

Tropical Cyclone Joan 30/11/1975 to 10/12/1975

(i) General

Of the eight tropical cyclones to operate in the Northwestern Australian Region during the season 1975/76 "Joan", the second cyclone, was by far the most noteworthy. "Joan" was, one of the most intense tropical cyclones on record to affect Australia. It was also comparatively well documented in all stages of its existence.

During its initial stages the system was located in the Northern Australian Region and the first alerts and warnings were issued by the Darwin TGWC. Responsibility for issuing the warnings was assumed by Perth TCWC at 0200 GMT 4 December 1976.

"Joan" was near its peak intensity when it crossed the Western Australian coast about 50km west of Port Hedland. A recorded surface wind gust of 208 km/h was generated at Port Hedland Airport. In Australia this gust has been exceeded only by gusts of 217 km/h at Darwin during the passage of "Tracy" on 25 December 1974, 232 km/h at Onslow in 1963 and 246 km/h at Onslow in "Trixie" on 19 February 1975.

Severe property damage occurred at Port Hedland and at other smaller settlements adjacent to the cyclone's track, particularly in the first twelve hours of its path over land. Subsequent flooding caused damage to roads and to sections of some of the iron ore railways particularly that of Hamersley Iron Pty Ltd. Sheep losses were heavy over pastoral properties which lay along and slightly east of the track between the coast and the Hamersley Range. No loss of human life or serious injury was reported but damage to private property and public facilities is estimated to have been about \$25 million.

(ii) Development

On 30 November the first indication that the development of a tropical cyclone might be imminent was given by the NOAA 4 satellite photographs. A large cloud mass typical of an incipient tropical cyclone was located in the Timor Sea. On 1 and 2 December cloud photographs were still the main evidence that a tropical cyclone was continuing to develop.

The first surface information of the increasing strength of "Joan" came as the cyclone moved westsouthwest past the northern most areas of Western Australia on 3 December. Kalumburu Mission reported a mean wind of 74 km/h, and the vessel "Bluff Creek" sheltering in a bay just to the northeast of the Admiralty Gulf experienced mean winds of 93 km/h.

During 4 December "Joan" passed south of Browse Island and Scott Reef automatic weather stations and north of the automatic station on Adele Island. The observations from these stations confirmed the interpretation of the day's satellite photographs that the cyclone was continuing to intensify.

At 060100 GMT "Joan" was about 120 km northnorthwest of Rowley Shoals automatic weather station. In the following 24 hours it moved through an arc of about 90 degrees around this station so that at 070100 GMT it was a similar distance west of Rowley Shoals and moving southward. In that time the pressure at the station fell from 992 mb to 983 mb suggesting that the cyclone was still intensifying slowly. Further evidence of

this continued intensification was gained from a satellite photograph which indicated a central pressure of about 915 mb.

At landfall the central pressure was estimated to have been about 925 mb. A barograph owned by Texas Gulf Marandoo Ltd and located at Mundabullangana homestead about 60 km westsouthwest of Port Hedland and about 6 km west of "Joan's" track recorded a minimum sea level pressure after correction of about 935 mb. This was the lowest pressure recorded pertaining to cyclone "Joan". It occurred about 1.5 hr after the eye of the cyclone had crossed the coast and when the centre was approximately 20 km inland from the point of landfall.

Once inland the cyclone weakened gradually with the strength of the winds falling below gale force within 24 hours. The decaying cyclone became part of a broad low pressure area which was covering almost the whole State on 9 December. On 10 December the former tropical cyclone was no longer an identifiable feature.

The value of the first anticyclonically curved isobar at maturity on 7 December was 1004 mb.

(iii) Features of the Track (rig. 2.1)

"Joan" was an active system for eleven days and in that time travelled about 2450 km. The track followed by "Joan" was quite typical if it is compared with the tracks of all cyclones; however, it is unusual for an early season cyclone generated in the eastern part of the Timor Sea to move so far westward before turning to cross the coast.

In its early stages "Joan" moved very slowly towards the southsouthwest. As it approached Troughton Island on 3 December it gradually veered to the westsouthwest and accelerated to about 13 km/h. It maintained this general direction and speed until 6 December when it turned and began moving directly to the south. On this path "Joan" made landfall about 50 km west of Port Hedland at about 072215 GMT. Thereafter it continued in its movement southwards over the Chichester and Hamersley Ranges to the vicinity of Meekatharra where it became indistinguishable in an extensive low pressure area.

While "Joan" was operative pressures over the western half of the continent were relatively low. This broad trough existed between high pressure systems located over the Indian Ocean and the eastern part of Australia. At and above 250 mb the axis of the upper ridge was oriented along about 15°S latitude. In this case the movement of the cyclone agreed well with winds above 250 mb.

(iv) Rainfall, Flooding and Related Damage

In its developing stages "Joan" brought some heavy rain to coastal parts of the West Kimberley. The highest falls in the 24 hours to 0900 WST 5 December were 216 mm at Kuri Bay, 214 mm at Cape Leveque and 169 mm at Cockatoo Island.

The rainfall associated with 'Joan's' passage overland showed a markedly asymmetrical distribution about the cyclone track. The area of maximum precipitation was on average some 70 km to the east of the track on 8 December. Along the Hamersley Iron railway the dense private rainfall recording network indicated an isohyetal gradient in excess of

500 mm in 60 km along the western edge of the four day isohyetal pattern shown in Fig. 2.2.

Although the centre of the cyclonic circulation continued to move southwards, the rainfall maximum remained centred over the Hamersley Range during 9 December and most of 10 December. It is estimated that falls in excess of 600mm occurred in an area northeast of Tom Price during this period. The highest rainfall recorded was 596 mm at the proposed site for the Marandoo Township. This fall was recorded in the 60 hours between 061600 GMT and 100400 GMT.

Coolawanyah, Mulga Downs and Hamersly Stations all recorded their highest ever three day rainfall totals. Record 24 hour totals, for periods ending 0900 WST, were received at Coolawanyah (270 mm on 9 December) and Mulga Downs (94 mm on 10 December) while Hamersly Station received its second highest fall in one day, 162 mm on 10 December. Further to the north Mundabullangana, Tabba Tabba, Indee and Boodarie all received near record 24 hour rainfalls.

Flooding occurred along a number of streams flowing into the Fortescue. In particular the Weelurnurra and Weeli Wollie Creeks overflowed causing washaways along the railway lines of Hamersley Iron Pty Ltd and Mt Newman Mining Co Pty Ltd respectively. Farther north serious flooding occurred along the Yule River.

The repair cost of the flood damage to roads and bridges in the Pilbara after 'Joan' passed through was estimated at \$1.5 million.

Stock losses were heavy with most stations between Wittenoom and the coast being affected. Thousands of kilometres of fencing were also destroyed in the floods.

(v) Wind and Related Damage

As mentioned previously the first reports of winds exceeding gale force were on 3 December. Kalumburu Mission reported 74 km/h and the ship "Bluff Creek" near Admiralty Gulf experienced 93 km/h.

Thereafter reports of gale or storm force winds were received frequently from ships in the vicinity of the cyclone. A selection of ship reports is given in Table 2.1. Wind reports received from the automatic weather stations at Scott Reef, Browse Island, Adele Island and later Rowley Shoals were all illustrative of the continued deepening of the cyclone and its westsouthwestward path followed by recurvature near Rowley Shoals. Browse Island which was closest to the track reported a mean wind of over 150 km/h averaged over a ten minute period immediately prior to its radio transmission at 040400 GMT.

At Broome on 5 December a 13 m boat broke its mooring in strong wind gusts and was wrecked against the jetty. This also caused damage to an oil pipe line beneath the wharf.

As "Joan" moved southward on 7 December winds at Port Hedland began to increase. By 070300 GMT mean winds were 46 km/h with gusts above 63 km/h. The mean winds had increased to 74 km/h with gusts over 100 km/h by 071200 GMT. At 071700 GMT winds were averaging 86 km/h and gusting to 126 km/h and still strengthening. When the cyclone was about to make landfall just west of the mouth of the Yule River at

072200 GMT winds were averaging 141 km/h at Port Hedland. The maximum gust recorded at Port Hedland, 208 km/h, occurred at 072220 GMT. After "Joan" crossed the coast winds at Port Hedland began to moderate and by 080300 GMT were averaging 83 km/h with gusts to 132 km/h. Not until 080945 GMT did the mean wind speed at Port Hedland fall below gale force (63 km/h).

Mean winds in excess of 90 km/h were experienced at Port Hedland for about ten hours from 071530 GMT to 080220 GMT and they exceeded 120 km/h for about three hours from 072030 GMT to 072340 GMT.

If the limitations of empirically derived formulae and analysis techniques can be accepted it is possible that a mean wind of 185 km/h and a maximum gust of 260 km/h could have occurred near the centre of "Joan" as it approached the coast.

While "Joan" crossed the coastal plain and the Chichester Range only a slow moderation in wind speeds associated with the cyclone seems to have occurred. As it crossed the Hamersley Range, however, the available evidence suggests that rapid weakening took place. Recording anemometers at the proposed Marandoo town and mine sites about 65 km from the cyclone track registered maximum mean winds of about 65 km/h when "Joan" was 150 km to the north, but when the cyclone reached its closest point to these sites at about 081600 GMT the mean wind speeds had dropped to less than 40 km/h.

Considerable damage was caused by the strong winds especially at Port Hedland, The damage to buildings was considered to be mostly superficial although very extensive. Some 85 per cent of homes were damaged. In ocean-front areas all homes sustained some damage and many were unroofed. Beach sand was piled up against houses to depths of one and two metres. The total cost of repairing buildings in Port Hedland was estimated at more than \$20 million and of this figure some \$2.25 million was the estimate for the replacement of the Port Hedland Hospital buildings destroyed. Damage to the Civic Centre was estimated at \$1 million.

Although strong winds continued for almost 24 hours after landfall, building damage other than in coastal areas was comparatively minor though numerous windmills were damaged and trees were stripped of foliage.

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

On 2 December ships in the Timor Sea were reporting swells of between 3.5 m and 5 m in height being generated by cyclone "Joan". At the same time sea waves of between 2 m and 3.5 m were observed. Rough seas and heavy swells were reported virtually continuously thereafter until the cyclone crossed the coast at 082215 GMT. Sea and swell conditions are included in the ship reports summarised in Table 2.1.

From coastal localities many reports of above normal tides were received. The tide gauge operated by the Port Hedland Port Authority within the main port area recorded a rise of 1.45 m above the predicted level of 6.5 m at high tide at 071736 GMT. In the following low tide the actual water level was 2.58 m above the predicted value. Thus at Port Hedland it is probable that a storm surge in excess of 2.6 m occurred prior to the predicted low tide at 072352 GMT. The maximum surge has been estimated to have been about 3.25 m. If the time of arrival of the storm surge peak and that of the high tide

had been simultaneous the resulting high water level of 9.75 m would have been about 1.9 m above the highest astronomical tide.

(vii) Radar Observations

"Joan" was under surveillance by the weather radar at Port Hedland aerodrome intermittently on 5 and 6 December when the cyclone was still north of Rowley Shoals. From 062350 GMT until 081200 GMT "Joan" was monitored continuously. Fig. 2.3 depicts the locations of the centre of the eye at various times within that period.

Because the position of the cyclone was able to be determined accurately using the radar, reliable and frequent statements of its speed and direction of movement were passed to the communities threatened by its approach.

(viii) Satellite Photograph Analysis

On the morning of 30 November 1975 photographs transmitted by the meteorological satellite NOAA 4 and received at the Tropical Cyclone Warning Centres (TCWC's) in Darwin and Perth showed a large cloud mass in the Timor Sea centred about 310 km westnorthwest of Darwin.

The satellite photograph received the next day, NOAA 4 orbit 4760 010040 GMT, showed that significant organisation had taken place in the cloud mass in the previous 24 hours. The spiral cloud banding characteristic of tropical cyclones was quite evident. On this basis Darwin TCWC issued the first Tropical Cyclone Warning and named the developing system "Joan". It was located about 70 km southsouthwest of its position the day before.

During the next seven days "Joan" remained over the ocean and continued to develop at a slow rate according to the Dvorak scheme. From 1 December the central dense overcast (CDO) was well defined. In the photograph NOAA 4 orbit 4812 050031 GMT an indistinct eye was visible and in Dvorak's scheme the system was assessed as T 6. On 6 December the eye was more clearly visible indicating that development was continuing. On 7 December the eye was very distinct and the tropical cyclone was estimated to be T 7. Because the outer cloud bands were beginning to cross a land environment and the central features were expected to become involved, some weakening was anticipated within the next 24 hours. "Joan" made landfall about 082215 GMT with an estimated central pressure below 925 mb. This would be consistent with a Current Intensity Number (CI No.) of about 6.5 in Dvorak's scheme. A summary of the data contained in the satellite photographs for the period before landfall is contained in Table 2.2.

Table 2.1

Selected Ship Reports

Ship	Position		Date/ Time (GMT)	Bearing/ Distance from centre (km)	Wind Directio n/ Speed (km/h)	Sea (m)	Swell (m)	Weather	Pressure (mb)
	°S	°E							
Bluff Creek	14.2	126.3	030400	190/080	130/74	-	-	Heavy rain	998.0
Bluff Creek	14.2	126.3	030700	180/060	100/83	-	-	Heavy rain	994.5
Bluff Creek	14.2	126.3	031400	150/065	070/89	-	-	Rain past hour	999.0
Japan oliue	14.7	119.5	060900	030/255	330/78	NW4	WNW 4	-	997.5
Konstantin Petrovsky	16.5	115.8	070600	310/290	220/93	Very High	-	-	998.0
Fuohsan- maru	16.0	117.9	070300	360/210	310/85	NW 3.5	SW 4	Heavy rain	995.5
Konstantin Petrovsky	16.5	115.8	070600	310/290	220/93	Very high	-	-	998.0
Alnwick- castle	19.9	118.1	070600	170/180	090/93	Very Rough	Heavy N	Torrential rain	993.5
Eden Bridge	19.9	117.3	071230	220/110	160/ Force 12	-	-	Squally	985
Eden Bridge	19.8	116.6	071500	250/145	130/ Force 12	-	Heavy	Continual heavy rain	992.1
Eden Bridge	19.6	117.5	081215	360/260	310/83	-	Heavy	-	999.8

Table 2.2

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		
NOAA 4		292346	11.1	128.3		
	4762	010040	11.6	128.2	3	994
	4774	012341	12.4	127.8	3.5	988
	4787	030036	13.4	126.7	4.5	973
	4799	032336	14.3	124.0	5.5	954
	4812	050031	15.9	121.2	6	942
	4825	060126	16.4	118.7	6.5	929
	4837	070026	17.6	117.9	7	915