

# FIJI METEOROLOGICAL SERVICE

## TROPICAL CYCLONE REPORT 96/8

### TROPICAL CYCLONE HINA

13 - 16 March 1997

**Issued by**

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#### INTRODUCTION

Tropical Cyclone Hina was the 10<sup>th</sup> cyclone to occur in Nadi Regional Specialized Meteorological Centre's (Nadi-RSMC) area of responsibility in the 1996/97 season. It was one of the few devastating cyclones to sweep through the southwest Pacific Ocean during this active season.

Hina was the first tropical cyclone to hit the Kingdom of Tonga this season and took less than two hours to inflict considerable damage on the islands. It caused an estimated damage of 18.2 million Tongan Pa'anga (USD15.2 million) to Tongatapu and 'Eua and was the worst cyclone to hit the Tongan group since Tropical Cyclone Isaac in 1982. Post-analysis revealed that Hina reached minimal hurricane intensity as it crossed Tongatapu. However, it is possible that some of the damage was due to secondary effects associated with the cyclone when it made landfall.

#### HISTORY

Hina began as a shallow depression which developed along the Monsoon Trough in the vicinity of Rotuma around 11<sup>th</sup> March. This was in a similar location to where Tropical Cyclone Gavin had formed and later ravaged through western parts of Fiji. The depression remained close to the north of Rotuma with no preferred movement and showing signs of only slow development for the first 48 hours. However, environmental conditions were conducive to further development and 24 hour pressure falls in the periphery of the system were observed to be as high as 9 hPa. Locating the centre was difficult due to lack of observations in the area and also due to poor organisation of the cloud structures as seen on the satellite imagery during early stages of development.

Around 0000 UTC<sup>1</sup> on the 13<sup>th</sup>, the system centre was re-located to within 60 nm<sup>2</sup> northwest of Rotuma and animated satellite imagery indicated that the depression was moving northward. In the next 12 hours, the depression moved north and later curved towards the east. It continued on an easterly track for about 12 hours before curving southeastwards to pass within 30 nm southwest of Niulakita, the southern-most island of Tuvalu.

Soon after passing close to Niulakita, the depression was officially named Tropical Cyclone "Hina" at 0000 UTC on 15<sup>th</sup> of March, almost 4 days after initial location.

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<sup>1</sup> UTC - Co-ordinated Universal Time (Same as Greenwich Mean Time)

<sup>2</sup> 1 nautical mile (nm) = 1.15 statutory mile = 1.85 kilometre

Shortly afterwards, Hina suddenly began accelerating and curved more south-southeastwards to pass close to the west of Futuna. Hina continued to accelerate towards the southeast and acquired a translational speed of about 25 knots when it passed over the islands of Tongatapu and 'Eua in southern Tonga around 0830 UTC on the 16<sup>th</sup>. Within the next 6 hours, Hina rapidly moved out of Nadi's area of responsibility.

## WARNINGS AND ADVISORIES

### (i) International Marine Warnings issued by Nadi

The first marine gale warning on the system was issued at 0300 UTC on 12<sup>th</sup> March indicating that winds may increase to 35 knots<sup>3</sup> within 100 nm of the depression centre in the next 24 to 36 hours. The next warning was issued at 0600 UTC and further warnings every 6 hours.

At 1200 UTC on the 12<sup>th</sup>, the gale warning was extended to cover 240 nm of the depression centre in the northern quadrant and winds were expected to increase to 35 knots in the remaining quadrants within the next 24 hours.

For the next 48 hours the gale warning on the depression was maintained, indicating winds up to 35 knots only in the northern quadrant. At 0000 UTC on the 15<sup>th</sup>, the depression was named Tropical Cyclone "Hina". The gale warning indicated sustained winds of 35 knots close to the centre, increasing to 45 knots in the next 12 to 24 hours.

The gale warning was upgraded to a storm warning at 1200 UTC on the 16<sup>th</sup>, indicating that Hina had winds up to 50 knots close to centre and possibly increasing to 55 knots in the next 12 hours. The next warning at 1800 UTC was the last warning issued by Nadi-RSMC on Hina before it moved into Wellington's area of responsibility.

### (ii) Tropical Disturbance Advisories issued by Nadi

Nadi issued Tropical Disturbance Advisories on the system every 12 hours from the time the initial tropical depression started forming at around 0600 UTC on 12<sup>th</sup> March until Hina moved well outside Nadi's area of responsibility at around 2000 UTC on the 16<sup>th</sup>.

A total of 10 Tropical Disturbance Advisories containing technical information on the cyclone were issued to other meteorological centres throughout the region and beyond.

### (iii) Special Weather Bulletins (SWB) issued by Nadi

#### (i) For Fiji

The first SWB was issued at 0330 UTC on the 12<sup>th</sup> for Rotuma, placing that island on Tropical Cyclone Alert. At this stage, the depression was located about 60 nm east-northeast of Rotuma and was almost stationary. The bulletin indicated that the system was intensifying and there was a possibility that it could develop into a tropical cyclone within the next 24 to 36 hours and may develop damaging gale force winds over Rotuma.

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<sup>3</sup> 1 knot = 1.85 kilometres per hour

The Alert was upgraded to a Gale Warning around 2330 UTC on the 12<sup>th</sup>, when the depression was re-located to within about 60 nm northwest of Rotuma. The depression was slowly intensifying and average wind speeds up to 35 knots with momentary gusts to 45 knots were forecast to affect Rotuma the next day.

The Gale Warning for Rotuma was maintained for more than 24 hours after which it became evident that the depression was moving away from Rotuma. Hence, the warning was downgraded to an Alert at 0330 UTC on the 14<sup>th</sup> and finally the Alert was cancelled at 0800 UTC on the same day.

#### (ii) For Tuvalu

Nadi issued the first SWB for Tuvalu at 0330 UTC on 12<sup>th</sup> March. The bulletin stated that a Tropical Cyclone Alert was in force for southern Tuvalu and that damaging gales may develop the next day over Funafuti, Nukulaelae, Niulakita and other nearby smaller islands.

Around 1200 UTC on the 12<sup>th</sup>, the Alert for southern Tuvalu was upgraded to a Gale Warning. At this stage, the depression was lying about 140 miles west-southwest of Niulakita and was almost stationary.

Due to the squally marginal gale force winds to the north of the Monsoon Trough, the Gale Warning for southern Tuvalu was extended to cover the whole group around 1200 UTC on the 13<sup>th</sup>.

The Gale Warning for the group was maintained for the next 48 hours. During this period, the islands experienced strong to gale force winds mainly due to an active convergence zone over them, while Hina moved eastwards and curved towards the southeast around 1200 UTC on the 14<sup>th</sup>, away from Niulakita. The warning for the group was cancelled at 1800 UTC on the 15<sup>th</sup> when the winds over the islands decreased below gale intensity.

#### (iii) For Wallis and Futuna

The first bulletin for Wallis and Futuna was issued at 2330 UTC on the 14<sup>th</sup> carrying a Gale Warning for the islands. At this stage, the system was still a depression but was expected to develop into a tropical cyclone before it moved close to the islands. Immediately following this, the system was named Tropical Cyclone Hina and was located about 120 nm northwest of Futuna. Average wind speeds up to 40 knots with gusts to 55 knots were forecast for Futuna and winds up to 35 knots with gusts to 50 knots for Wallis. The cyclone was moving southeast at about 12 knots and was expected to pass close to Futuna around 0900 UTC on the 15<sup>th</sup>.

The Gale Warning was maintained for the islands over the next 24 hours and cancelled around 2330 UTC on the 15<sup>th</sup>, when the cyclone was well to the south of the islands.

#### (iv) For Tonga

Nadi issued the first SWB for Tonga at 1945 UTC on the 15<sup>th</sup>, mentioning a Gale Warning for Vava'u, Ha'apai and Tongatapu groups. Average wind speeds of 40 knots with momentary gusts to 60 knots were forecast to affect Vavau, Ha'apai and Tongatapu in the evening. At this stage, Hina was 220 nm northwest of Vavau and was moving southeast at about 15 knots.

At 0000 UTC on the 16<sup>th</sup>, the forecast winds for the southern Tonga groups were increased to 45 knots with momentary gusts to 65 knots. SWBs were then issued at 3 hourly intervals for the southern Tonga groups indicating that Hina was expected to pass close to Tongatapu around 0900 UTC on the 16<sup>th</sup>. The last bulletin was issued at 1330 UTC on the 16<sup>th</sup> when the Gale Warning for the southern Tonga groups was downgraded to a strong wind warning.

A total of 14 SWBs were issued for Rotuma, 17 SWBs were issued for Tuvalu, 8 SWBs were issued for Wallis and Futuna, and 8 SWBs were issued for Tonga. Furthermore, RSMC-Nadi issued 21 international marine warnings and 10 Tropical Disturbance Advisories to other National and Regional Meteorological Centres throughout the Southwest Pacific and beyond.

## EFFECTS

Hina was the first cyclone to affect Tonga during the 1996/97 season, shortly after Tropical Cyclone Gavin ravaged through the western parts of Fiji. During its early stages of development, Hina passed within 30 nm southwest of Niulakita and later, after it was named, passed close to the west of Futuna. The survey reports for Tuvalu indicated that it was difficult to assess damage done by Hina alone because Tropical Cyclone Gavin had already affected the islands only a week earlier. Nevertheless, the reports mentioned that Hina did some damage to the remaining food crops on the southern islands of Tuvalu and also on the northern and eastern coasts of Futuna. Hina was also blamed for destroying parts of the road on the northern and eastern coasts of Futuna. There were no significant damage reported on Wallis.

The worst damage was reported on Tongatapu and 'Eua, the southern most islands of the Kingdom of Tonga. The anemograph trace from Fua'amotu airport on Tongatapu showed that Hina passed close to but just to the west of the airport around 0830 UTC on the 16<sup>th</sup>.

Major damages were reported on the eastern and central coast of Tongatapu and complete devastation on 'Eua island. Almost over 600 people were left homeless. Power lines and telecommunication systems were badly damaged, including heavy structural damages to the National stadium, government buildings, schools, etc. There were reports of extensive damage to agriculture and vegetation as well.

Moreover, other factors such as defective construction materials and practices probably contributed significantly to the damage.

Despite the seriousness of the damage, not one casualty was reported. A 65 year old sea captain died of heart attack while evacuating his house, but his death was not attributed directly to the cyclone.

Fortunately, the cyclone crossed Tongatapu shortly after the occurrence of the lowest tide for the day. There were reports of some villages on the northwestern part of the main island being flooded by sea water, but damage due to this was minimal.

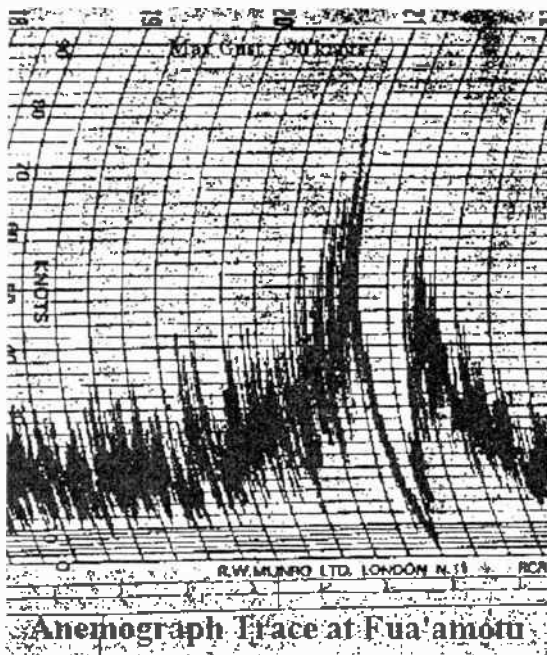
The estimated cost of the damage was reported to be around 18.2 million Tongan Pa'anga (approx. USD \$15.2 million).

Table 1 : Wind and Pressure data recorded on the island of Tongatapu during the passage of Tropical Cyclone Hina on 16<sup>th</sup> March, 1997.

Station	Mean Wind dir/spd(knots)	Date/Time (UTC)	Maximum Gust (knots)	Lowest Pressure (hPa)
Fua'amotu	360/58	16/0845	90	963.1
Nuku'alofa	070/50	16/0800	90	961.0*
Seaframe (AWS) (Nuku'alofa Wharf)	269/40	16/0800	88	972.1

\* suspect due to barogram being smudged by ink spill

Fig.1 : The Anemograph and Barogram trace at Fua'amotu Airport on Tongatapu during the passage of Tropical Cyclone "Hina" on 16th March, 1997.



## OPERATIONAL ASPECTS

Tropical Cyclone Hina was forecast to have estimated average wind speeds of 45 knots and momentary gusts to 65 knots close to the centre when making landfall at Tongatapu on 16<sup>th</sup> March. Post-analysis indicates that the intensity of the cyclone at this stage was underestimated. Hina was accelerating towards an area of increasing strong vertical wind shear which suggested that further intensification would be suppressed. The cloud structures on the satellite imagery showed that the cyclone was close to its maximum intensity. Moreover, guidance from other meteorological centres such as Guam and Honolulu were suggesting that the cyclone was of only moderate intensity. However, the guidance from Brisbane indicated that Hina had sustained winds of 60 knots close to its centre.

The analysis of damage reports and observed data suggests that the effect of the winds were much greater than those that would be expected from a cyclone of such intensity. The observed average wind data suggest that Hina had sustained winds of storm intensity but had peak gusts of those comparable to a minimal hurricane. Furthermore, the lowest pressure values recorded along the path of the cyclone also indicate that the winds would have to be stronger than those estimated for it to fit known pressure-wind relationships. From these results and observations it can be deduced that Hina was probably a marginal hurricane with average winds of about 65 knots when it crossed the island of Tongatapu in southern Tonga group around 0830 UTC on 16<sup>th</sup> March. Locals claim that there was a period of 15 to 20 minutes calm conditions before the winds returned from the other direction, but at a lesser strength. This suggests that Hina had an eye diameter of approximately 14 kilometres which was unfortunately not visible on the satellite imagery at the time. The locals further claim that the cyclone had spawned one or two tornadoes during its passage. A survey of the damage revealed that although there was a possibility of such a phenomenon to have occurred, no direct evidence was found.

The severity of the damage could also be attributed to the presence of jet streak(s) which are associated with landfalling and intensifying cyclones. Hina had persistent deep core convection and a translational speed of approximately 25 knots when it made landfall on Tongatapu. This enhanced core convection may have been responsible for transporting stronger winds (with gusts similar to the ones measured) to the surface. The increased low level inflow (convergence) on the left side of the cyclone may have also resulted in development of strong low level jets. This also explains the fact that the worst damage was confined to the area just east of the cyclone path.

Verification statistics for cyclone Hina are presented in Appendix 1.

Predicting the track of Hina was difficult especially during its early stages of development but once the cyclone was named, it moved in a straight southeastward track. Since the cyclone was subjected to northwesterly shear for most of its life, there was a lot of difficulty in locating the low level centre on the satellite imagery. Nevertheless, the initial positioning error was quite low and also the 12 hour error was average for the basin but no skill was achieved over persistence forecast. The 24 hour forecast error was larger, however some skill was achieved over persistence error.

## CONCLUSION

Hina was a relatively small cyclone which intensified as it accelerated southeastwards under the influence of strong upper level northwesterly flow. It had a consistent southeastward movement and forward speed (once it was named) and therefore was easily tracked by Nadi-RSMC. Even though the damage was extensive, it was fortunate in one respect that the cyclone's speed of movement was comparatively fast and high winds over the group were experienced only for a short period of time.

**VERIFICATION STATISTICS**

Position forecast verification statistics for Hina are shown in Table 1. For comparison, verification statistics are compared with forecasts based on a simplistic track movement over the previous 12 to 24 hours (known as persistence forecasts). The forecasts are generally perceived to be of some use or skill if they have smaller errors than persistence forecasts.

**Table 1. Verification statistics for Tropical Cyclone Hina**

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Forecast Period	Number of warnings	Forecast error (km)	Persistence error (km)
0hr	16	28	-
12hr	6	98	92
24hr	4	299	366

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# TRACK OF TROPICAL CYCLONE *HINA*

13 - 16<sup>th</sup> MARCH, 1997

