km/h at 050700 GMT.

At about 051300 GMT "Karen" veered to the southwest away from the coast. Winds at coastal stations adjacent to the cyclone's path for the next 30 hours were therefore mainly offshore and although most stations reported brief periods of gales or squally winds, these were not long-lived.

On the morning of 7 March "Karen" passed among the Islands of the Dampier Archipelago. The maximum winds reported occurred at about this time. A tug sheltering between West and East Lewis Islands reported a southwest wind of 148 km/h at 062130 GMT. At the Dampier Port Control at East Intercourse Island the eastnortheast wind was estimated at 130 km/h at 070230 GMT. In each case the cyclone was within about 40 km of the report location.

By 072000 GMT "Karen" had reached the township of Exmouth where the maximum gust recorded was 155 km/h. Winds exceeding 95 km/h were reported from Ningaloo on the western side of Northwest Cape shortly before the eye passed over the station. At about 090330 GMT Cape Cuvier reported a brief period when the northeast winds reached 65 km/h. This was the last report of gale force winds associated with cyclone "Karen".

While the cyclone was developing several ships encountered gale force winds. A selection of their reports is given in Table 4.1. The last ship report of winds exceeding gale force was from a tug sheltering in Flying Foam Passage when the wind was northeasterly at 102 km/h. After that time all ship reports indicated the vessels were outside the radius of gale force winds.

All centres along and close to the northwest coast suffered damage because of the strong winds. The main damage occurred at Exmouth where one woman was injured, several house roofs were damaged, power lines broken and numerous trees uprooted. Elsewhere the damage was minor. Shrubs and trees were damaged, power supplies and shipping schedules disrupted.

(vi) Seas, Swell, Storm Surges and Related Damage

A ship "Lady Cynthia" reported southerly 6 m swells at 052300 and 060030 GMT. Similar swells were also reported by the oil rig "Regional Endeavour" at 070600 GMT. These were the highest swells reported in the vicinity of cyclone "Karen". Sea and swell data from selected ships are included in Table 4.1.

No storm surges were reported.

Damage due to sea action was slight; one yacht was wrecked at East Intercourse Island.

(vii) Satellite Analysis

Tropical cyclone "Karen" was under daily surveillance by meteorological satellites NOAA 4 and NOAA 5. Selected data from NOAA 5 photographs is given in Table 4.2.

In the days prior to 2 March a large area of convective cloud existed over the Kimberley and the waters north of the Continent and east of longitude 117°E. On 2 March the satellite photographs indicated that some organisation was beginning to occur in the western parts of this cloud mass. A cloud system centre (CSC) was apparent just east of Browse Island. In Dvorak's scheme the system was classified as T 2 with ongoing development expected. Over the following days the system became detached from the extensive cloud mass to its east. The CSC moved under the deep layer convection area on 4 March and on 5 March the tropical cyclone became organised into a cloud system with a small central dense overcast (CDO) and a broad outer cloud band on the western and southern sides. It was then classified as T 4. In the next 24 hours only limited development occurred owing possibly to "Karen's" proximity to the land mass. The system was designated T 4.5.

On 7 March the cyclone reached maturity at T 5. However, the cirrus outflow was becoming unidirectional and downstream convection seemed to be weakening. Overall weakening of the cyclone was therefore expected. "Karen's" trajectory took it across land for several hours late on 7 March. "Karen" passed once more over tropical waters on 8 March, but the weakening trend was well established. Most of the dense convective cloud about the CDO had disappeared and the feeder bands were almost entirely composed of low cloud. By 9 March only a low cloud circulation was evident,

(viii) Analysis of Radar Reports.

Both Broome and Port Hedland meteorological radars were used to track cyclone "Karen". Radar returns were visible at Broome from 040930 GMT to 060620 GMT. During the period 042130 to 051150 GMT a possible centre of circulation could be established. After 051150 GMT, although "Karen" was still approaching Broome from the north, it was not possible to determine the centre of circulation. This situation continued while "Karen" remained within radar range of Broome.

Cyclone "Karen" was visible on the Port Hedland radar from 060015 to 070455 GMT. From 060215 until 061005 GMT the eye wall rain echoes were visible but thereafter the centre was determined by the spiral banding. The diameter of the "eye" was about 55 km at first but decreased to about 25 km just before the eye wall cloud broke up.

The positions of the cyclone centre shown by the radars at both Broome and Port Hedland agree well with those determined from conventional reports and satellite data.

Ship	Position		Date/Time (GMT)	Bearing/Distance from Centre (km)	Wind Direction / Speed (km/h)	Sea (m)	Swell (m)	Weather	Pressure (mb)
	°S	°E							
Wambiri	16.3	122.9	040001	150/165	010/83			Recent Squalls	989.8
Wambiri	16.5	122.7	041800	140/90	060/76			Moderate intermittent rain	991.5
Lady Cynthia	18.3	119.8	052300	250/115	180/111	3	S 6	Continuous rain	997.5
Lady Cynthia	18.0	120.1	060030	310/68	190/93	3	S 6 SE 4	Continuous light rain	996
Kasagisan Maru	17.1	118.9	060300	330/215	230/63	2	S 3	Past Showers	1002.5
Norselion	19.8	118.3	060600	240/180	130/81			Slight drizzle	1001
Norselion	18.7	117.7	061200	321/115	250/87		SE 3	Frequent light showers	1000
Regional Endeavour	19.9	115.7	070600	010/120	260/70	5	6	Moderate showers	995.9
Tug	20.6	116.8	062030	200/55	140/130				997
Tug	20.7	116.6	062130	210/39	220/148				995.5
Tug	20.6	116.8	070330	080/135	040/102				

Table 4.2

Data from Satellite Photographs

Satellite Name	Orbit Number	Date/Time (GMT)	Estimated posn. of centre		Final T No.	Min. Sea Level Pressure (mb)
			°S	°E		
NOAA5	2665	020034	14.0	124.5	1	
	2677	022349	14.0	122.9	2	996
	2690	040102	14.9	122.0	3	992
	2702	050018	16.3	122.1	4	985
	2714	052334	18.3	120.5	4.5	975
	2727	070052	20.5	116.4	5	970
	2739	080006	22.4	113.6	3.5	990
	2752	090115	24.1	112.5	2	1003