Cyclone Seroja at the Yarragadee Geodetic Observatory - Preparation and effect

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Abstract

On the 11th of April 2021 at approximately 1430 UT, Category 3, Tropical Cyclone Seroja passed directly over the Yarragadee Geodetic Observatory. Wind speeds in excess of 160km/h were measured but thankfully the cyclone passed through very quickly, meaning structural damage was limited mainly to non-geodetic infrastructure. Although a lot of superficial damage was caused and we were without communications for some time and commercial power for 11 days, the impact to operations was minimal, with our first SLR data obtained within 36 hours of the cyclone passing.
The Geoscience Australia survey team performed a minimized local tie survey as soon as possible post cyclone and the results are discussed in this poster.
Even though a nearby 13m satellite dish was damaged and wind speeds were very close to maximum load ratings, our 12m VLBI dish was mostly unaffected apart from needing a new pointing model, due mostly to movement in elevation.

1. Introduction

On the 11th April 2021, Cyclone Seroja crossed the Western Australian coast and, just below category 3 storm level, passed almost directly over the Geodetic Observatory at Yarragadee. Several hundred homes along the cyclone's path were destroyed or severely damaged. The worst of the damage occurred in the towns of Kalbarri where the cyclone made landfall, and Northampton, about 80km away, 22km inland from the coast. Luckily, although a lot of ancillary infrastructure at the Observatory was damaged, very little impact to geodetic operations occurred. In fact the SLR system was operational the next day.

This was partly due to good luck but also to good preparation.

2. Preparations

Thankfully, the WA Midwest community had three days warning of the predicted possible cyclone paths provided by the Australian Bureau of Meteorology's cyclone threat map, and preparations could be made. The predicted path was quite accurate even three days out and by 48 hours prior to expected landfall, were very close to the final track the cyclone actually took (see figure 1).

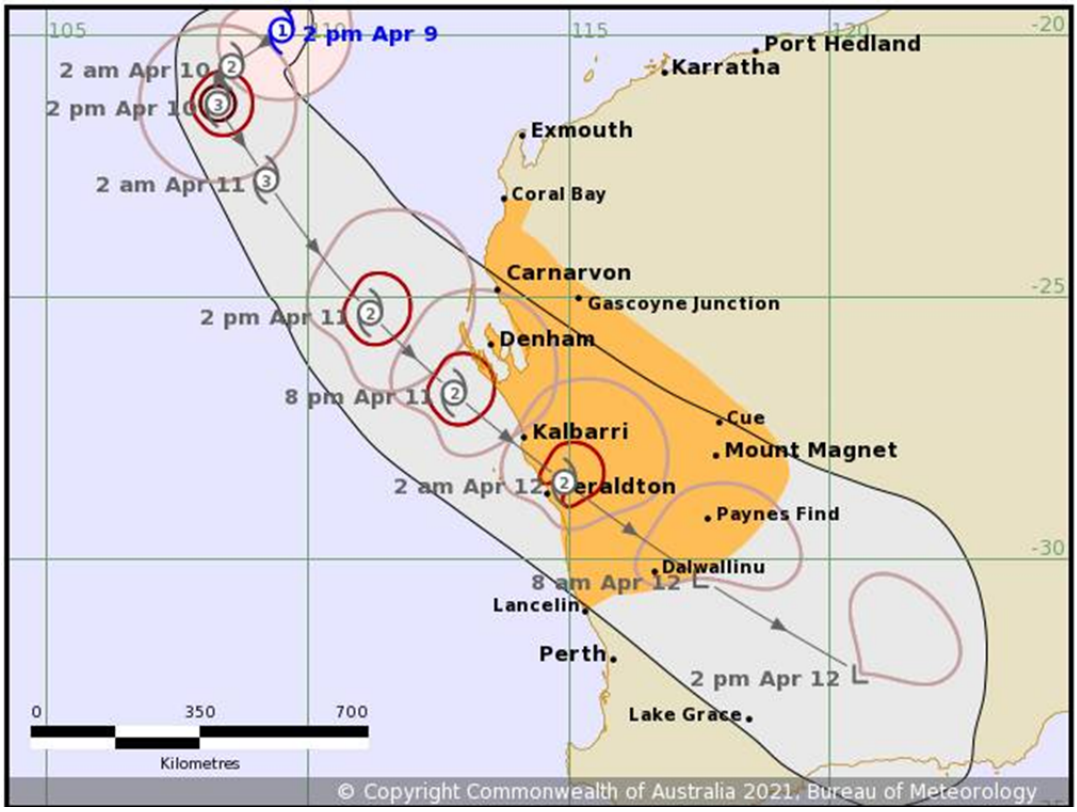

Figure 1. Cyclone Seroja threat map approx. 60 hours prior to expected landfall (credit: Australian Bureau of Meteorology)

At Yarragadee, we checked and tightened all tie down cables and replaced any defective or missing ones. Fortunately, we had concrete anchor points installed because of previous cyclones in the late 70's. The two NASA vans were well tethered in all directions except for the MOMS van to the east (see figure 2). As for the VLBI dish, it was decided we did not have time (an elevated work platform would be needed) to tie the 12m main reflector to its anchor footings. Since the dish was designed to withstand 168 kph winds in stow, untethered, and the cyclone was expected to weaken rapidly once it crossed the coast, we felt our preparations were sufficient.

The site was tidied and, with the sky darkening in the west and the wind steadily increasing, by 1300 local all staff evacuated the site to protect their homes.

Figure 2: Tie down cables secured (and new ones added), prior to impact.

Credit: R Carman

3. Impacts

At around 2100 local, the cyclone crossed the coast and power and most communications went down at all staff homes. At that time winds at Yarragadee were a steady 70kmh. The Observatory continued to be monitored by the VLBI operations team at the University of Tasmania. The two anemometers on-site recorded a maximum wind gust of 162kmh sometime between 2125 and 2147 (see figure 4). At that time the operations building lighting circuit was tripped, most likely when the verandahs and carport departed. The eye of the cyclone passed over YGO from 2200-2215 after which, the winds increased dramatically again – back to around 160kmh. Fortunately, the cyclone was travelling abnormally quickly and wind gusts over 140kmh were only felt for about 25 minutes in total, which significantly reduced the risk of really extensive damage.

4. The Damage

Access to YGO next morning was slow going, with many large trees having fallen across the road, especially as we got closer to the Observatory. The appearance of a lot of roofing sheets in the bushes and snapped power poles on approach didn't bode well. (See figure 5)

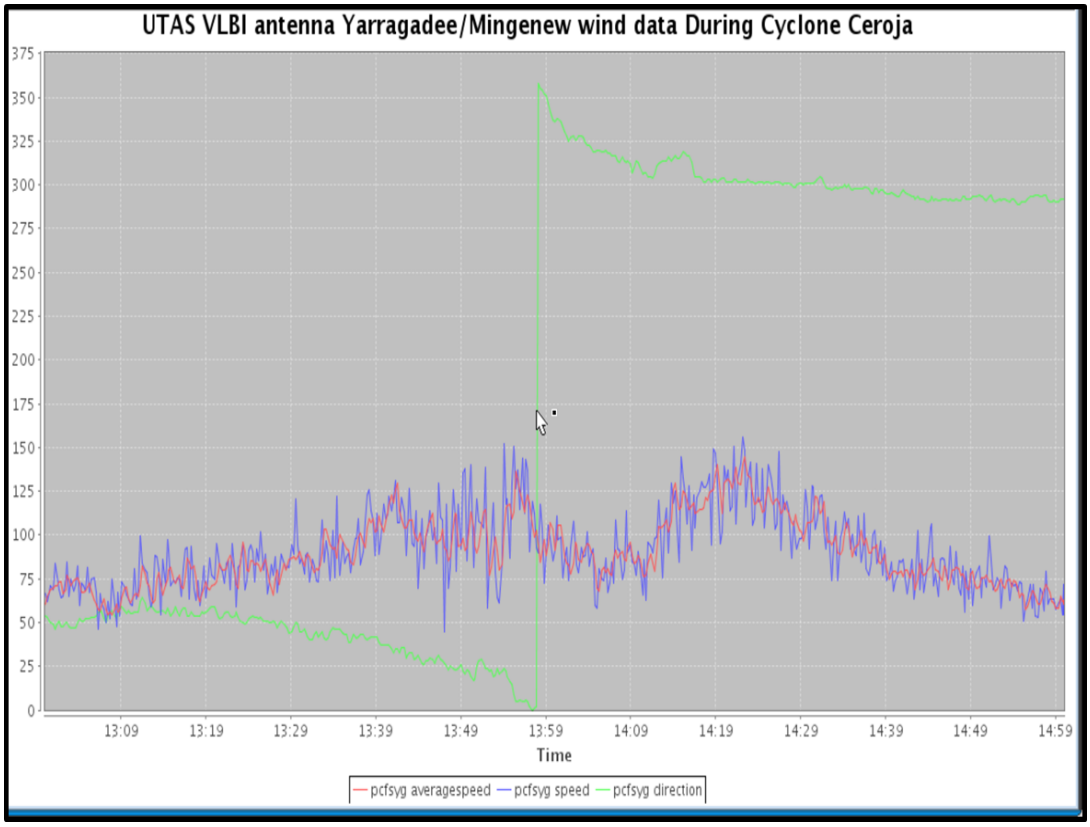

Figure 4: Wind speeds recorded on YGO anemometer during cyclone Seroja

Credit: Brett Reid UTAS

Infrastructure impacted:

- Mains power out for 11 days (backup generator ok)
- 3 bay carport destroyed (see figure 5)
- Operations building verandahs gone – causing water to enter maser room
- Two sheds lost some roofing
- Gravity hut and VLBI shed had damaged timber framed walls
- Communications tower (supporting anemometers) bent
- MOMS stairs, weighing about 400kg blown across compound (see figure 5)
- Perimeter fencing damaged
- MOMS van appeared to have moved slightly to the west

5. Effect on Geodetic Infrastructure

SLR tracking resumed within 36 hours of Cyclone Seroja passing through. There was a small (<0.008 degree) offset in az/el biases post cyclone, but this was removed with a quick pointing adjustment using mirror B. The MOMS van, or the telescope van floor, had moved about 10mm west relative to the 75cm telescope mount, judging by the mount wrap arm and the floor slot it used to go through. The floor plate slot needed enlarging for the arm to function.

Figure 5: Damage at YGO and nearby was extensive Credit R Carman and J Paff

VLBI operations resumed once a new pointing model had been determined and adopted (elevation had changed by 0.2 degrees) and solid communications had been restored – two 24hr experiments were missed.

The Geoscience Australia survey team performed a "mini" (VLBI not included) local tie survey two months post cyclone. Preliminary results confirmed that negligible movement of either the IVP or ground targets had occurred. See Figure 6.

Figure 6: The Geoscience Australia survey results comparing pre and post cyclone offsets between SLR IVP and GNSS YAR2 monument.

Year	de	Dn	du
2021	-22.1411	6.7049	3.2234
2010	-22.1418	6.7038	3.2265
Diff	0.0007	0.0011	-0.0031

Courtesy R. Ruddick Geoscience Australia (personal communication)

6. Conclusions and lessons learned

- YGO came through direct impact of a category 2 severe tropical cyclone relatively unscathed, but with most climate models showing the Midwest region of WA will experience an increasing number of cyclones in future, we need to be even better prepared.
- The van tethers seemed to work well but the MOMS van should ideally be anchored to the east as well – however this would involve digging a footing close to Don92
- Having the site unmanned during severe cyclone events was a good decision.
- All ancillary structures should be cyclone rated or well tethered too. We were very lucky none of the debris seriously damaged critical infrastructure : metal from the carport or verandah struck the rear panels of the 12m, fortunately side on to it.
- Repairs have been completed (see figure 7)

Figure 7: Repairs completed! Credit R Carman

With the upgrading several of the buildings and communications tower, to category 4 cyclone rating and improvements in the tie downs on the NASA vans, we feel we are better prepared for future cyclone impacts should they occur.

We are still waiting on final local tie survey results, which would show any instrumental movement caused by the cyclone, from Geoscience Australia. We will forward them to the ILRS community as soon as we receive them.