Australian Government
Bureau of Meteorology

Tropical Cyclone *Kara*

23-30 March 2007

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A. Summary

A low moved off the West Kimberley coast and developed reaching cyclone intensity about 465 km north northwest of Port Hedland at 25/06UTC as it tracked to the west. The midget system then rapidly developed to category four intensity by 26/06UTC and recurved to the east southeast. It remained at that intensity for 24 hours before rapidly weakening to a low by 28/00UTC near the east Pilbara coast at 80 Mile Beach.

Although communities were placed on alert, there was no reported wind impact or damage on the coast. Offshore oil and gas facilities were evacuated and there was likely to be considerable economic impact due to lost production.

B. Meteorological Description

A low moved off the west Kimberley coast on the evening of the 23rd and developed. Although convection weakened during the 24th with some easterly shear evident, conditions improved on the 25th resulting in rapid intensification. Cyclone intensity was estimated at 25/06UTC about 465 km north northwest of Port Hedland. Curvature of the convection was better indicated on microwave (TRMM) than on IR or visible imagery. During the 24 and 25 movement was a steady westerly with the mid-level ridge to the south. The “best track” is shown in Figure 1 and the maximum wind shown in Figure 2. The best track positions and intensities are listed in Table 1.

With favourable low shear and good upper outflow *Kara’s* development pushed the upper limits of the Dvorak development rate. By 25/18UTC an eye emerged on microwave imagery and then on IR imagery at 25/2030UTC. The small scale of *Kara* enhanced the intensification rate, gales being estimated at extending just 60 nautical miles from the centre and the eye diameter being about 10 nautical miles. This period of development peaked at 26/06UTC when maximum winds were estimated at 100 knots (10 minute mean). At this stage the system recurved to the east southeast in response to an approaching mid-level trough and steered towards the east Pilbara coastline.

The eye weakened temporarily from 26/08UTC but then redeveloped from 26/21UTC peaking at about 27/03UTC when maximum winds were estimated at 105 knots. The radius of maximum winds was estimated at just 8 nautical miles and the radius of gales just 40 nautical miles. The small scale nature of *Kara* is shown by the Quickscat pass at 26/2255UTC in Figure 4, the visible image at and the microwave image at Microwave (SSMIS 91GHz) at 27/0033UTC in Figure 5 and Modis Visible (Terra) image at 27/0225UTC in Figure 6.

Kara's features then weakened dramatically on satellite imagery by strong wind shear from strong upper level winds associated with the mid-latitude trough. By 27/12UTC there was an absence of deep convection about the centre. Given the small size of the system and the rapid deterioration in the imagery the Dvorak weakening rate was broken with a reduction from 100 to 65 knots from 06 to 12UTC and then a further drop to 30 knots in the following 12 hours. It is estimated that the system fell below cyclone intensity by 28/00UTC although it is possible that there remained an area of southerly gales in the western quadrant only. The remnant low then took a northerly course and later a westerly track in response to lower level steering.

C. Impact

Although communities were placed on alert, *Kara* weakened before impacting the coast and there was no reported wind impact or damage. Offshore oil and gas facilities were evacuated and there was likely to be considerable economic impact due to lost production.

The heaviest rainfall fell over remote parts of the east Pilbara and no flooding was reported although local roads are likely to have been closed particularly following the previous rainfall events associated with cyclones *George* and *Jacob* earlier in the month.

D. Observations

Wind

There were no reports of gale force winds from coastal or island locations.

Rainfall

Kara caused high rainfall in parts of the eastern Pilbara. Rainfall totals in the 48 hours to 9am WST 28 March included 361mm at Pardoo Station (285mm on 27th), 249.4mm at Mandora (197mm on 28th), 244mm at Wallal Downs (to be confirmed) and 109mm at Telfer Airport. Rainfall totals tapered off dramatically further west, with 65.2mm being registered at Marble Bar and 35.2mm at Port Hedland in the same period. The weekly rainfall map to 9am 29 March (Figure 3) shows that rainfall exceeding 100mm was limited to an area from the west Kimberley south to a line from Port Hedland to Telfer.

E. Forecast Performance

The first indication that a potential cyclone may develop was provided on the daily Tropical Cyclone Outlook for Northwest Australia issued at 12:40pm WDT 24 March (24/0340UTC). A few hours later the first shipping warning and public advice (TC watch) for areas between Onslow and Cape Leveque were issued at 3:55pm WDT (24/1455UTC). At 2:45pm WST 25 March (25/1445UTC) *Kara* was named operationally and at 5:50pm WST (25/0950UTC) a warning was issued for areas

between Exmouth and Wallal with a Watch continuing from Wallal to Broome. As *Kara* began its sharp turn to the east southeast overnight on the 26/27th, the coastal threat zone shifted to the east eg 26/18UTC although the timing of the forecast movement was a little slower than the actual track. By 11:55am 27 March (27/0355UTC) the warning zone was between Roebourne and Bidyadanga contracting to Pardoo to Bidyadanga at 9pm WST (27/13UTC). At 8:45am WST 28 March (28/0045UTC the warning was finally cancelled.

It is very significant that a category 4 system was within 190 km (103nm) north northwest of Port Hedland and there was sufficient confidence in the forecast to not put Port Hedland and other major towns on yellow alert thus saving the communities and in particular industry in costly preparation measures. Only the sparsely populated region between Pardoo and Sandfire were placed on Yellow alert.

Despite the difficulty in getting accurate numerical weather guidance information the official forecasts were reasonably successful in providing the basic messages of:

1. The system will develop as it moves to the west southwest.

2. It is likely to recurve to the southeast.

3. The system should weaken prior to reaching the coast.

Aside from that there were inaccuracies in the details specifically not picking the rapid intensification to category four level and not getting the sharp recurvature to the east southeast accurately.

The early track forecasts eg 24/18UTC were quite accurate. As *Kara* developed and moved to the southwest it seemed a coastal impact was possible in the particularly sensitive region of Port Hedland where category five TC *George* had passed just weeks before. Although weakening was expected a cyclone impact remained a possibility at Port Hedland until 9pm 27 March (27/21UTC) when the warning zone contracted to Pardoo to Bidyadanga.

Table 1. Best track summary for *Kara,* 23-30 March 2007.

Year	Month	Day	Hour (UTC)	Position Latitude S	Position Longitude E	Position Accuracy nm	Max wind 10min knots	Max gust knots	Central Pressure hPa	Rad. of Gales nm	Rad. of storm force winds	Radius of Hurricane force winds	Radius Max. Wind (RMW)
2007	3	23	6	16.2	124.5	25	15	35	1005				
2007	3	23	12	16.0	123.9	35	20	45	1004				
2007	3	23	18	15.8	123.1	35	25	45	1002				
2007	3	24	0	16.0	121.7	25	25	45	1000				
2007	3	24	6	16.2	120.7	25	25	45	998				
2007	3	24	12	16.2	119.3	20	25	45	998				
2007	3	24	18	16.3	118.1	15	25	45	998				
2007	3	25	0	16.4	117.5	15	30	45	996				
2007	3	25	6	16.5	116.8	15	40	55	990	50			25
2007	3	25	12	16.6	116.1	20	50	70	982	60	15		25
2007	3	25	18	17.0	115.8	15	60	85	972	60	20		10
2007	3	26	0	17.6	115.4	10	80	115	952	70	25	15	10
2007	3	26	6	18.0	115.2	10	100	135	926	60	25	15	8
2007	3	26	12	18.3	115.5	15	90	125	940	60	25	15	10
2007	3	26	18	18.4	116.1	10	90	125	940	50	25	15	10
2007	3	26	21	18.4	116.3	10	95	135	934	45	25	15	8
2007	3	27	0	18.5	116.9	10	100	140	926	40	25	15	8
2007	3	27	3	18.6	117.4	10	105	150	920	40	25	15	8
2007	3	27	6	18.7	118.0	15	100	140	926	40	25	15	8
2007	3	27	9	18.8	118.7	20	80	115	952	40	25	15	8
2007	3	27	12	18.9	119.6	25	65	90	968	40	25	10	10
2007	3	27	18	19.4	120.3	25	50	70	982	30			10
2007	3	28	0	19.4	121.2	15	30	45	996				
2007	3	28	6	18.8	121.3	20	25	45	998				
2007	3	28	12	18.3	121.4	20	25	45	1000				
2007	3	28	18	18.0	121.5	20	25	45	1000				
2007	3	29	0	17.9	121.4	15	25	45	1000				
2007	3	29	6	17.9	121.3	10	25	45	1000				
2007	3	29	12	17.8	120.9	20	25	45	1000				
2007	3	29	18	17.6	120.5	20	25	45	1000				
2007	3	30	0	17.5	120.1	10	25	45	1000				

Table 2. Tropical Cyclone Advice summary for TC *Kara*.

Date/Time (UTC)	Action	Location
24/1455	TC Watch and Shipping warning issued.	Onslow to Cape Leveque
25/1445	Named *Kara*. Watch issued.	Onslow to Broome
25/1750	Warning issued. Watch continues	Exmouth to Wallal. Wallal to Broome.
27/0355	Warning continues. Watch cancelled.	Roebourne to Bidyadanga.
27/2100	Warning continues.	Pardoo to Bidyadanga
28/0045	Warning cancelled	

Table 3. Verification statistics: Track and Intensity.

Parameter	**0 hr**	**6 hr**	**12 hr**	**18 hr**	**24 hr**	**36 hr**	**48 hr**	**72 hr**
Count	16	15	14	15	16	14	12	10
Distance (km)	12	50	91	135	181	255	334	416
Mean Wind (knots)	9	10	12	12	15	19	21	6

Figure 1. Track of Tropical Cyclone *Kara*, 23-30 March 2007.

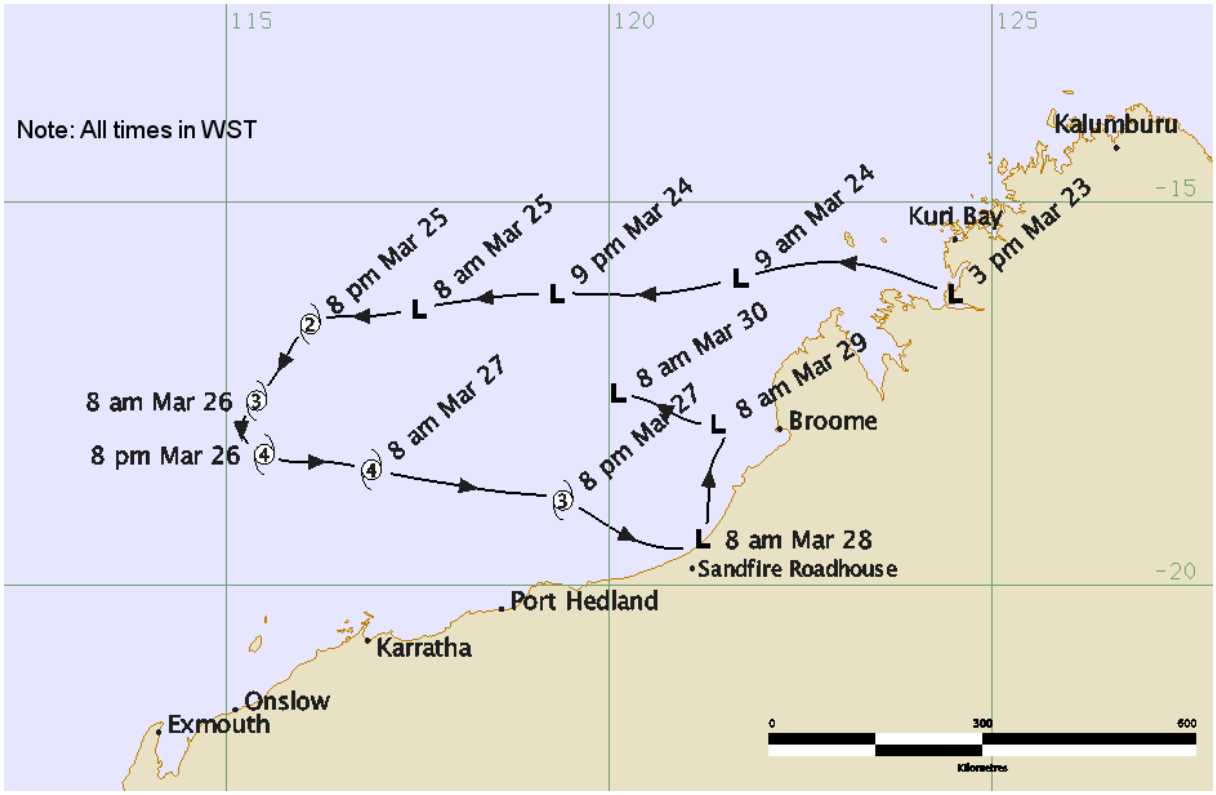

Figure 2. Best Track maximum mean winds (10 minute) for Tropical Cyclone *Kara*, 23 -30 March 2007.

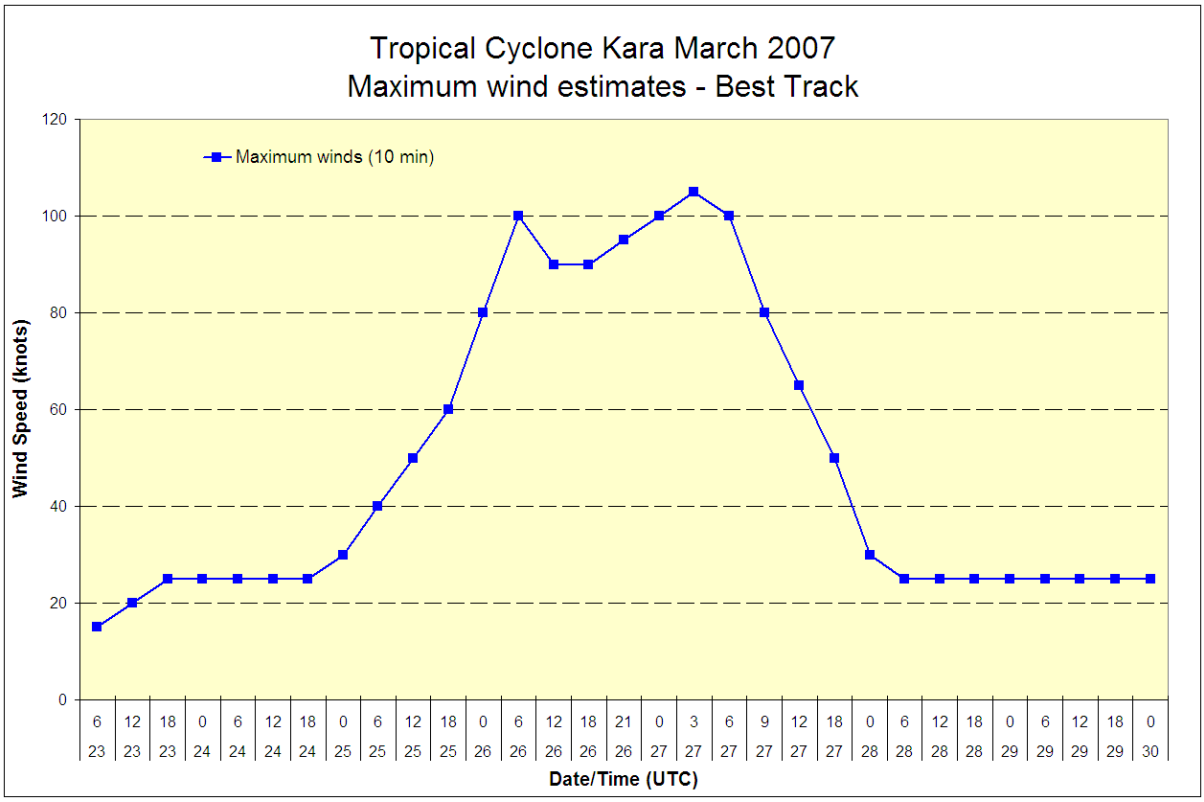

Figure 3. Weekly rainfall to 9am 29 March showing rainfall associated with *Kara*.

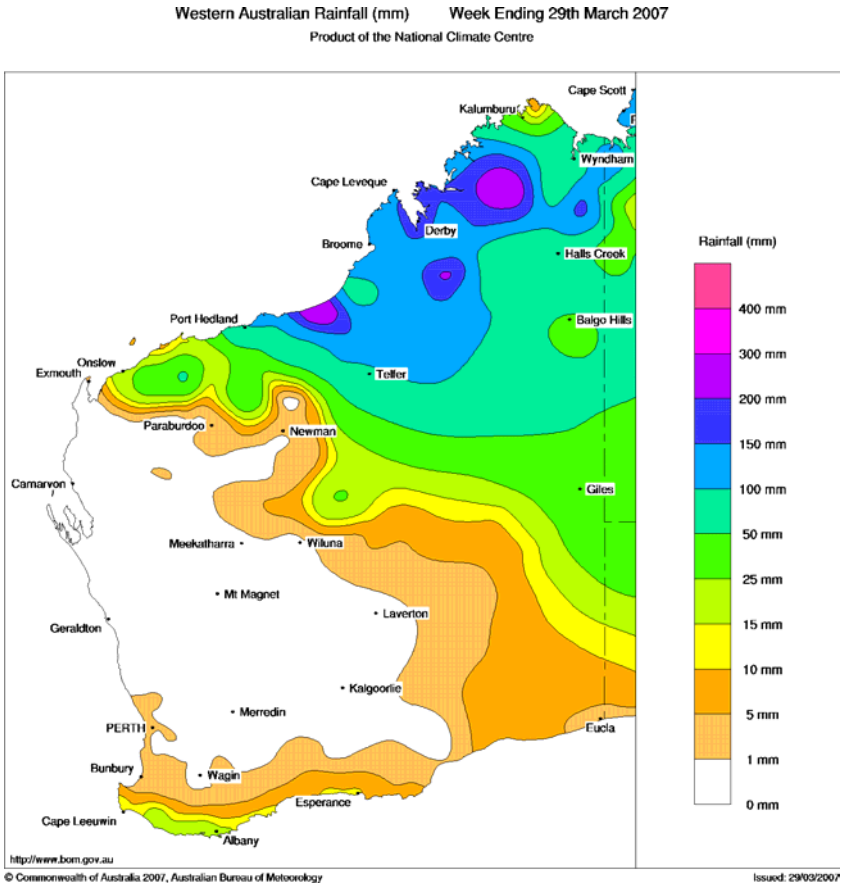

Figure 4. Quickscat at 22:55UTC 26 March 2007.
(image courtesy of RSS: http://www.ssmi.com/)

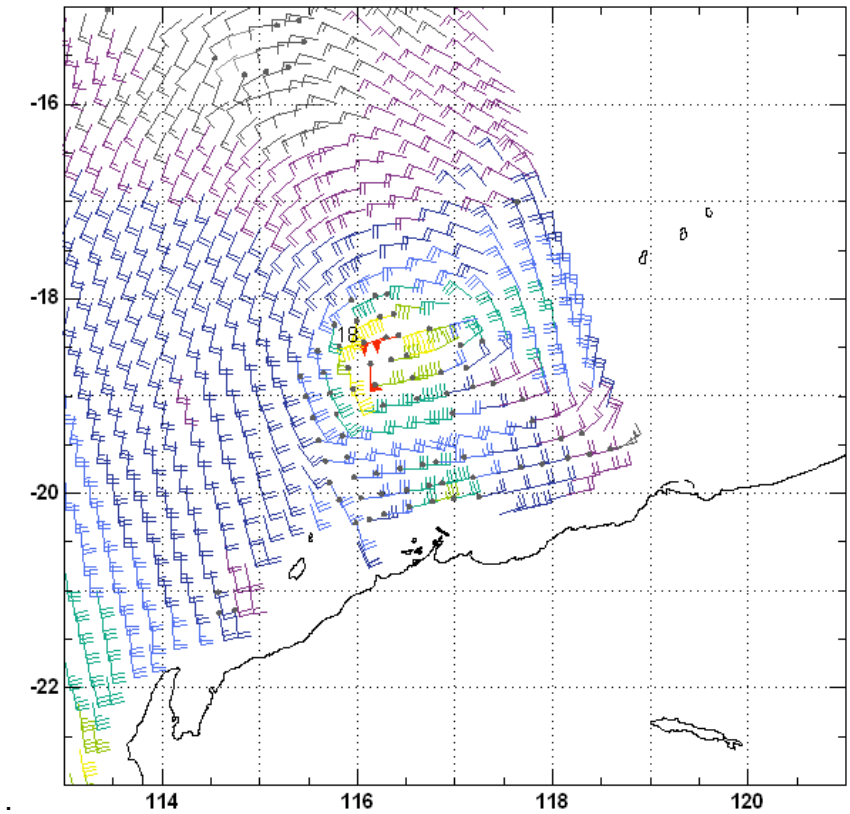

Figure 5. Microwave (SSMIS 91GHz) image at 27/0033UTC.
(image courtesy of US NRL: http://www.nrlmry.navy.mil/)

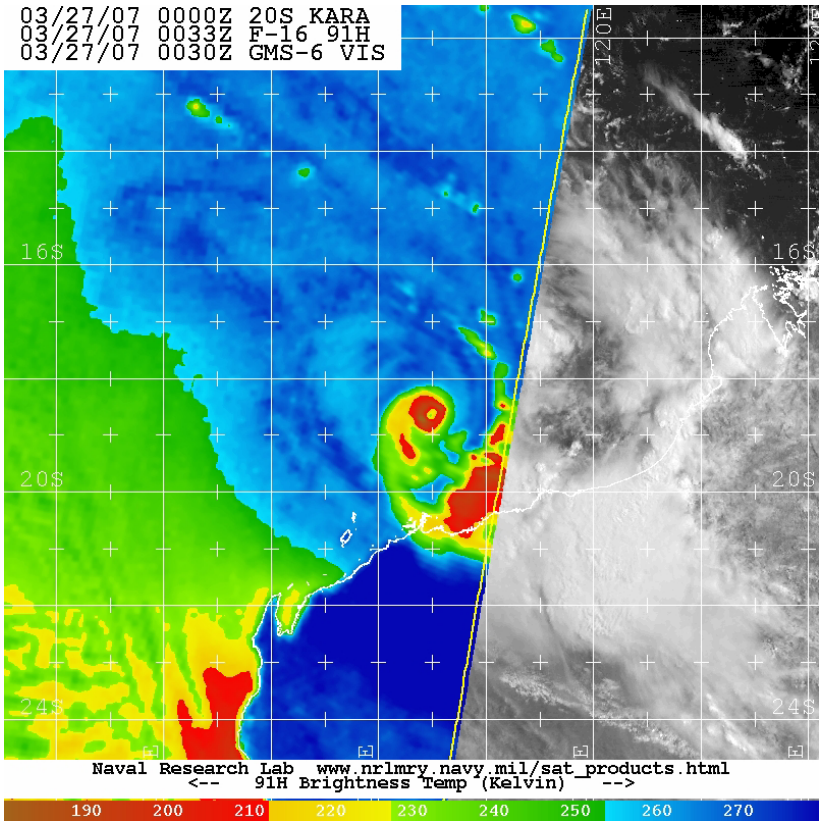

Figure 6. Modis (Terra) Visible image at 27/0225UTC.
(image courtesy of NASA)