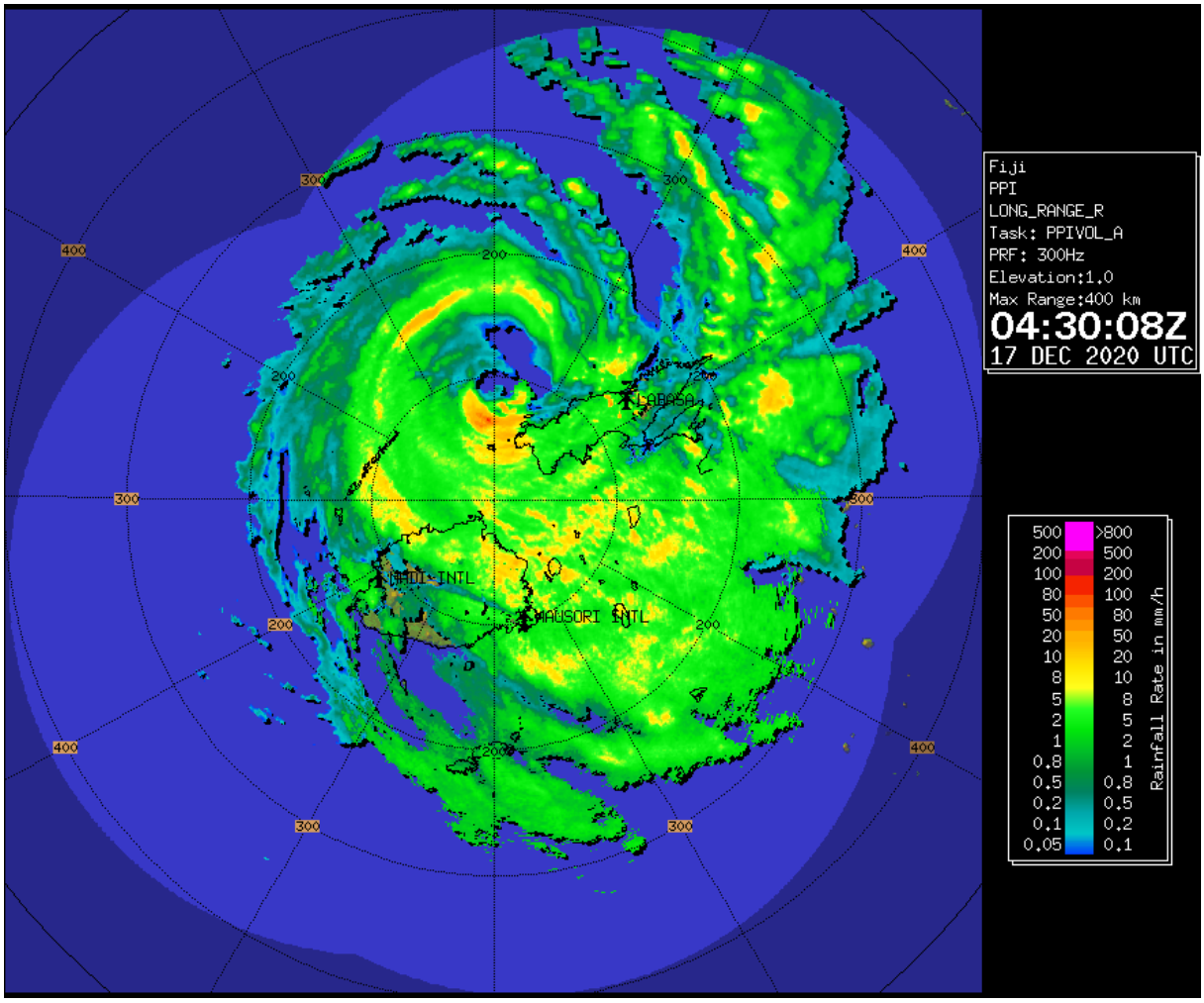
FIJI METEOROLOGICAL SERVICE

TROPICAL CYCLONE REPORT 2020/21

SEVERE TROPICAL CYCLONE YASA

10th – 20th December 2020



SEVERE TC YASA CENTER TRACKING TOWARDS LAND FALL OVER BUA PROVINCE, CAPTURED BY THE COMPOSITE OF THE THREE RADARS, TIME 04:30PM FST ON THE 17TH OF DECEMBER 2020.

Compiled by: Iosefo Cauravouvinaka

ACKNOWLEDGEMENT

I would like to thank everyone who contributed to the completion of this preliminary report. A special thank you to:

1. Mr Terry Atalifo, Acting Director of Meteorology for his continuous briefing with the relevant authorities and responding to media request during the passage of Yasa which tremendously eases the work of the tropical cyclone forecasters; but most importantly for giving the opportunity to compile and complete the TC Yasa summary and the preliminary report.

2. Senior Scientific Officers Forecasting, Mr Stephen Meke for his continuous support, guidance in sharing his expertise firstly in compiling TC Yasa Summary followed by the compilation of the preliminary report, especially in post event analysis, verification and providing discussion details of TC Yasa track and data.

3. Senior Scientific Officer Forecasting (Mr Stephen Meke, Mr Samisoni Waqavakatoga and Mr Sakeasi Rabitu) for the monitoring of tropical cyclone Yasa in the Nadi Area of Responsibility, analysing observed meteorological data during TC Yasa and issuing warnings accordingly.

4. NWFC scientific officers for assisting tropical cyclones forecasters in answering phone calls, analyzing the environment of TC Yasa and ensuring consecutive numbering in SIGMETS and warnings.

5. Senior System Analyst, Mr. Leonard Bale and the rest of the IT team for running the storm surge and wave model and ensuring this data are available to TC forecasters during the passage of TC Yasa.

6. Technical assistants serving in the outer stations for their continuous reporting of meteorological observation data during the passage of Yasa in Fiji.

7. NWFC Technical staff for collating observed meteorological data, making it readily available to tropical cyclone forecasters and answering phone calls from the public during the passage of TC Yasa.

8. Scientific officer climate, Rovil for assisting tropical cyclones forecasters in transforming TC Yasa track, rainfall and mean wind observed/recorded during the passage of Yasa into GIS application for briefings.

9. Technical Officers Climate for collating AWS data after TC Yasa and answering phone calls.

10. Mr Osea Tikonatabua, Technical Assistant Yasawa-i-rara Weather station for reports and pictures of damages caused by Yasa in Yasawa-i-rara.

11. Media Liaison Officer, Ana Sovaraki for the media and social media report.

For without their assistance this report would not be as comprehensive as it is.

TABLE OF CONTENT

1. INTRODUCTION

Yasa was the first tropical cyclone to form in the South Pacific and named by the Nadi Regional Specialised Meteorological Centre[1] (RSMC) for the 2020/21 season. Yasa reached category[2] 5 cyclone intensity with sustained winds estimated to be 125 knots and gusts to 175 knots while in RSMC Nadi's Area of Responsibility

Tropical cyclone Yasa, developed from an active trough just northwest of Rotuma as a tropical low pressure system. Yasa was monitored by the Nadi RSMC, through its life span in the Nadi Area of Responsibility (AOR) from its early development as tropical disturbance TD02F, through to a severe category 5 tropical cyclone, through its weakening stages up until it dissipated to the southern parts of Fiji.

Yasa had been generally slow moving over open waters between Vanuatu and the Fiji group for a little more than forty-eight hours before showing signs of an east-northeast wards track. Yasa than made an east-southeastwards track towards the Fiji group, made land fall over Vanua Levu (second largest island in Fiji), over the Lau group (eastern group islands of Fiji) then ultimately exiting and dissipating through the southern open waters of Fiji.

The system remained over open waters between Vanuatu and the Fiji group or about 484 kilometres(km) east-northeast of Vila as a category 1 cyclone from 1200UTC[3] to 2100UTC on December 13th. At around midday(0000UTC) on the 14th of December while drifting west-nortwestwards, Yasa intensified into a category 2 system while maintaining this intensity for the next twelve to fifteen hours. TC Yasa centre made a double anticlockwise loop in its track and continued with the second anti-clockwise loop from a southwestwards movement to an east-northeastwards movement then later intensifying into a severe tropical cyclone, category 3 at 1500UTC on December 14th. After nine hours Yasa rapidly intensified into a category 4 cyclone at 0000UTC on December 15th west-northwest of Viwa in the Fiji group. The system continued its general north-eastwards track while further intensifying to category 5 at 1200UTC on December 15th. Severe TC Yasa later made a southeastwards turn heading towards the Fiji group after 2100UTC on the same day till December 17th when making landfall over

1 RSMC Nadi's area of responsibility is between equator and 25S and between 160E and 120W.

2 The category system is based on the Australian Tropical Cyclone Category system. Category 1 cyclone has mean winds 34-47 knots, category 2 cyclone has mean winds 48-63 knots, category 3 cyclone has mean winds 64-85 knots, category 4 cyclone has mean winds 86-107 knots and category 5 cyclone has mean winds greater than 107 knots.

3 Universal Coordinated Time

Vanua Levu in the Fiji group then eventually weakening as it passed through the Lau group and dissipating early on the 20th. Severe TC Yasa wreaked havoc (widespread damages) over the Yasawa group, Vanua Levu, northern and eastern parts of Viti Levu and other islands in the Lomaiviti and Lau group along its path.

In the next section of this Tropical Cyclone Report on Yasa, a historical account is given of the development and movement of TC Yasa through the Southwest Pacific from the 10th to the 20th of December 2020. Details of all the warnings and advisories issued for Yasa are given in the following section with suggestion on the operational aspects encountered during the activation of the tropical cyclone forecasting bench. In the impacts section, a description of the damages caused by Yasa is provided. Following the impact section is a discussion on the verification result on the tracking and the forecast intensity of TC Yasa in RSMC Nadi AOR. An appendix section provides some extra information on TC Yasa, including verification statistics, best track map, best track details and analysis track,

observations during the passage of Yasa, microwave imagery, ascat pass and pictures of the damages caused by Yasa, and finally the media and social media report on the RSMC Nadi communication platforms. The recommendation section contains suggestions on how Fiji can enhance data collection and validation from high risk areas to initialise possible impacts on these communities. The conclusion section is a brief summary of the effects of Severe Tropical Cyclone Yasa and the performance of the warning system.

2. HISTORY

Tropical Cyclone Yasa had been initially monitored as a tropical low at 0000UTC on the 10th of December and in twenty-four hours it became the second numbered tropical disturbance, TD02F whilst twenty-four hours thereafter intensified further into a tropical depression. Tropical depression, TD02F was named Tropical Cyclone Yasa and became a category 1 cyclone around 1200UTC on the 13th of December while over open waters between Vanuatu and the Fiji group. Yasa was monitored by RSMC Nadi for about nine days before gradually weakening and eventually declassified within the border of the Nadi AOR.

On December 13th at around 1200UTC, TC Yasa intensified to a category 1 cyclone when it was primarily monitored for about 84 hours west of Rotuma from its incipient stage while moving in a general west-southwest track with its centre located over open water

between Vanuatu and Fiji (see Figure 1a). The infrared (IR) satellite imagery (Figure 1a) depicts spiral deep convective bands wrapping into a low level circulation centre (LLCC) that is partially obscured by deep convection.

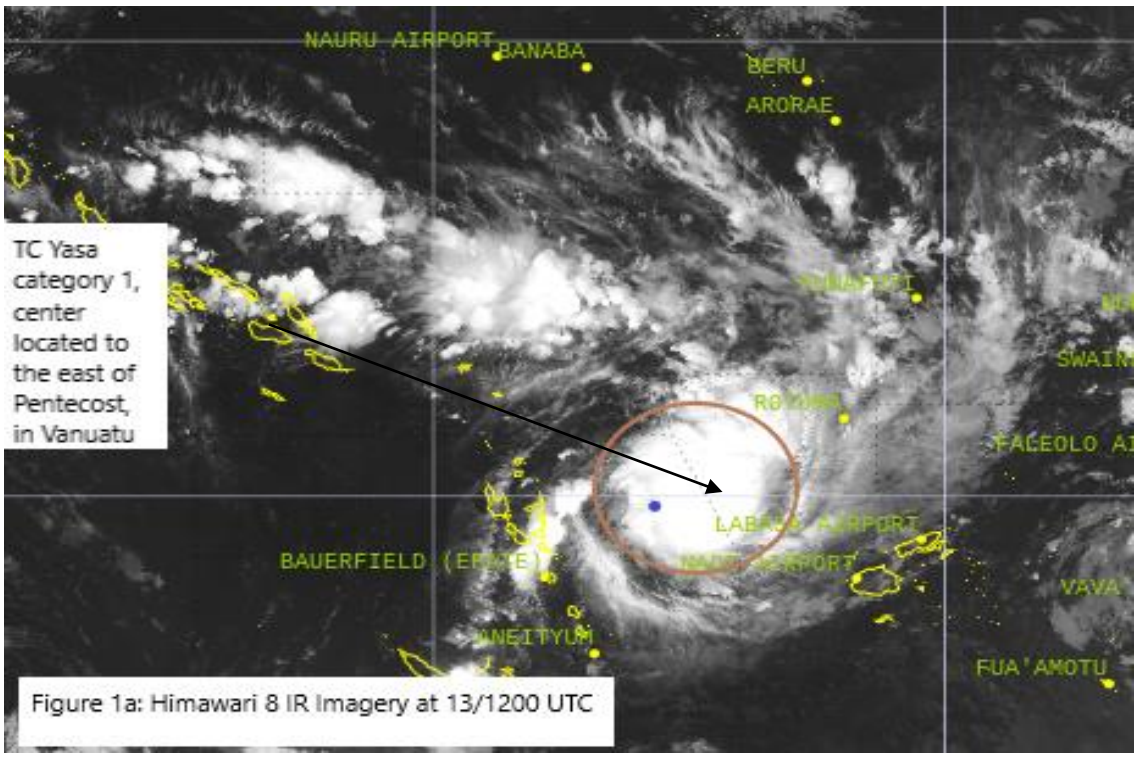
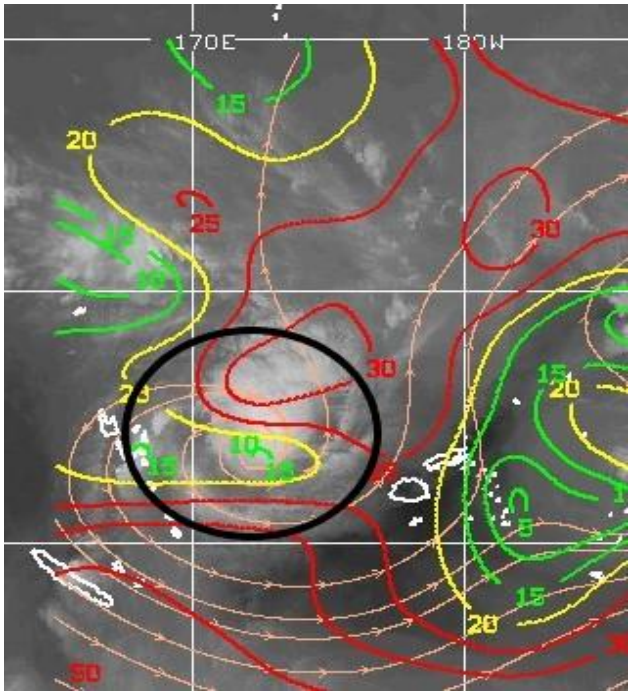


Figure 1a: Himawari 8 IR Imagery at 13/1200 UTC

Yasa had been generally breeding and slow moving over favourable ocean and atmospheric environment of warm (28-29 Celsius) sea surface temperatures (SST) between (see Appendix 2e) Vanuatu and Fiji for most of its lifetime enhancing the system to reach category 5 in close to 3 days. The movement and steering of Yasa had been initially controlled by the subtropical ridge to the south with a brief interaction with an approaching mid-latitude upper level trough (Figure 1e) causing the system to be situated mostly between Vanuatu and Fiji, then later dominated by the near equatorial ridge to the north pushing the system east-southeastwards.

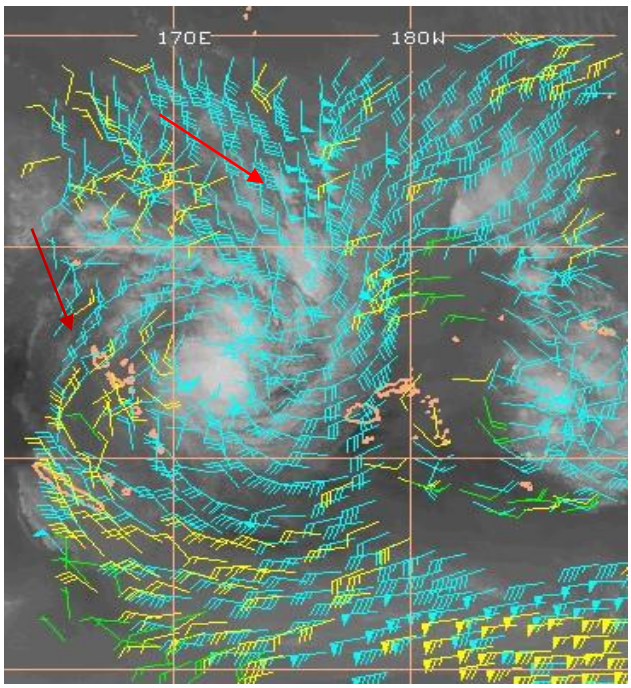
Additionally, figures 1b-d shows that TC Yasa has also been situated over low to moderate (10-15 kts) vertical wind shear and well established poleward and equatorward flow with good upper level divergence aloft.

Figure 1b: CIMMS wind shear(kts) at 13/1200UTC



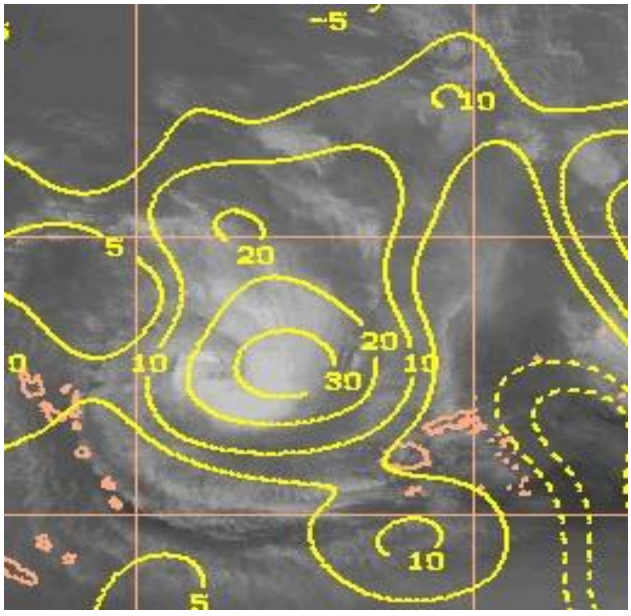
TC Yasa under moderate to high (10-15knots) shear environment. The system developed further and shifted the high shear(red line) environment away from it.

Figure 1c: CIMMS Mid-Upper level winds at 14/0000UTC



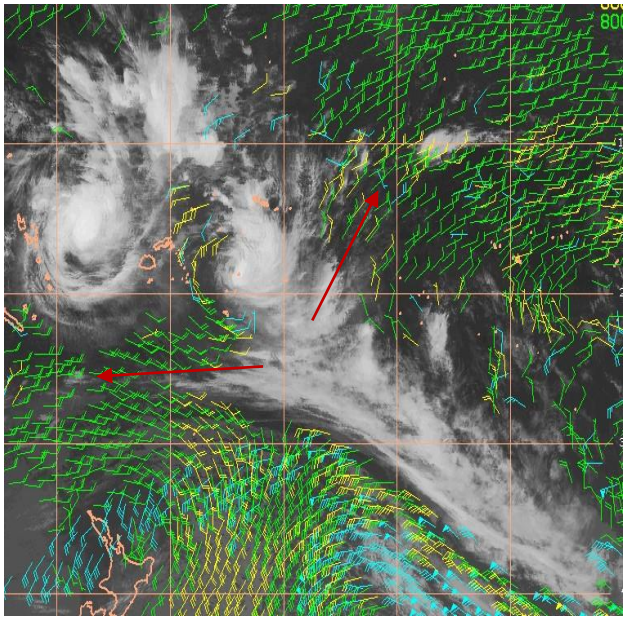
TC displaying good poleward and equatorward outflow

Figure 1d: CIMMS Upper level winds at 15/0000UTC



Upper level divergence of about 20 to 30 knots over the system, aiding in further development of TC Yasa.

Figure 1e: CIMMS Mid-Lower level winds (steering) at 14/1200UTC



TC Yasa being controlled (steered) initially by the subtropical ridge to the north of NZ and later by the near equatorial ridge entering from the

northeast of the system.

Early on the 14th of December while slowly drifting west-northwestwards at about 16km/hr, Yasa was upgraded to a category 2 system with estimated sustained winds of 95 km/hr close to its centre. Yasa made its anticlockwise loop due to the interaction between the steering subtropical ridge and an incoming mid-latitude trough (Figure 1e) from the west that resulted in this complex steering environment on Yasa from a southwest movement then a sudden east-northeast track from 1200UTC.

TC Yasa, once made the second anticlockwise loop intensified into a severe category 3 tropical cyclone at 1500UTC on December 14th as it started moving in an east-northeastwards track of about 16km/hr into a more favourable environment, thus TC Yasa rapidly intensified further to a category 4 cyclone at 0000UTC on December 15th about 511 kilometres west-northwest of Viwa in the Fiji group.

Severe TC Yasa further intensified and was upgraded to category 5 at 1200UTC on December 15th and several hours later eventually made an east-southeastwards turn towards the Fiji group with an average speed of 18 km/hr after 2100UTC on the same day till December 17th. At around 0600UTC on the 17th, Severe TC Yasa centre made landfall over Vanua Levu, over the Bua province, in the Fiji group with estimated sustained wind speed of up to 215 km/hr with momentary gust of 295 km/hr. Severe TC Yasa centre drifted northeastwards while over Vanua Levu encroaching over Cakaudrove and the Macuata province. The system centre eventually exited Vanua Levu through the Cakaudrove province and into the northern Lau group waters 3 hours after making land fall. Severe TC Yasa thereafter gradually weakened, where it was a category 3 cyclone as it drifted over Lau waters, just to the east of Lakeba on the 18th, and later as a category 2 to the east of Ono-I-Lau early on the 19th and as a category 1 later on the 19th to the south of Ono-I-Lau. TC Yasa

eventually was declassified as a former tropical cyclone to the south of Ono-I-Lau later on the 20th of December or early on the 21st (Fiji Standard Time) when it had lost all its tropical cyclone characteristics and re-named former TC Yasa.

Severe Tropical cyclone Yasa rapidly developed from a category 2 to a category 5 in less than 48 hours from 14/0000UTC to 15/1800UTC. Figure 1f to 1i below shows the Himawari satellite imagery on the development of Yasa.

Figure 1f: Himawari- IR imagery at 14/1200UTC with Yasa, category 2

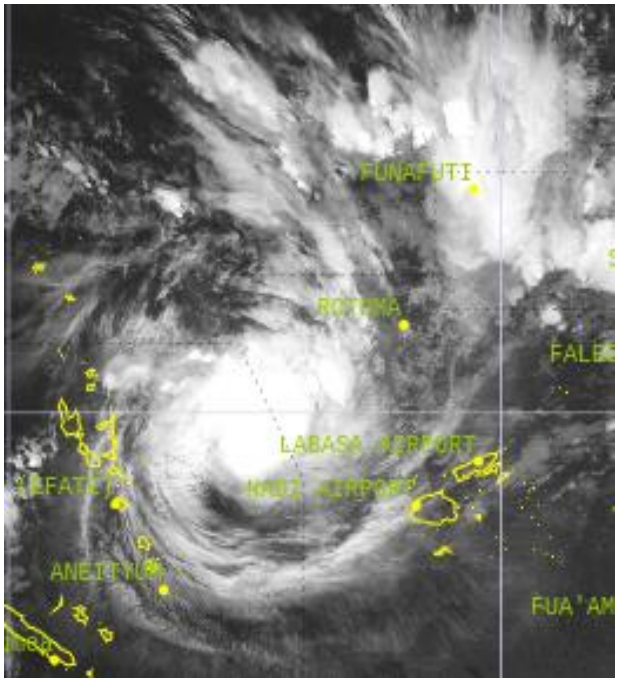


Figure 1g: Himawari- IR imagery at 14/1800UTC with Yasa, category 3

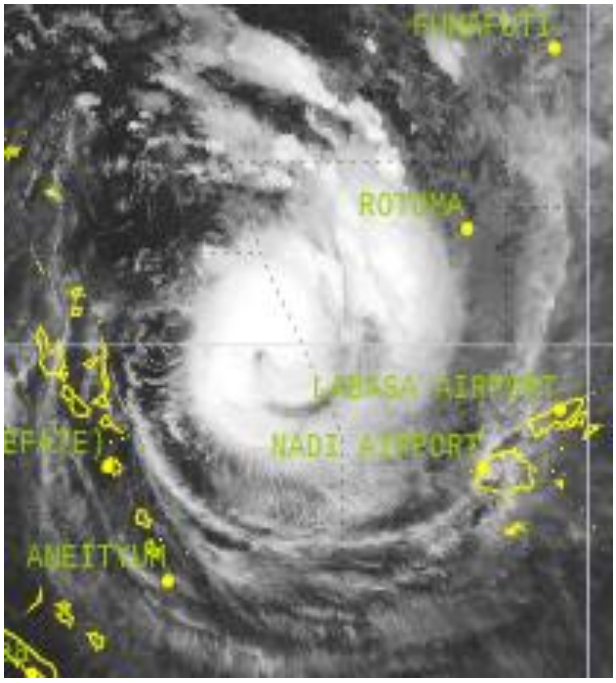


Figure 1h: Himawari- Vis imagery at 15/0000UTC with Yasa, category 4

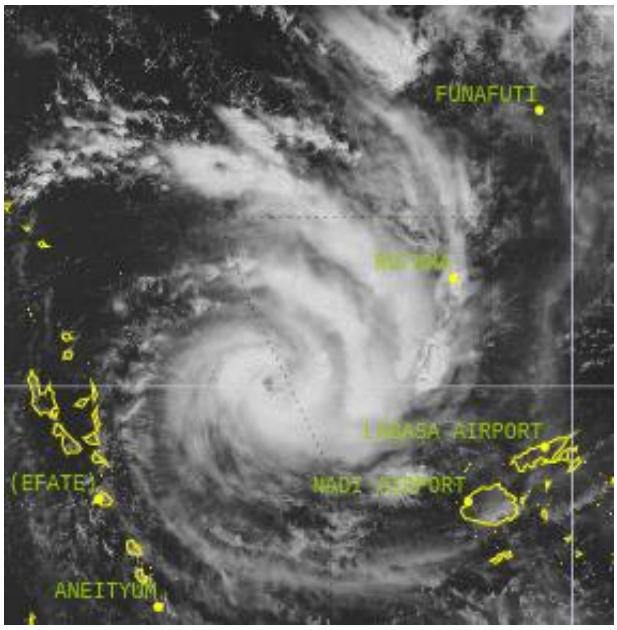
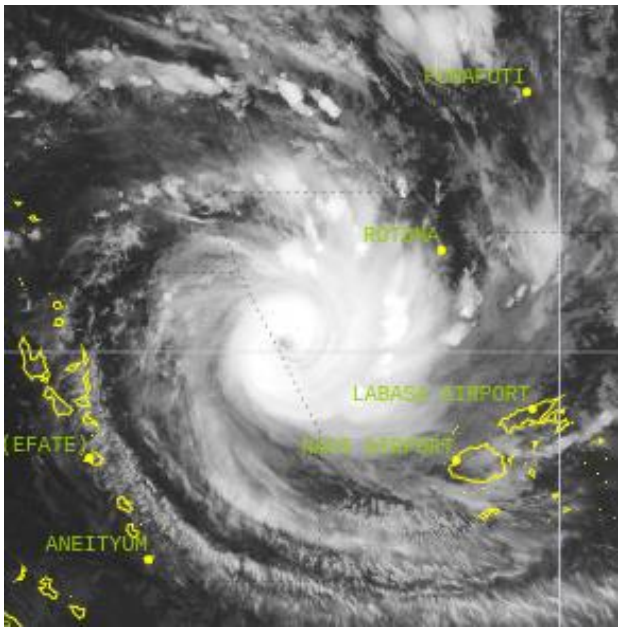


Figure 1i: Himawari- IR imagery at 15/1800UTC with Yasa, category 5



Severe TC Yasa developed a well-defined eye with diameter of about 20km (Figure 2a,2c) while still located at about 474 km northwest of Viwa. Subsequently, after 6 hours at 2100UTC on December 15th, Yasa was now moving along the periphery of the near equatorial ridge located to the northeast of the system.

The system entered into the Fiji waters at 0000UTC on December 16th while reaching peak intensity for 6 hours from 1800UTC (Figure 2b) with centre located north-northwest of Yasawa-i-rara and closing over the group with estimated sustained winds of 250km/hr with momentary gusts to 350km/hr.

Figure 2a: Himawari- IR imagery at 15/1530UTC with Yasa, category 5

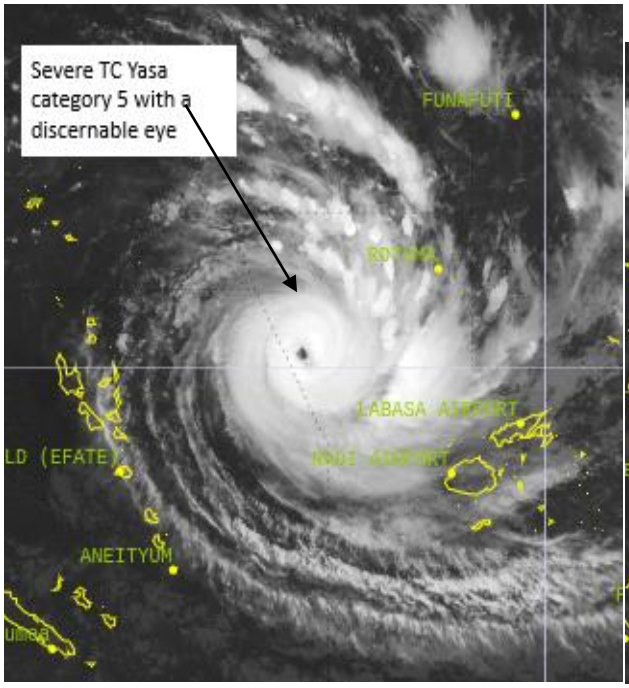


Figure 2b: Himawari- IR imagery at 16/1800UTC with Severe TC Yasa cat 5, at peak intensity within Fiji waters

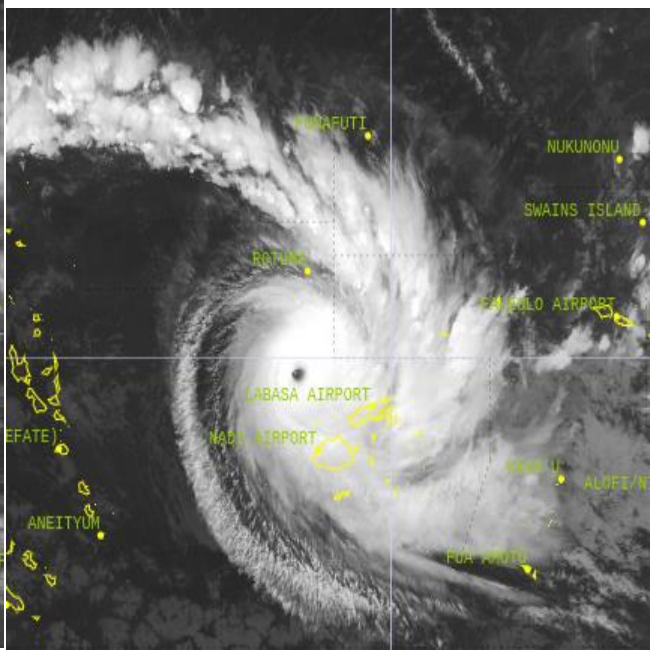


Figure 2c: Himawari- IR imagery at 15/1800UTC with Yasa, category 5.

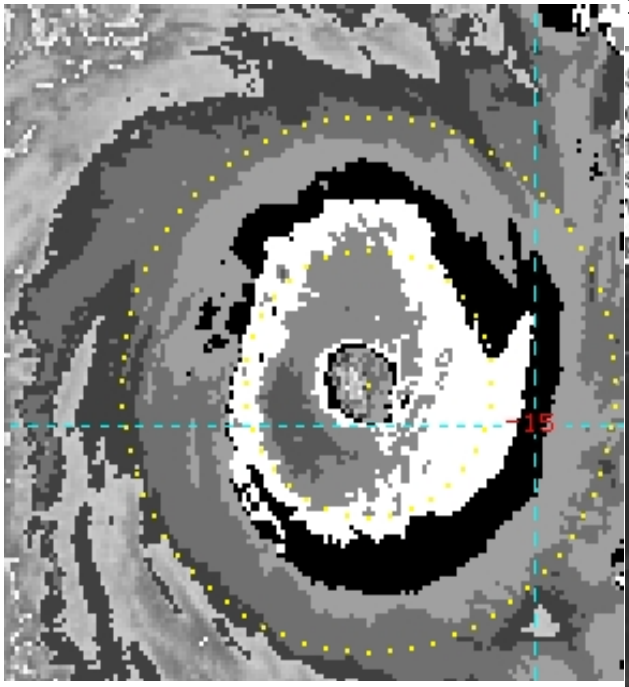
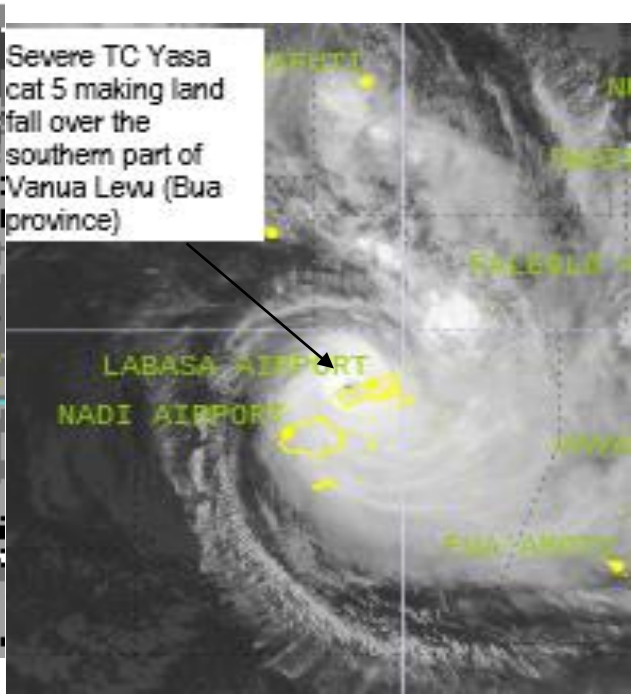


Figure 2d: Severe TC Yasa, Eye making land fall over the southern parts of Vanua Levu at 17/0600UTC.



In addition, on the 17th of December (161800UTC), the group of islands in the Yasawas, began experiencing destructive storm4 force winds as the centre of severe TC Yasa passed to the north of Yasawa-i-rara. Severe TC Yasa remained as a category 5 cyclone when it continued heading towards the southern parts of Vanua Levu. The system centre later made landfall at about 0600UTC on December 17th over the western coast of Bua province (see Figures 2d and 3d) and travelled east-southeastwards over land areas for about 3 hours towards Cakaudrove then over the southern parts of Taveuni late in the evening maintaining its category 5 strength. Yasa had wide spread damages over most parts of Vanua Levu with destructive to very destructive experienced for 8 hours or even more for certain areas. Ultimately, destructive storm to very destructive hurricane force winds upto 215 km/hr with momentary gusts up to 295 km/hr was estimated over Vanua Levu, Taveuni and nearby smaller islands, Koro and the Lau group with heavy to torrential rain over the whole of Fiji (Figure 3a-3d: Radar imagery when Yasa was in Fiji's Radar range).

Storm surges and damaging heavy swells were experienced over Yasawa-i-rara with massive surges of about 3 to 4 meters estimated to be experienced during high tides over smaller islands near Vanua Levu, coastal villages of Vanua Levu, Taveuni and parts of Lomaiviti and Lau group as the centre passed over or nearby these places.

The northern parts of Viti Levu and the rest of Lomaiviti group experienced damaging gale to destructive storm force winds estimated to be up to 110km/hr with gusts to 155km/hr and the rest of the Fiji group experienced strong to damaging gale force winds up to 85 km/hr with momentary gusts up to 120km/hr.

4 Gale force winds: 10-minute average winds between 34 to 47 knots. Storm force winds: 10-minute average winds between 48-63 knots. Hurricane force winds: 10-minute average winds more than 63 knots.

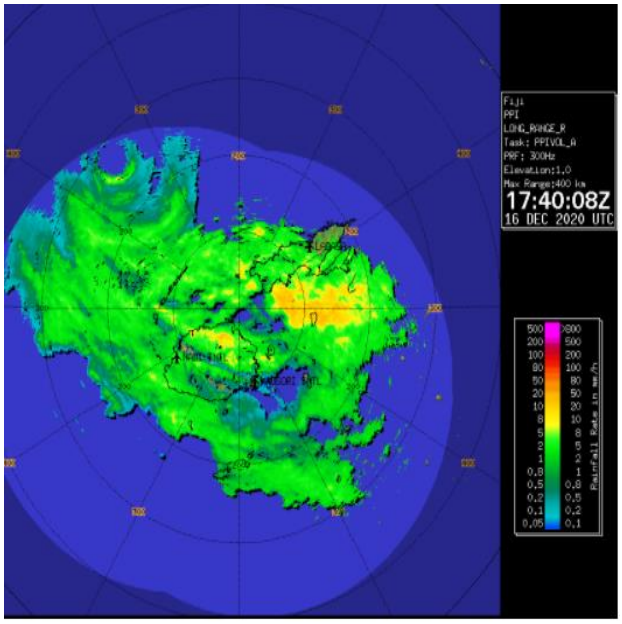


Figure 3a: Center of severe TC Yasa approaching from the northwest of Fiji and in the radar range. Time is 1740UTC of December or 0550am on the 17th Fiji Standard Time(FST)

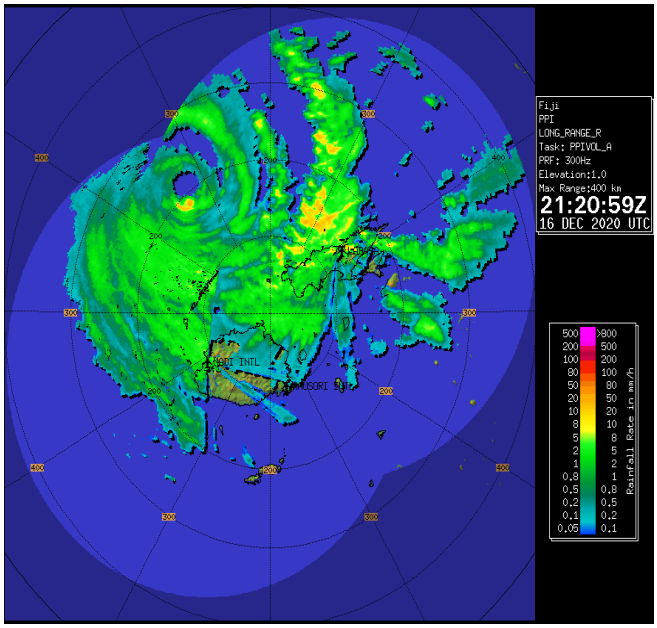


Figure 3b: Center of severe TC Yasa, category 5, just north-northwest of Yasawa-i-rara. Time is 2120UTC on the 16th or 0920am (FST).

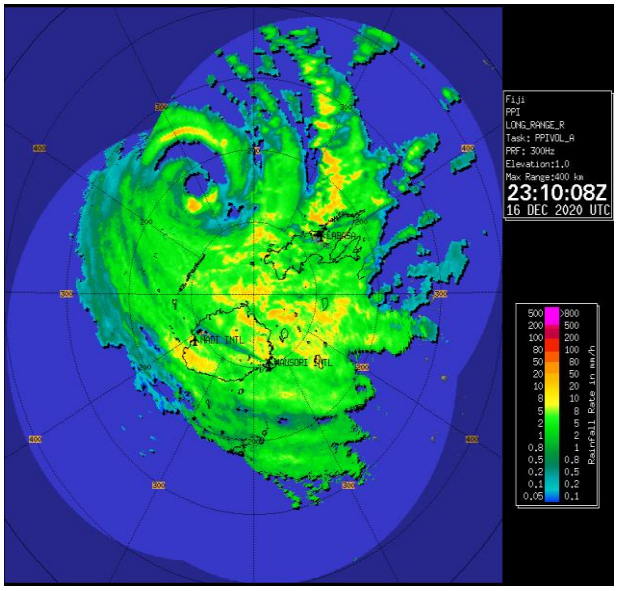


Figure 3c: Center of severe TC Yasa, category 5, just north of Yasawa-i-rara or northwest of Bua. Time is 2310UTC on the 16th or 1110am (FST).

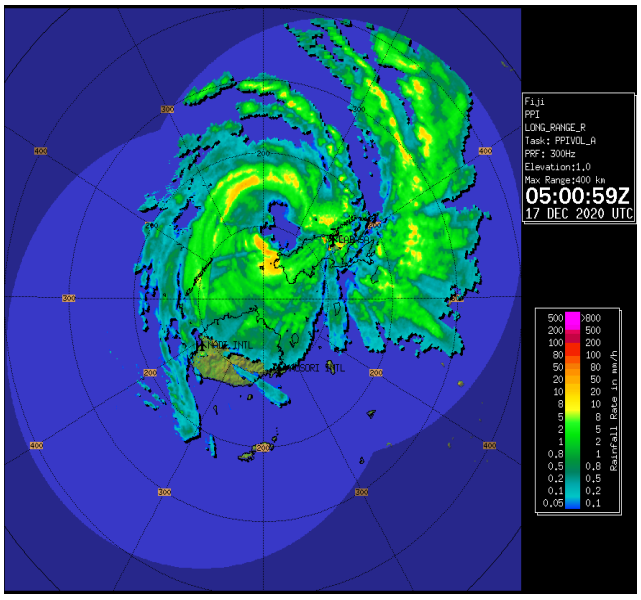


Figure 3d: Center of severe TC Yasa, category 5, making land fall over the western coast of Bua. Time is 0500UTC on the 17th or 0500pm (FST).

The northeastern eyewall is closing on and sweeping over Vanua Levu and nearby smaller islands. Torrential and heavy rain affecting the whole of Fiji.

Most of Vanua Levu, Taveuni and nearby smaller islands, eastern Viti Levu and Lomaiviti group experiencing very destructive hurricane force winds and heavy rain.

Severe TC Yasa remained a category 5 system till 0900UTC on the same day it created havoc over Vanua Levu and nearby smaller islands. The land interaction couple with cooler SST, high sheared environment and unfavorable conditions to the south of the group had an immediate effect on weakening the system while the re-emergence of the subtropical ridge

from the south and east influencing Yasa to track in a more southwestwards movement early on 19th December (181500UTC). Eventually, Yasa dissipated after 1800UTC on the next day while estimated to be about 200 km west-southwest of Fua'amotu.

3. WARNINGS AND ADVISORIES

1. International Marine Warnings

Although several gale warnings were issued because of the presence of TC Yasa, the first international marine warning associated with Yasa was a gale warning issued by RSMC, Nadi at 110110UTC. Clockwise winds up to 35 knots were expected to develop in the next 12 to 24 hours in sectors from northwest through east to southeast from 60 to 150 nautical miles of disturbance (TD02F) centre.

The subsequent storm warning (first WTPS) was issued at 121800UTC estimating maximum sustained winds up to 40 knots close to the centre within 60 to 150 nautical miles of centre in sectors from northwest through east to southeast with winds increasing to 50 knots in the next 18 to 24 hours.

The following hurricane warning (first WHPS) was issued at 140729UTC estimating maximum sustained winds of 55 knots close to the centre and increasing to 65 knots in 24 hours. Hurricane force winds were expected near the centre within the next 24 hours and storm force winds expected within 60 nautical miles of southeast quadrant, 50 nautical miles within the southwest quadrant, 40 nautical miles in the northwest. Gale force winds were expected within 160 nautical miles in the northeaster quadrant, within 160 nautical miles in the southeast quadrant and 100 nautical miles in the southwest quadrant and 100 nautical miles in the northwest quadrant.

The last WHPS was issued at 180717UTC with sustained winds of 65 knots close to the centre decreasing to 60 knots by 181200UTC.

The last international marine warning for Severe Tropical Cyclone Yasa was issued at 200726UTC. Thus, RSMC Nadi issued a total of thirty-nine international marine warnings during the passage of TC Yasa.

2. Tropical Disturbance Advisories (TDA)

RSMC, Nadi issued the first Tropical Disturbance Advisory B1 for TC Yasa at 120214UTC. The next TDA was issued at 120753UTC. Subsequent advisories were issued at approximately 6-hour intervals containing information on Tropical Cyclone Yasa's position, movement, intensity, wind distribution and organizational characteristics with the expected changes every 12 hours out to 48 hours. RSMC, Nadi issued twenty-nine Tropical Disturbance Advisories in total, with the last TDA being issued at 191800UTC.

3. CREX

RSMC, Nadi issued twenty-six CREX messages (specially coded information) on Cyclone Yasa to major Global Numerical Weather Prediction Centres.

4. Aviation Weather Advisories and Warnings

RSMC, Nadi issued twenty-six Tropical Cyclone Advisories (TCA) on Yasa. These bulletins were solely for the purpose of international air navigation in Fiji's Tropical Cyclone Advisory area of responsibility.

5. Special Weather Bulletin

RSMC, Nadi issued thirty Special Weather Bulletins (SWB) on TC Yasa. Particularly, alert was issued after every 6 hours and warning every 3 hours.

6. Sigmets

RSMC, Nadi issued twenty-three Sigmets on TC Yasa.

7. The storm surge model

The storm surge was run every 6 hours with result usually available at 0230UTC, 0830UTC, 1430UTC and 2030UTC or earlier.

8. OPERATIONAL ASPECTS

The tracking and forecasting of cyclone Yasa were handled satisfactorily by RSMC, Nadi even with another tropical cyclone (TC Zazu) in the region. The first Tropical Disturbance Advisory on TC Yasa was issued at 120214UTC. The use of satellite data and surface observations were major components in locating the position and movement of TC Yasa. Likewise, other centres were providing fixes and movement as well. The majority of the tropical cyclone forecasts and warnings were prepared in TC Module. The usage of TC Module on preparing cyclone forecasts and warnings allowed considerable time saving and minimal constrains.

9. IMPACTS

Severe Tropical Cyclone Yasa made landfall over Bua province in Vanua Levu as category 5, around 0600UTC on December 17th and exiting through the southern parts of Taveuni after 1712000UTC and moving towards the Lomaiviti and northern Lau group. The maximum winds estimated during land fall, after the post event analysis, Yasa had estimated sustained winds of 115 knots with gusts to 160 knots and central pressure of about 928hpa.

There were extensive damages encountered and reported over land and coastal communities especially over Yasawa-i-rara, Vanua Levu, Taveuni and nearby smaller islands, Koro and parts of the Lau group ranging from destructive to very destructive winds, torrential rainfall, severe flooding, storm surges, damaging heavy swells, high waves and phenomenal.

TC Yasa had huge humanitarian impact and affected population in high risk areas exposed to impacts generated from hazards linked to this meteorological event. Extensive damages were inflicted on human lives, properties and infrastructures, livestock and agriculture, disruption in communication networks, power shut down, communities being cut off due to flooding and land slide and coastal inundation due to storm surge and wind driven waves. Damages in the appendix (see Appendix 5) outlines brief damages caused by Yasa and not a fair reflection of the actual severity of TC Yasa over affected communities in Fiji.

It is important to note, as per post event analysis, the lowest pressure estimated of Severe TC Yasa was 917hpa around 1800UTC on December 16th and the maximum wind estimated was 125 knots gusting to 175 knots. At this time Yasa was still over open waters and approaching Fiji. These figures were based on the Post event analysis track data including Re-Dvorak analysis (CI – Current Intensity) of Severe TC Yasa at RSMC, Nadi. *see appendix 1,b)Table 1 for details*.

10. DISCUSSIONS

1. Observations

As severe TC Yasa was anticipated to track into Fiji waters, all observation networks (stations) were activated as per TC directive procedures. Atmospheric conditions like wind speed, pressure, rainfall and other parameter (Appendix 2) were recorded on automatic weather stations (AWS) on specific location and manual stations. There were some quality observation and reports received from few available observation networks, however, it was noted that some observation was not of the quality or standard anticipated as a few of the stations reporting estimated reading from the subjective beaufort wind scale estimation. Therefore, these observation network sources tend to vary and affected intensity forecasting. This variation could probably be due to instrument calibration error, observation instrument sheltered and flawed in standard estimation practice. In addition, with severe damages on the Nabouwalu observation network and other AWS stations being unserviceable especially near the track of Yasa, close to real time verification and validation on the intensity of the system was affected.

1. Post event track analysis for Severe TC Yasa.

1. The tracking of TC Yasa generally showed minimal deviation throughout its life span, however its tracking made two variations from the post event track analysis (Appendix 1a). The initial variation in the track of Yasa was observed during its early stage development from a category 1 system through into a category 3 system as it remained over open waters of Vanuatu and Fiji. The system supposedly made a single clockwise loop compared to the double anti-clockwise loop in the analysis track (Appendix 1e).

2. The other variation occurred while the system had gradually weakened as it tracked towards the southern Lau group on December 18th while moving into a close consensus several hours later.

3. Consequently, to ease these possible track forecast inconsistencies, TC forecasters to:

    - consistently upgrade TC track forecasting skills to improve confidence level in determining TC positions and tracking.
    - ensure relevant tools are readily available close to real time.

4. Post event Verification of Position and Intensity for Severe TC Yasa.

Refer to Table 3 in APPENDIX 1

5. The forecasts for Severe Cyclone Yasa issued by the Nadi RSMC have a good degree of skill as they have smaller mean distance errors in the position forecast. Most of the Global Models performed well but was limited with timely access.

6. For the first 12 hours RSMC Nadi did well, the error increases to more than 100km for the forecast position at 24 hours onwards.

7. ECMWF and JTWC did well out to 48 hours and this should increase confidence in using them beyond 24hrs in the future.

Refer to Table 4 in APPENDIX 1

8. RSMC Nadi did well in the intensity forecast of Yasa out to 24 hours.

9. Though the intensity error within 24 hours is within 15 knots it is relatively satisfactory as it is a strong system, however there had been some issues with determining the category as the difference from one category to another is a difference of 5 to 10 knots. This had been the case on and prior to making landfall.

10. Verification and analysis of Storm surge model

The storm surge model was developed by JMA for the Fiji area and the region. The model has input from the track issued by RSMC Nadi and its accuracy is very dependent on the track, radius of maximum winds, intensity and pressure.

Though the bathymetry data of coastline areas was not considered or well represented in the model to estimate coastal inundation, the model was run successfully with massive storm height estimated over areas during high tide with total wave heights expected around 3m to 4m especially over the coastal areas of Vanua Levu, Taveuni and nearby smaller islands waters. Thus, certain areas had reports of storm surge and wind driven wave impacts over coastal and land areas, fortunately the landfall was before high tide.

Ultimately, the storm surge and wave forecast model acts to be a reliable tool as it delineates and prepares communities to brace for possible storm surge impacts and wind driven waves especially along high risk coastal communities. Therefore, for the

incorporation of storm surge heights in special weather bulletins, coastal communities are triggered for related response and actions.

11. RECOMMENDATIONS

To ensure improvement in tropical cyclone forecasting and operation:

1. Severe Weather Bulletin (SWB) template to be revised and simplified to include impact information for the different hazards.

2. TC module data from maps to be automatically converted and incorporated into the SWB for consistency and timeliness.

3. A communication team to be form and activated during severe weather event (TC) to attend to weather inquiries from stakeholders. Hence, allowing TC forecaster more space to focus on core components of TC forecasting.

4. The availability of an additional workstation with TC module installed would be important to accommodate a second TC forecaster/or duelling officer if there is more than one TC in the Nadi AOR.

5. Data(csv) from TC module to be utilise in automating TC briefing maps/information.

6. Portal to be created for media liaison officer and communication team of Fiji Meteorological Service to gather impending severe weather information for media releases, weather jargons translation, inquiries and for awareness.

7. Tide gauges and wave buoys to be installed along most coastal areas including those in the northern parts of Fiji for regular measurement of wave heights over Fiji waters. This is critical for frequent wave data reporting and validation of storm surge model. Further it is important to note that if Fiji is to move forward to implement this recommendation, clear planning and SOPs to be developed to ensure these wave gauges are maintained regularly, are installed and deployed to withstand category 5 cyclones and ensure it meets WMO and IMO standards.

8. Attain bathymetry data over Fiji coastal areas to estimate accurately wave height and distance of wave travelled onshore/inland. This will generally enhance the coastal inundation and impact based forecast capability of Fiji Meteorological Service.

9. More Automatic Weather Station (AWS) to be installed strategically over black spot areas in Fiji for frequent and accurate reporting of data especially wind strength and rainfall intensity. This will ensure the wind strength and rainfall intensity of severe tropical cyclones affecting Fiji is measured accurately. Further, it will lead to a better

estimate on the impacts of such hazards and assist in warning or advising the vulnerable and exposed communities in the future, thus enhancing Impact based forecasting capability in Fiji.

10. Weather equipment (including AWS, Tide gauges, wave buoys etc) and stations to be mounted to withstand severe tropical cyclone strength and other meteorological events. This will enable Fiji Meteorological Service to get long periods of data which will be beneficial for Fiji as decisions and advise will be made on historical Fiji data rather than decisions based on data or analysis from another country.

11. CONCLUSIONS

Yasa caused havoc in the Fiji group especially over the Yasawa group, northern and eastern Viti Levu, Vanua Levu and parts of Lomaiviti and Lau group within its path. Torrential and heavy rain, flooding was felt over the whole of Fiji. Destructive to very destructive winds and damaging gale force winds, phenomenal seas, damaging heavy swells and massive storm surges associated with Yasa were felt over Vanua Levu and other smaller islands within the path of Yasa as it tracked towards and over the group.

While Yasa was very destructive, the forecasters intensity and tracking was more subjective with further guidance from numerical model including storm surge and wave forecast and other meteorological tools that led to timely forecasts and effective warnings by RSMC Nadi, with warnings and advisories issued in a timely manner, in turn to an extent minimized fatality from such devastating and life-threatening storm.

TC Yasa intensity was estimated using the Dvorak technique with storm surge and wave heights in special weather bulletins and briefings estimated from the storm surge and wave model output.

12. REFERENCES

http://www.bom.gov.au/products/IDYOC062.Pacific.SSTAnalysis.shtml

http://fms-aifs-op.met.gov.fj/fwo/tcopspage/index.htm

https://manati.star.nesdis.noaa.gov/datasets/ASCATData.php

https://www.nrlmry.navy.mil/tc_pages/tc_home.html

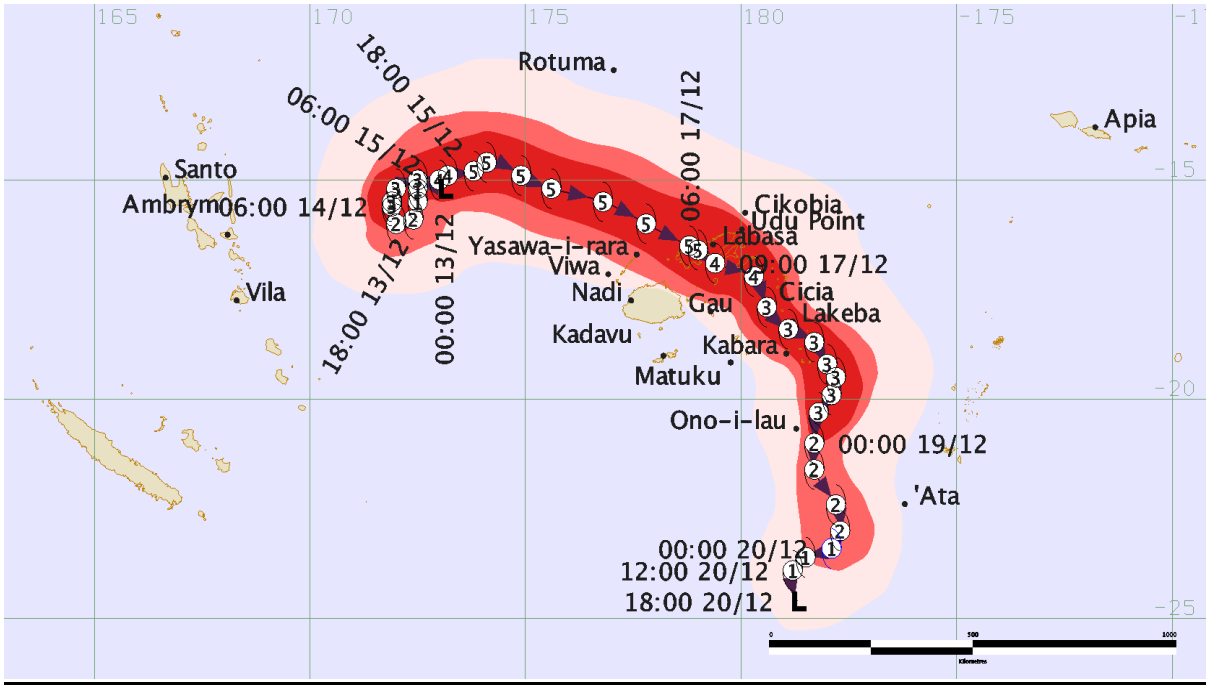
http://tropic.ssec.wisc.edu/archive/data/SEPacific/20201214/MidLowerWindsLarge/20201214.18.SEPacific.MidLowerWindsLarge.png

http://tropic.ssec.wisc.edu/realtime/imagemain.php?&basin=austeast&sat=gms&prod=irn

13. APPENDICIES

Appendix 1: Track Map

1. Post Event Best Track Analysis Results



Note:

1) All time in UTC.

2) The track highlights the extent of:

Gale force wind
Storm force wind
Hurricane force wind

2. Best Track Data and Intensity

Table 1

Time (UTC)	Lat.	Long.	Uncertainty (Nm)	Mean Wind (knots)	Wind Gust (knots)	Category	Pressure (hpa)	Radius of Max. Winds (Nm)
13/0000	-15.2	173.1	30	30	45	0	997	
13/0600	-15.2	172.5	45	35	50	1	996	25
13/1200	-15.5	172.5	60	45	65	1	991	30
13/1800	-15.9	172.4	30	50	70	2	987	40
14/0000	-16	172	20	60	85	2	982	30
14/0600	-15.6	171.9	20	70	100	3	972	30
14/1200	-15.5	171.9	60	70	100	3	972	30
14/1800	-15.2	172	30	75	105	3	967	25
15/0000	-15	172.5	20	80	110	3	966	15
15/0600	-15	173	15	90	125	4	953	15
15/1200	-14.9	173.2	20	95	135	4	946	15
15/1800	-14.8	173.8	25	110	155	5	932	15
16/0000	-14.6	174.1	25	120	170	5	919	15
16/0600	-14.9	174.9	25	120	170	5	921	15
16/1200	-15.2	175.6	10	120	170	5	920	15

16/1800	-15.5	176.8	15	125	175	5	917	15
17/0000	-16	177.8	15	120	170	5	923	15
17/0600	-16.5	178.8	15	115	160	5	928	15
17/0700	-16.6	179	15	115	160	5	928	15
17/0900	-16.9	179.4	15	105	145	4	940	20
17/1200	-17.2	-179.7	25	95	135	4	954	20
17/1800	-17.9	-179.4	45	75	105	3	969	20
18/0000	-18.4	-178.9	30	70	100	3	970	20
18/0300	-18.7	-178.3	25	70	100	3	971	40
18/0600	-19.2	-178	40	75	105	3	967	25
18/1200	-19.5	-177.8	60	75	105	3	964	25
18/1800	-19.9	-177.9	80	65	90	3	972	20
18/2100	-20.3	-178.2	50	65	90	3	973	30
19/0000	-21	-178.3	20	60	85	2	978	40
19/0600	-21.6	-178.3	20	55	75	2	980	45
19/1200	-22.4	-177.8	20	50	70	2	985	45
19/1800	-23	-177.7	20	50	70	2	984	45
20/0000	-23.4	-177.9	20	45	65	1	986	45
20/0600	-23.6	-178.5	20	40	55	1	990	45
20/1200	-23.9	-178.8	20	35	50	1	993	45
20/1800	-24.6	-178.7	20	30	45	0	997	45

3. Best Track Wind Radii

Table: 2

Time (UTC)	Lat.	Long.	Uncertainity (Nm)	Mean Wind (knots)	NE Gale Rad. (Nm)	SE Gale Rad. (Nm)	SW Gale Rad. (Nm)	NW Gale Rad. (Nm)	NE Storm Rad. (Nm)	SE Storm Rad. (Nm)	SW Storm Rad. (Nm)	NW Storm Rad. (Nm)	NE Hurr. Rad. (Nm)	SE Hurr Rad. (Nm)	SW Hurr Rad. (Nm)	NW Hurr Rad. (Nm)
13/0000	-15.2	173.1	30	30												
13/0600	-15.2	172.5	45	35	30	90	35	35								
13/1200	-15.5	172.5	60	45	55	105	90	35								
13/1800	-15.9	172.4	30	50	45	95	90	35	35	40	25	25				
14/0000	-16	172	20	60	80	75	55	50	30	40	40	30				
14/0600	-15.6	171.9	20	70	55	115	115	45	30	35	35	30	20	30	30	20
14/1200	-15.5	171.9	60	70	55	105	90	60	30	30	0	30	20	30	30	20
14/1800	-15.2	172	30	75	75	55	60	110	30	0	30	30	20	30	30	30
15/0000	-15	172.5	20	80	125	115	95	100	30	0	40	55	35	30	25	20
15/0600	-15	173	15	90	140	80	100	130	55	30	55	65	35	30	20	35
15/1200	-14.9	173.2	20	95	145	115	100	130	85	50	55	75	40	30	30	40
15/1800	-14.8	173.8	25	110	150	130	100	130	80	50	55	75	40	30	30	40
16/0000	-14.6	174.1	25	120	145	120	100	130	50	50	55	75	40	30	30	40
16/0600	-14.9	174.9	25	120	145	125	100	120	75	50	65	75	40	30	30	40
16/1200	-15.2	175.6	10	120	145	125	70	110	75	50	65	70	40	30	30	45
16/1800	-15.5	176.8	15	125	145	125	70	110	75	50	65	55	40	35	35	25
17/0000	-16	177.8	15	120	145	95	75	110	75	45	65	40	40	35	30	25
17/0600	-16.5	178.8	15	115	145	85	75	110	75	45	65	40	45	40	30	35
17/0700	-16.6	179	15	115	145	85	75	110	80	45	65	65	75	40	30	25
17/0900	-16.9	179.4	15	105	150	85	70	100	75	60	45	50	70	50	45	25
17/1200	-17.2	-179.7	25	95	155	100	70	70	55	60	45	40	30	45	45	25
17/1800	-17.9	-179.4	45	75	140	100	70	95	40	50	45	20	30	35	25	15
18/0000	-18.4	-178.9	30	70	115	100	50	30	30	45	45	15	25	30	0	20
18/0300	-18.7	-178.3	25	70	110	110	60	60	40	40	45	35	20	20	40	25
18/0600	-19.2	-178	40	75	125	125	45	105	55	55	45	35	25	25	50	25
18/1200	-19.5	-177.8	60	75	125	125	60	100	55	45	35	40	30	25	35	25
18/1800	-19.9	-177.9	80	65	140	55	70	95	40	50	30	20	30	35	25	15
18/2100	-20.3	-178.2	50	65	140	55	70	95	40	50	30	20	30	35	25	15
19/0000	-21	-178.3	20	60	100	100	60	55	25	30	20	20				
19/0600	-21.6	-178.3	20	55	75	85	50	50	25	45	25	15				
19/1200	-22.4	-177.8	20	50	75	85	50	50	25	45	50	15				
19/1800	-23	-177.7	20	50	75	85	50	50	25	45	50	15				
20/0000	-23.4	-177.9	20	45	75	85	50	50								
20/0600	-23.6	-178.5	20	40	75	85	50	50								
20/1200	-23.9	-178.8	20	35	75	85	50	50								
20/1800	-24.6	-178.7	20	30												

4. Verification statistics for Severe Tropical Cyclone Yasa

1. **Table 3**: The **Position forecast verification statistics** for Cyclone Yasa based on warnings issued by RSMC Nadi (NFFN) and some other sources. Mean is the mean distance error in kilometres from the forecast to the actual position of Yasa.

	Distance	**0hr**	**12hr**	**24hr**	**36hr**	**48hr**	**72hr**
NFFN	Mean(km)	30	69	107	146	176	240
	Std Dev(km)	34	39	57	66	79	129
GFS-AVNI	Mean(km)	23	55	101	146	195	310
	Std Dev(km)	11	24	52	67	105	149
ECMWF	Mean(km)	23	29	87	124	153	227
	Std Dev(km)	15	18	33	41	61	100
JTWC	Mean(km)	18	51	78	111	134	200
	Std Dev(km)	12	25	39	43	56	101
UKMO	Mean(km)	24	73	128	182	244	330
	Std Dev(km)	11	48	97	146	186	245
JMA	Mean(km)	24	57	116	190	250	350
	Std Dev(km)	11	31	83	122	151	258

Note: RSMC Nadi standard for mean distance error are:

1. Less than 30 Nm (55.6 km) – Good b) 30 to 60 Nm (55.6 to 111 km) c) More than 60Nm (111 km) - Poor

1. The forecasts for Severe Cyclone Yasa issued by the Nadi RSMC have a good degree of skill as they have smaller mean distance errors in the position forecast especially for the first 12 hours

2. Out to 24 hours the forecast position was fairly estimated.

3. 36 hours to 72hours out, the position was poorly estimated as the uncertainty increases.

1. **Table 4**: The **Intensity forecast verification statistics** for Cyclone Yasa based on based on Dvorak analysis, microwave imagery analysis and ASCAT by RSMC Nadi (NFFN) and some other sources. Mean is the mean speed error in knots from the forecast to the estimated intensity of Yasa.

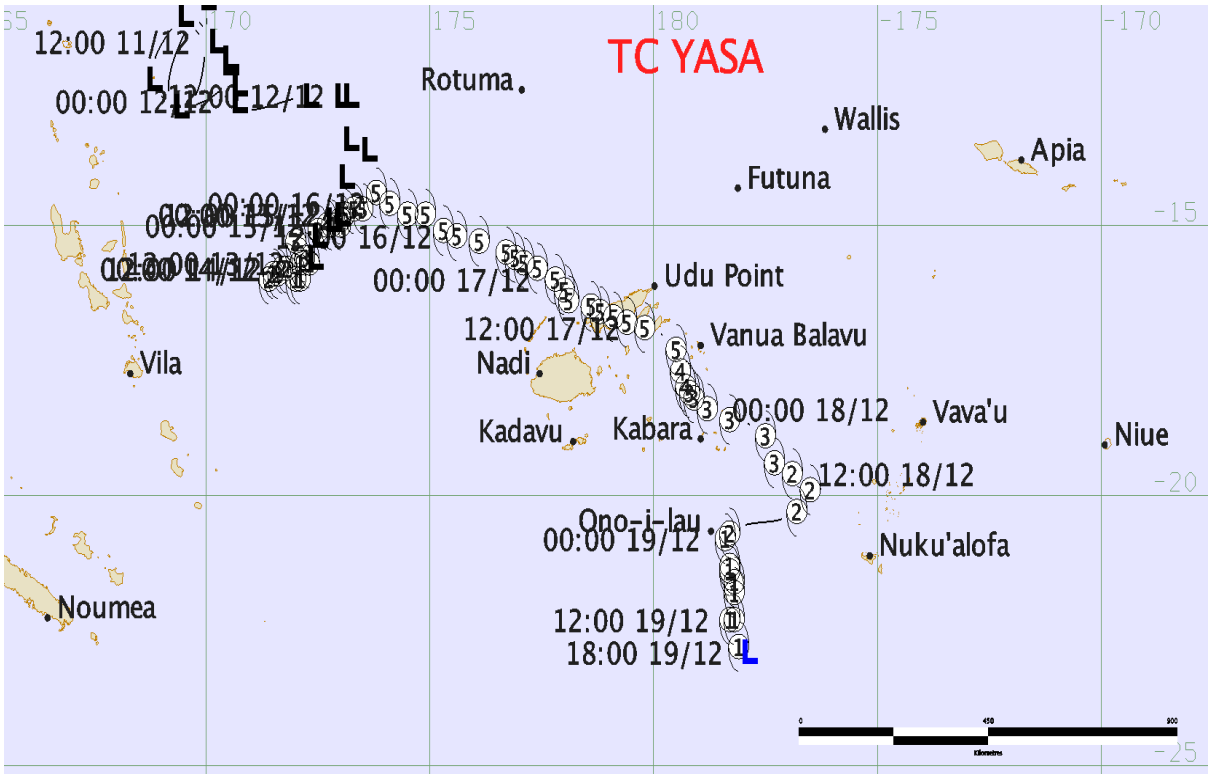
	Distance	**0hr**	**12hr**	**24hr**	**36hr**	**48hr**	**72hr**
NFFN	Mean(knots)	12	13	15	19	25	32
	Std Dev(knots)	14	17	20	25	31	34
GFS-AVNI	Mean(knots)	10	8	11	15	20	25
	Std Dev(knots)	10	10	13	18	23	29
ECMWF	Mean(knots)	16	16	21	22	23	24
	Std Dev(knots)	14	13	17	18	19	29
JTWC	Mean(knots)	11	10	10	15	18	23
	Std Dev(knots)	11	12	15	19	20	25
UKMO	Mean(knots)	51	50	54	59	61	70
	Std Dev(knots)	47	47	50	54	58	65
	Mean(knots)	9	12	21	31	39	54

JMA	Std Dev(knots)	10	19	25	38	44	61

1. RSMC Nadi did well in the intensity forecast of Yasa out to 24 hours.

2. Though the intensity error within 24 hours is within 15 knots it is relatively satisfactory as Yasa was a strong system

3. Analysis Track Map –TC Yasa



Note: *All time in UTC*

Appendix 2: Observations

1. AWS DATA

The maximum sustained winds, wind gust and lowest pressure recorded from Fiji's automatic weather stations during the passage of Severe Tropical Cyclone Yasa over Fiji waters is tabulated below

Table 5

TC YASA DATA - AWS

Station Details	Date	Time	Maximum Gust Speed			Station Details	Date	Time	Mean Wind Speed			Station Details	Date	Time	Lowest MSLP
			m/s	kts	km/hr				m/s	kts	km/hr				
Udu Point AWS	17/12/2020	23:30	44.7	87	161	Udu Point AWS	17/12/2020	23:00	33.6	65	121	Saqani AWS	17/12/2020	21:50	971.7
Saqani AWS	17/12/2020	21:20	41.8	81	150	Rakiraki AWS	17/12/2020	14:20	28.2	55	102	Lakeba AWS	18/12/2020	12:00	972.6
Yasawa - I -Rara AWS	17/12/2020	13:00	40.8	79	147	Yasawa - I -Rara AWS	17/12/2020	10:10	28	54	101	Wainikoro AWS	17/12/2020	21:40	976.4
Rakiraki AWS	17/12/2020	16:20	37.9	74	136	Vanuabalavu AWS	18/12/2020	7:10	25	49	90	Seaqaqa AWS	17/12/2020	17:20	977.4
Labasa AWS	17/12/2020	18:40	37.8	73	136	Koro Island AWS	17/12/2020	20:50	23.1	45	83	Nadi AWS	17/12/2020	17:20	977.4
Wainikoro AWS	17/12/2020	21:20	37.6	73	135	Wainikoro AWS	17/12/2020	20:10	20.8	40	75	Labasa AWS	17/12/2020	18:40	980.5
Vanuabalavu AWS	18/12/2020	7:20	37.5	73	135	Viwa AWS	17/12/2020	12:00	20.5	40	74	Yasawa - I -Rara AWS	17/12/2020	13:00	981.8
Koro Island AWS	17/12/2020	20:40	32.3	63	116	Levuka AWS	17/12/2020	18:20	20.2	39	73	Vanuabalavu AWS	18/12/2020	4:50	984.4
Yaqara Pastoral AWS	17/12/2020	19:50	31.2	61	112	Saqani AWS	17/12/2020	21:20	18.6	36	67	Kubulau AWS	17/12/2020	17:00	986.3
Nadarivatu AWS	17/12/2020	20:40	30.8	60	111	Labasa AWS	17/12/2020	18:40	17	33	61	Udu Point AWS	17/12/2020	22:20	987.2
Levuka AWS	17/12/2020	18:30	30.4	59	109	Nadarivatu AWS	17/12/2020	18:10	17	33	61	Ba AWS	17/12/2020	15:20	988.4
Seaqaqa AWS	17/12/2020	17:00	27.2	53	98	Ono-I-Lau AWS	18/12/2020	19:40	21.1	41	76	Rakiraki AWS	17/12/2020	16:20	988.7
Nadi AWS	17/12/2020	17:00	27.2	53	98	Vunisea AWS	17/12/2020	21:20	15.8	31	57	Koro Island AWS	17/12/2020	21:00	990
Kubulau AWS	17/12/2020	16:00	27.1	53	98	Yaqara Pastoral AWS	17/12/2020	18:30	15.7	31	57	Viwa AWS	17/12/2020	16:30	991.5
Viwa AWS	17/12/2020	12:10	27	52	97	Kubulau AWS	17/12/2020	16:30	14.7	29	53	Yaqara Pastoral AWS	17/12/2020	17:40	991.6
Vunisea AWS	17/12/2020	21:20	23.7	46	85	Seaqaqa AWS	17/12/2020	17:00	13.6	26	49	Levuka AWS	17/12/2020	20:30	992
Matuku AWS	18/12/2020	6:00	23.2	45	84	Matuku AWS	18/12/2020	22:20	14.7	29	53	Momi AWS	17/12/2020	17:20	993.1
Ono-I-Lau AWS	19/12/2020	5:30	32	62	115	Momi AWS	17/12/2020	17:20	12.9	25	46	Nadarivatu AWS	17/12/2020	17:40	994.2
RKS Lodoni AWS	17/12/2020	20:00	21.7	42	78	Korolevu AWS	17/12/2020	18:20	11.7	23	42	Korolevu AWS	17/12/2020	17:10	995.1
Momi AWS	17/12/2020	21:50	21.6	42	78	Rotuma AWS	17/12/2020	20:30	11.3	22	41	Keiyasi AWS	17/12/2020	17:00	995.4
Korolevu AWS	17/12/2020	18:30	21.5	42	77	RKS Lodoni AWS	17/12/2020	19:20	11.3	22	41	Lomaivuna AWS	17/12/2020	18:30	996.1
Rotuma AWS	17/12/2020	8:10	21.4	42	77	Ba AWS	17/12/2020	16:00	9.8	19	35	RKS Lodoni AWS	17/12/2020	18:10	996.3
Lakeba AWS	18/12/2020	14:10	45.1	88	162	Lomaivuna AWS	17/12/2020	18:40	9.4	18	34	Sigatoka AWS	17/12/2020	17:20	996.4
Ba AWS	17/12/2020	16:10	19.7	38	71	Nadi AWS	17/12/2020	17:50	9.3	18	33	Matuku AWS	18/12/2020	5:00	996.8
Lomaivuna AWS	17/12/2020	13:30	18.3	36	66	Lakeba AWS	18/12/2020	14:10	34.2	66	123	Navua AWS	17/12/2020	17:10	997.1
Navua AWS	17/12/2020	20:10	16.3	32	59	Navua AWS	17/12/2020	20:20	8.7	17	31	Vunisea AWS	17/12/2020	16:20	1000.1
Sigatoka AWS	17/12/2020	19:50	15.8	31	57	Sigatoka AWS	17/12/2020	19:50	7.4	14	27	Rotuma AWS	17/12/2020	3:30	1000.2
Keiyasi AWS	17/12/2020	19:30	12.3	24	44	Keiyasi AWS	17/12/2020	17:30	5.1	10	18	Ono-I-Lau AWS	19/12/2020	7:50	988.1
Suva AWS						Suva AWS						Suva AWS			

Station is being down since 16th October,2020.

2. Maximum Sustained Wind

Maximum sustained winds recorded in Fiji during the passage of TC Yasa

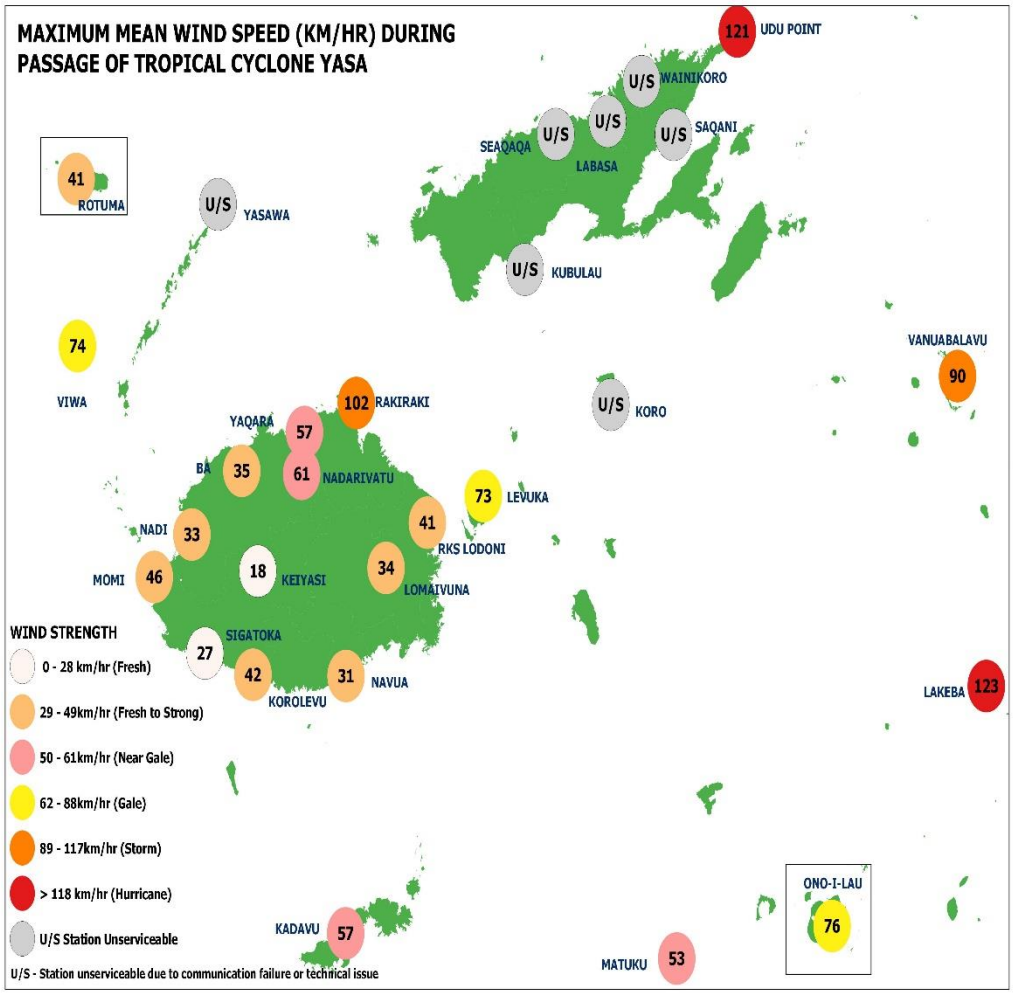
The maximum sustained winds with the relevant gust from Fiji's manual and automatic weather stations during the passage of Severe Tropical Cyclone Yasa over Fiji waters is tabulated below:

Table 6

Time of Report	Station	Max. winds recorded	Pressure recorded
170100Z	Yasawa	15050G75KT (estimate)	998HPA
170200Z	Yasawa AWS	15052G80KT	980HPA
170300Z	Viwa	17080G90KT (estimate)	994HPA
170400Z	Viwa	17070G80KT (estimate)	993HPA
170500Z	Viwa	17060G70KT (estimate)	994HPA
170600Z	Koro island AWS	10037KT	999HPA
	Rakiraki AWS	16037KT	990HPA
170700Z	Udu point AWS	35045KT	991HPA
170800Z	Udu point AWS	35045KT	991HPA
170900Z	Udu point AWS	10046G60KT	994HPA
	Udu point AWS	34049KT	990HPA
171000Z	Udu point AWS	33060KT	987HPA
171100Z	Udu point AWS	32065KT	987HPA
171200Z	Udu point AWS	32062KT	989HPA
171300Z	Udu point AWS	31055KT	992HPA
171400Z	Udu point AWS	29052KT	993HPA
	Vanuabalavu	01050G60KT (estimate)	990HPA
171500Z	Vanuabalavu	01050G65KT(estimate)	987HPA

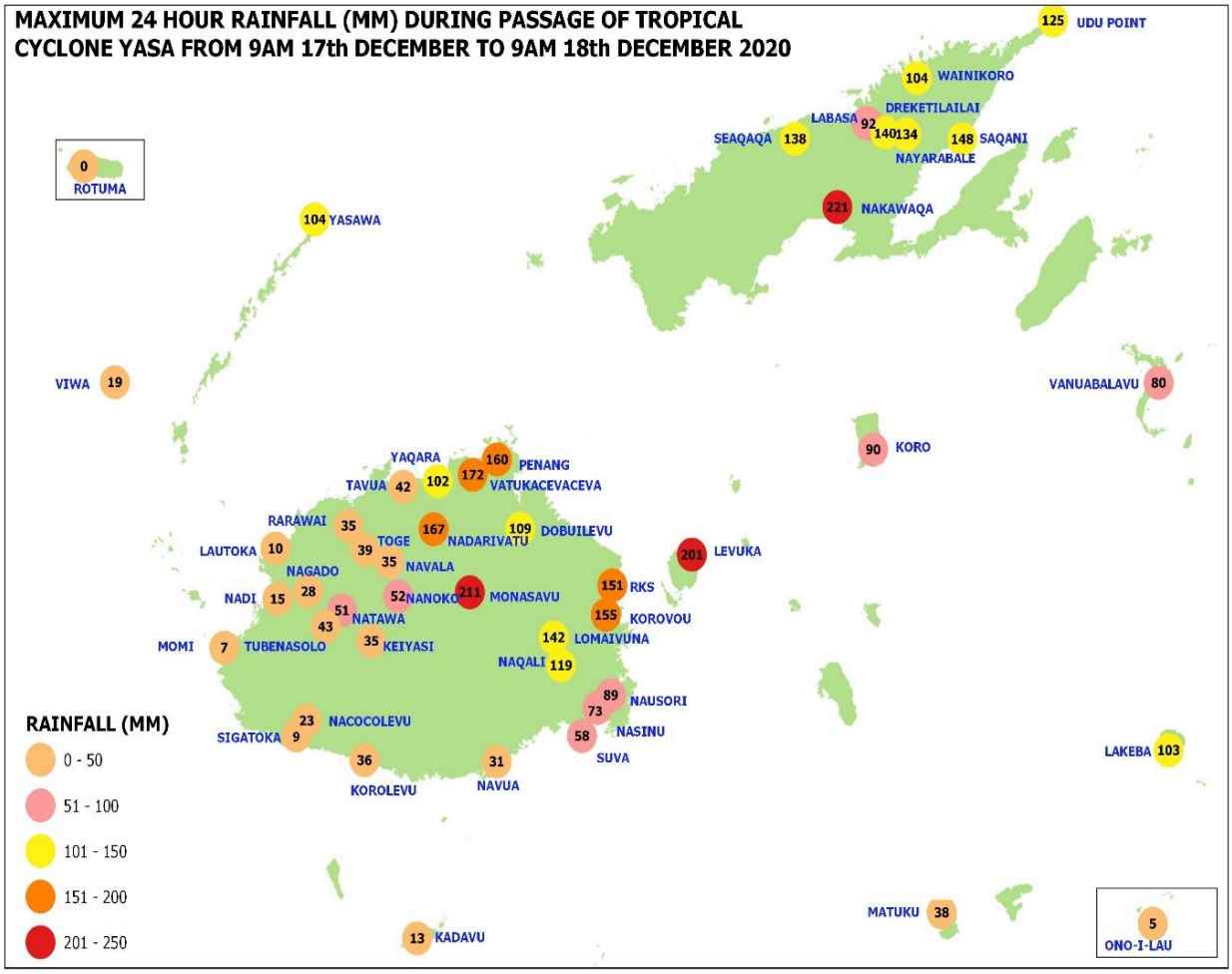
171600Z	Vanuabalavu	36060G75KT (estimate)	984HPA
171700Z	Vanuabalavu AWS	35044G74KT	984HPA
171800Z	Vanuabalavu AWS	34038G66KT (estimate)	986HPA
		09016G72KT	987HPA
	Lakeba AWS	04040G50KT(estimate)	
171900Z	Vanuabalavu AWS	33049G69KT	987HPA
172000Z	Vanuabalavu AWS	32041G57KT	989HPA
172100Z	Vanuabalavu AWS	13040KT	990HPA
172200Z		30008G42KT	990HPA
	Vanuabalavu AWS	02070G90KT(estimate)	
172300Z	Yasawa	21016KT	999HPA
180000Z	Vanuabalavu	27055G75KT (estimate)	992HPA
180100Z	Vanuabalavu	28050G75KT(estimate)	992HPA
180200Z	Vanuabalavu	27030G45KT (estimate)	996HPA
180300Z	Lakeba	26060G80KT(estimate)	984HPA
180400Z	Lakeba	25060G60KT (estimate)	997HPA
180500Z	Ono i Lau	12060G75KT(estimate)	995HPA
180600Z	Ono i Lau	12060G70KT (estimate)	995HPA
180700Z	Lakeba	25035G45KT(estimate)	995HPA
180800Z	Lakeba	25030G50KT(estimate)	996HPA
180900Z	Ono i Lau	11055G65KT (estimate)	994HPA
181000Z	Ono i Lau	11055G65KT(estimate)	994HPA

Figure 2b.i): <u>Graphical output of maximum mean wind speed</u>



3. Rainfall

Figure 2c. i) Graphical output of maximum 24-hours rainfall


MAXIMUM 24 HOUR RAINFALL (MM) DURING PASSAGE OF TROPICAL CYCLONE YASA FROM 9AM 17th DECEMBER TO 9AM 18th DECEMBER 2020
125 UDU POINT
104 WAINIKORO
DREKETILAILAI
LABASA 92
140
134
148 SAQANI
SEAQAQA 138
NAYARABALE
221 NAKAWAQA
0 ROTUMA
104 YASAWA
VIWA 19
VANUABALAVU 80
90 KORO
YAQARA
160 PENANG
TAVUA 42
102
172 VATUKACEVACEVA
RARAWAI 35
167
109 DOBUILEVU
LAUTOKA 10
39 TOGE
NADARIVATU
35 NAVALA
201 LEVUKA
NAGADO
NADI 15
28
52 NANOKO
211 MONASAVU
151 RKS
51
NATAWA
155 KOROVOU
43
MOMI
7 TUBENASOLO
35 KEIYASI
142 LOMAIVUNA
NAQALI 119
89
73 NAUSORI
RAINFALL (MM)
23 NACOCOLEVU
SIGATOKA 9
58 NASINU
0 - 50
36
31
SUVA
LAKEBA 103
KOROLEVU
NAVUA
51 - 100
101 - 150
151 - 200
201 - 250
MATUKU 38
5
ONO-I-LAU
13 KADAVU

4. Storm Surge and Wave Forecast Models

RSMC Nadi Storm Surge Model (developed by JMA)

The storm surge was run every 6 hours with result usually available at 0230UTC, 0830UTC, 1430UTC and 2030UTC or earlier.

Fiji Run

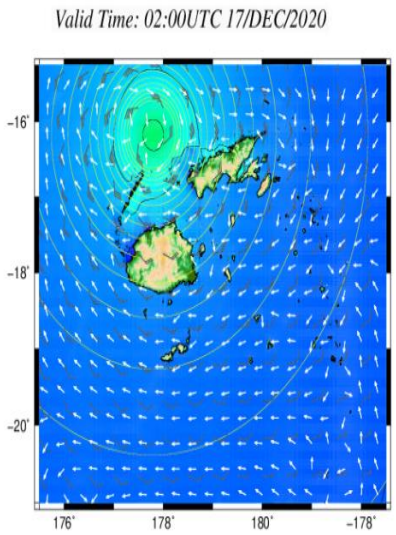


Figure 2d.i: Model run at 16/1800UTC estimating surge about 1m with total water level, that is including (low tide) tide around 1.5 m near the centre. Forecast at 17/0200UTC, TC Yasa approaching southern Vanua Levu from the northwest. The storm surge model forecasted very little surge at this time over Yasawa-i-rara with 8 hours lead time. Note: wind driven waves are normally very high and this could be a contribution in surges over the coastal communities in Yasawa.

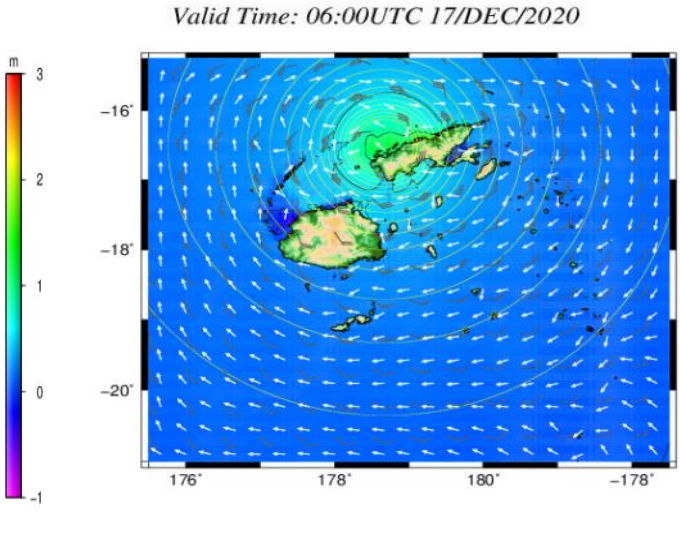


Figure 2d.ii: Model run at 17/0000UTC.

Forecast at 17/0600UTC for TC Yasa when making landfall over the western coast of Bua in Vanua Levu. The estimated wave height during low tide close to 1m and when TC Yasa moves close or makes landfall over the coast of Bua the estimated total water level with surge at around 2m would accumulate reaching almost 3m or even more, thus coastal inundation imminent.

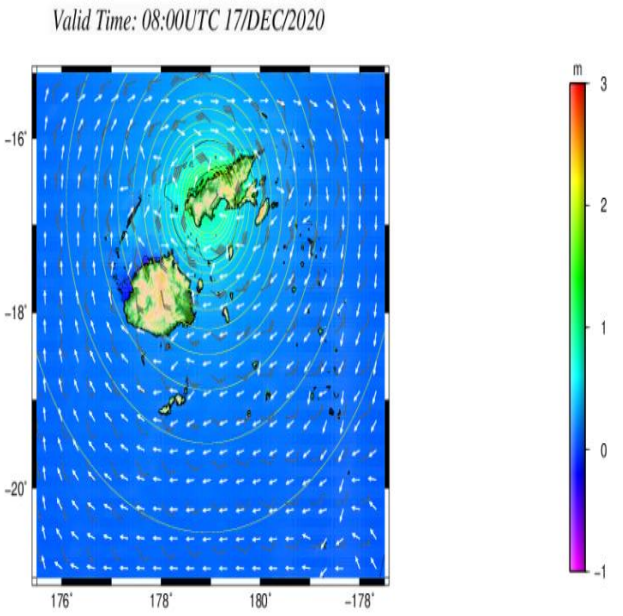


Figure 2d.iii: Model run at 17/0000UTC.

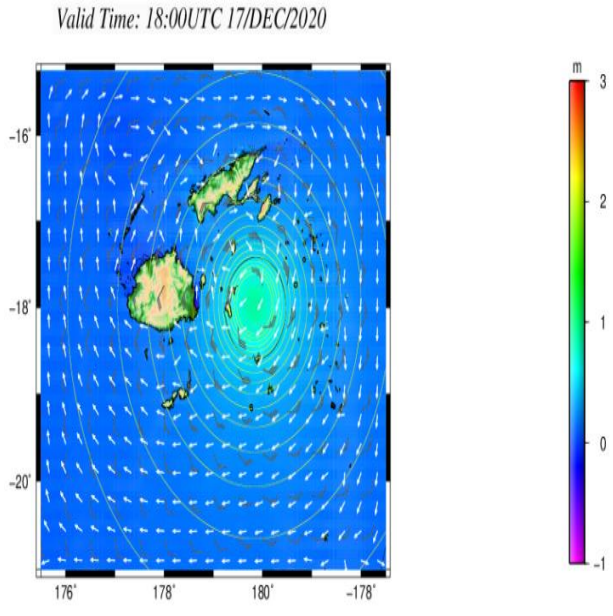


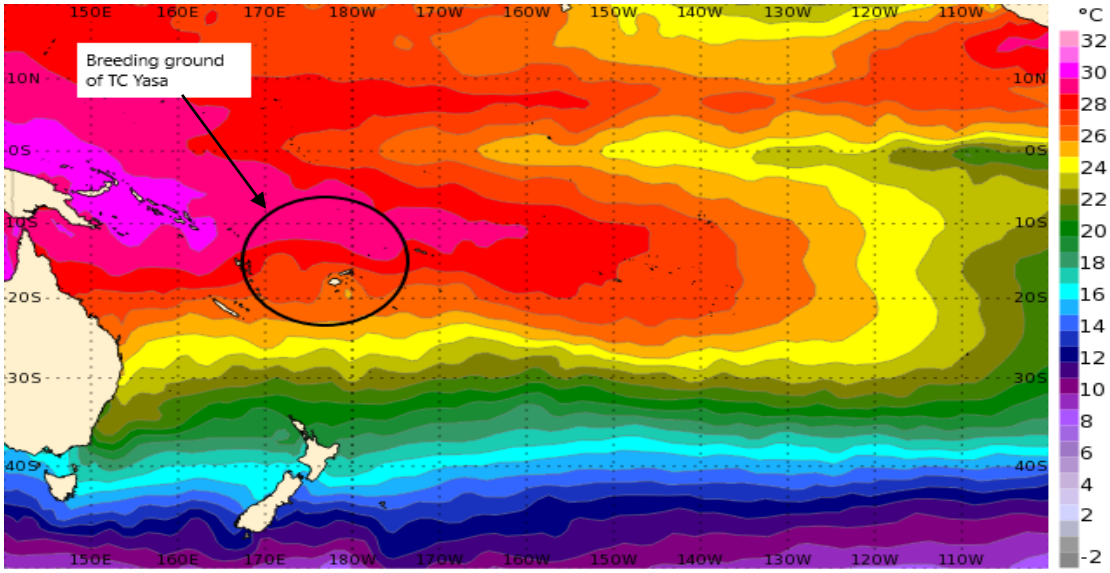
Figure 2d.iv: Model run at 16/1800UTC.

Forecast at 17/0800UTC, for TC Yasa to make landfall over the western coast of Bua in Vanua Levu and tracking towards the coast of Cakaudrove and Taveuni with wave heights up to 2m. The lead time about 8hours, and forecast time coincides with high tide, thus massive storm surge over these areas with total wave heights expected around 3m to 4m.

Forecast at 17/1800UTC, for TC Yasa while tracking towards Lomaiviti and Lau group with wave heights less than 1m. The lead time about 24 hours, and forecast time coincides with low tide with total wave heights expected around 1m and increasing further to 2m with high tide drawing and combining with wind driven waves. Thus storm surge expected, especially over communities along low bathymetry near TC Yasa

center.

5. Sea Surface Temperature



Sea surface temperature (deg C): Weekly analysis centred on **Thu 17 Dec 2020**
Issued: 21 Dec 2020

Figure 2e. i: Outlines the breeding ground of TC Yasa between 26 to 30 degree celsius (^{0}C).

Appendix 3 - Microwave imagery

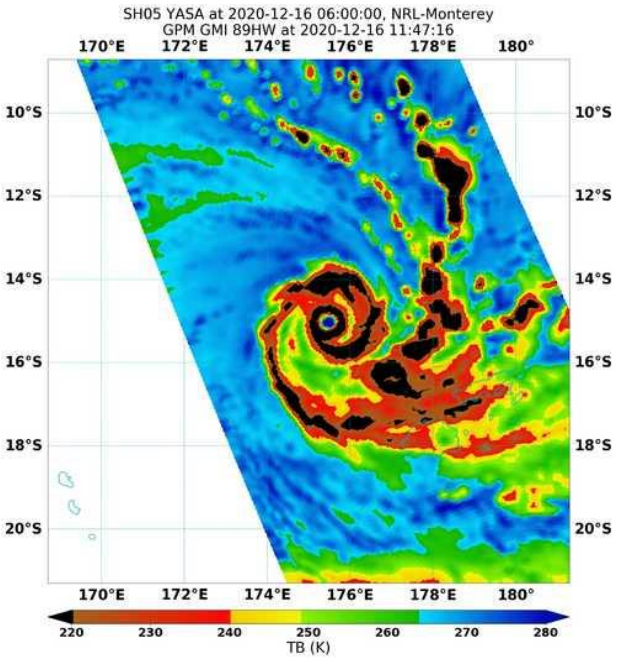


Figure 3a. i): Severe TC Yasa, 16th Dec 2020 at 1147Z estimated max. wind speed of 140 knots

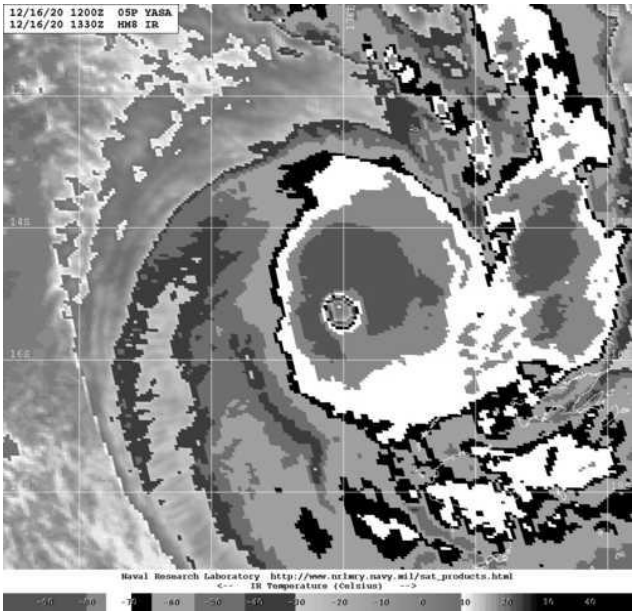


Figure 3a.ii): Severe TC Yasa, 16th Dec 2020 at 1330Z

Appendix 4 – <u>Ascat Pass</u>

Figure 4a.i : Ascat pass on 13th December at 0937utc while still depression TD02F, 3 hours from being upgraded to tropical cyclone Yasa

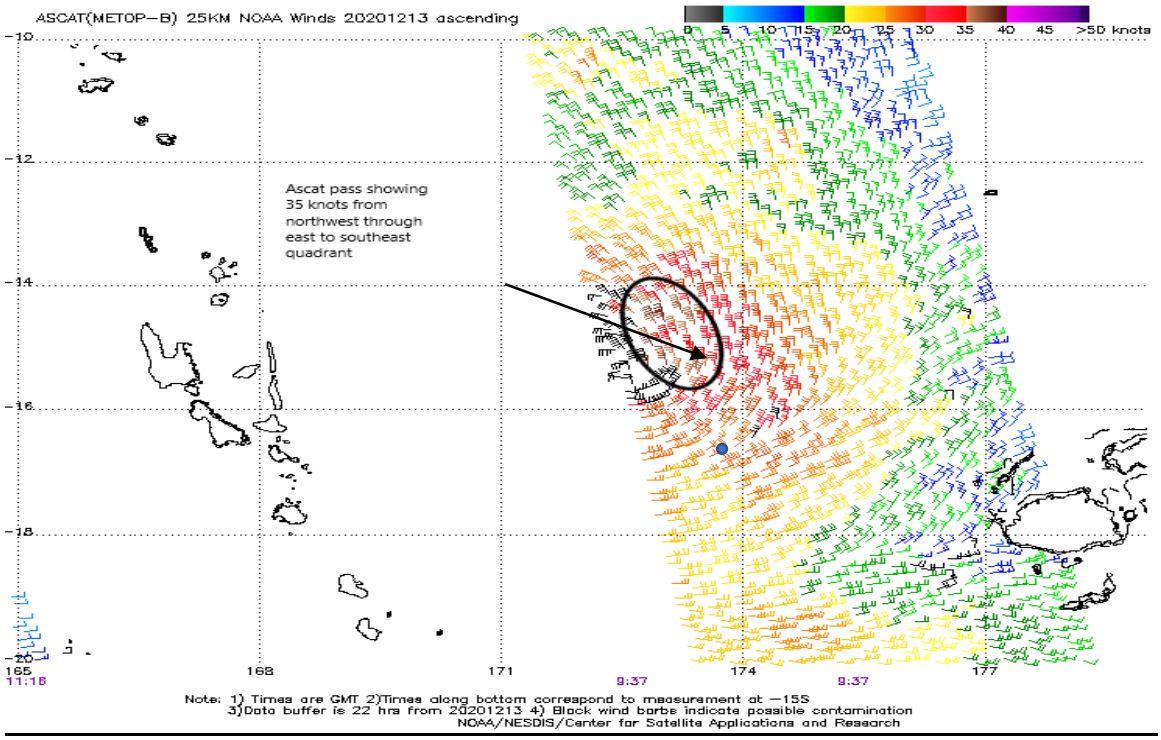


Figure 4b.i : Altimeter pass on 17th December at 0000utc while severe TC Yasa in the vicinity of the Fiji group with significant wave height of almost 13 ft.

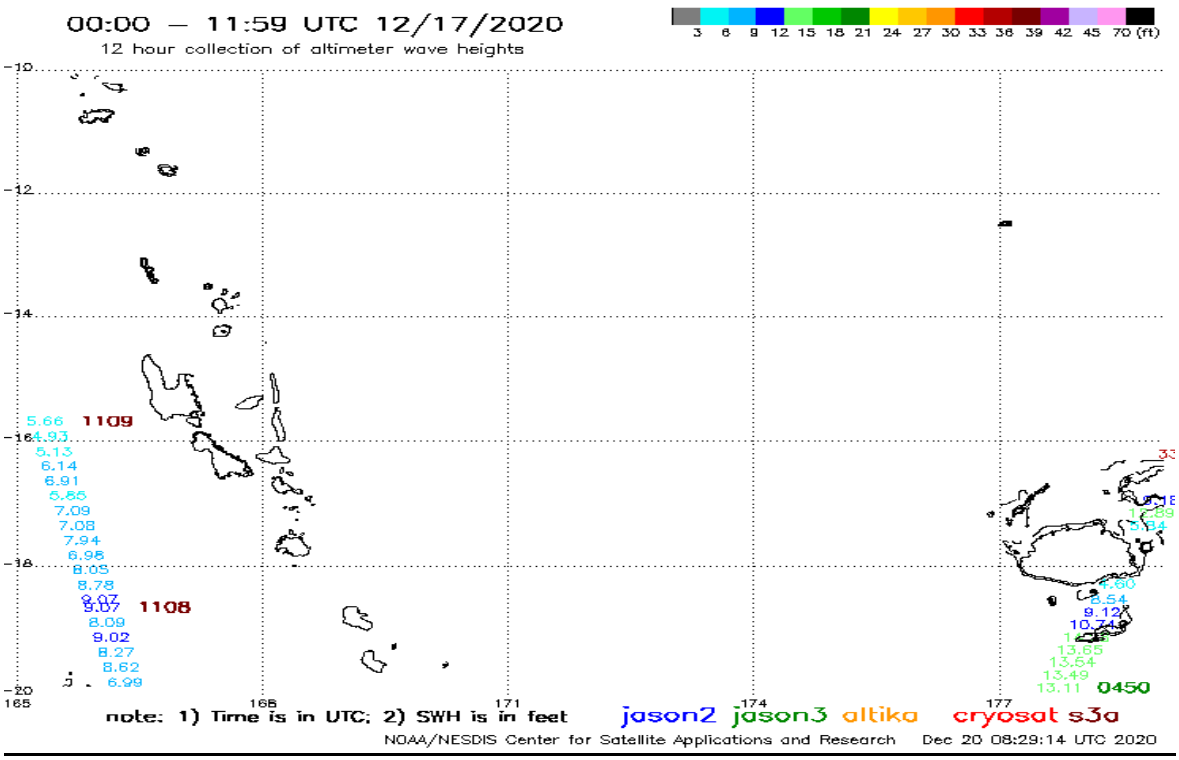
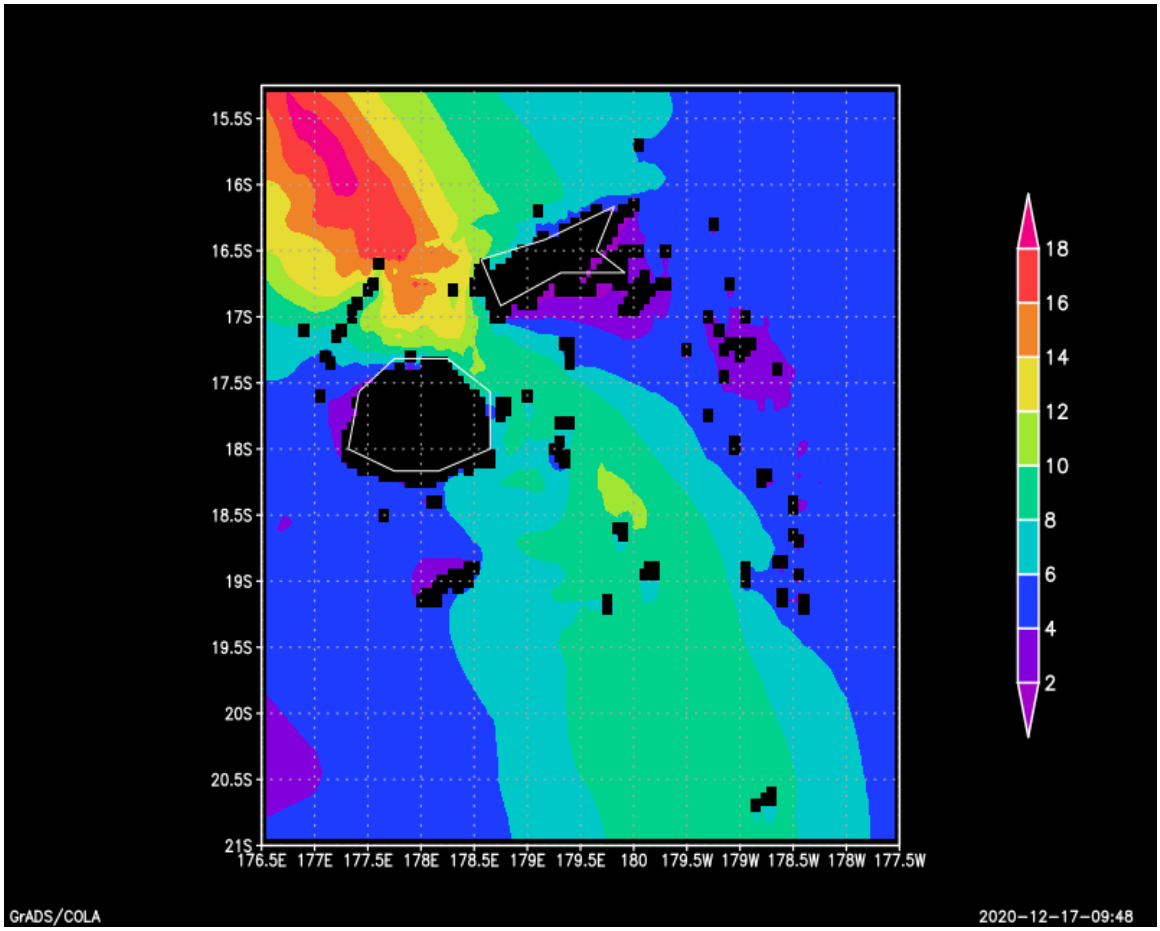


Figure 4c.i: Significant wave height model (Amit) on 17th December as severe TC Yasa is headed towards the Fiji group.


15.5S
16S
16.5S
17S
17.5S
18S
18.5S
19S
19.5S
20S
20.5S
21S
176.5E 177E 177.5E 178E 178.5E 179E 179.5E 180 179.5W 179W 178.5W 178W 177.5W
18
16
14
12
10
8
6
4
2
GrADS/COLA
2020-12-17-09:48

Appendix 5 – <u>Damages During TC Yasa</u>

1. <u>Northern Division</u>

1. <u>Bua</u>

1. Nabouwalu

Photo Credit: Rosi Bale Ledua & Laisa Tukana (FB-Bula FM, Fiji)

2. Navave Village

3. Nasavu Village

4. Nawaca Village

Photo Credit: Samuela Railoa (FB-Bula FM, Fiji)

5. Dama District School

6. Lekutu

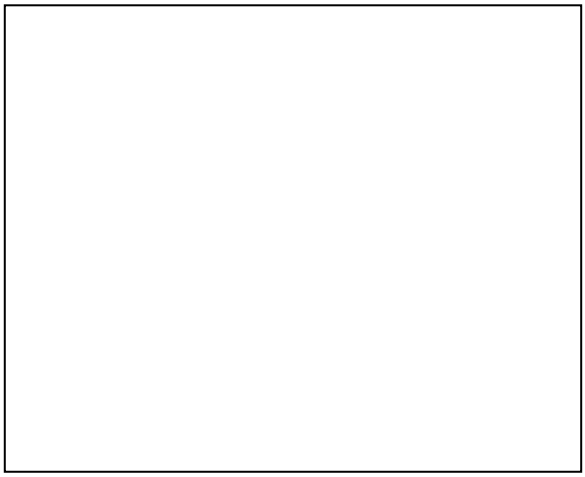
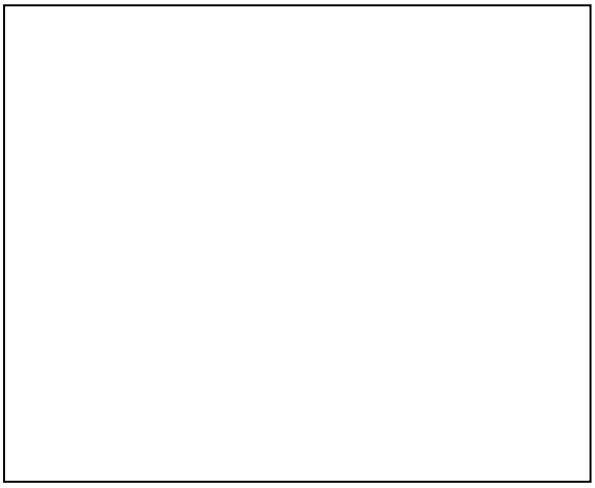


Photo Credit: Josese Bolabasaga Niutini (FB-FBC)



Lekutu Secondary School, Bua (Photo Credit: FBC)

7. <u>Cakaudrove</u>

1. Bagata Village

2. Belego

Photo Credit: Uday (FB-FBC News)

3. Nabalebale Village

Photo Credit: Dan Ligairi

4. **Wailevu** (Wailevu Distruct School and teachers quarters)

5. Vunidamoli

Photo Credit: NoaTamani (FB-FBC News)

6. Vunivesi

Photo Credit: Inny Masurogo (FB-Bula FM, Fiji)

7. Saqani

Photo Credit:Joe Vosailagi (FB-FBC News)

8. Savusavu

Lesiaceva

Drekeniwai Road

Wainivunia

Natewa crossing

9. **Taveun**i

10. Wariki (Coastal inundation)

3. <u>Macuata</u>

a) Kia Island

Photo Credit: NDMO

b) Kia island – Yaro Village




Photo Credit: Una Cagilaba Joji (FB-Fiji Index)

1. Daku

Photo Credit: Kamlesh Lal (FB-FBC News)

2. Labasa Town

Photo Credit: Akisi Daunivakasala (FB-FBC News)

3. Namara




4. Soasoa

Photo Credit: Sinkal Fiji Philip (FB-Bula FM, Fiji)

5. Malau

6. Some road crossings in Macuata

Batiri - Seaqaqa

Natau – Seaqaqa

Nakorotari - Labasa

Dreketilailai – Labasa

7. <u>Western Division</u>

1. Yasawa-i-rara

Photo credit: Osea Tikonatabua

2. Nasoqo (Yasawa)

3. Rakiraki

4. Sigatoka

Raiwaqa crossing (Kavanagasau)

5. <u>Central Division</u>

1. Naitasiri/Namosi

Serea

Naqali flat

Old Queens road – Nabukavesi (Namosi)

2. Tailevu

Viwa (Korovou) of Kings road

Nabulini - Wainibuka

Vuci road

3. **Rewa** (Rewa river)


Photo credit: FBC News

4. <u>Eastern Division</u>

Koro Island

Nacamaki


Photo credit: Fiji TV

Appendix 6 – TC Yasa Media and Social Media Report

1. Media Releases

1. A total of nine media release disseminated to all mainstream media outlets as well as our stakeholders.

2. The first media release was issued on the 11th of December and the final issue on the 18th of December.

3. These were disseminated to mainstream media outlets namely: Fiji TV, FBC(TV+Radio), Communications Fiji Limited (Radio + Fijivillage Website), Fiji Sun Newspaper, Fiji Times Newspaper.

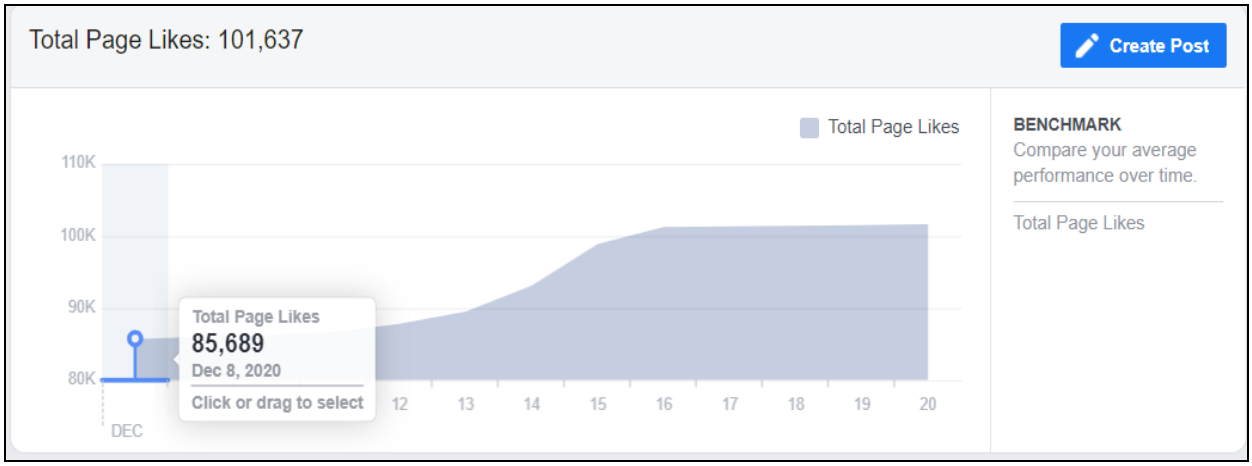
4. Stakeholders namely: SRIF, University of Fiji, NFA, Fiji Airports, EFL, Fiji Roads, Fiji Hotel and Tourism Association, MRD, FNU, Red Cross, UNDP, UNCDF, Femlink Pacific, WAF, MOE, Ministry of Agriculture, NDMO, MSAF, MOH, Tower Insurance, Save the Children, Department of Information, Ministry of Infrastructure & Transport, Warwick Hotels, Mobil.

5. These were posted on our social media pages: Facebook, Twitter and Instagram.

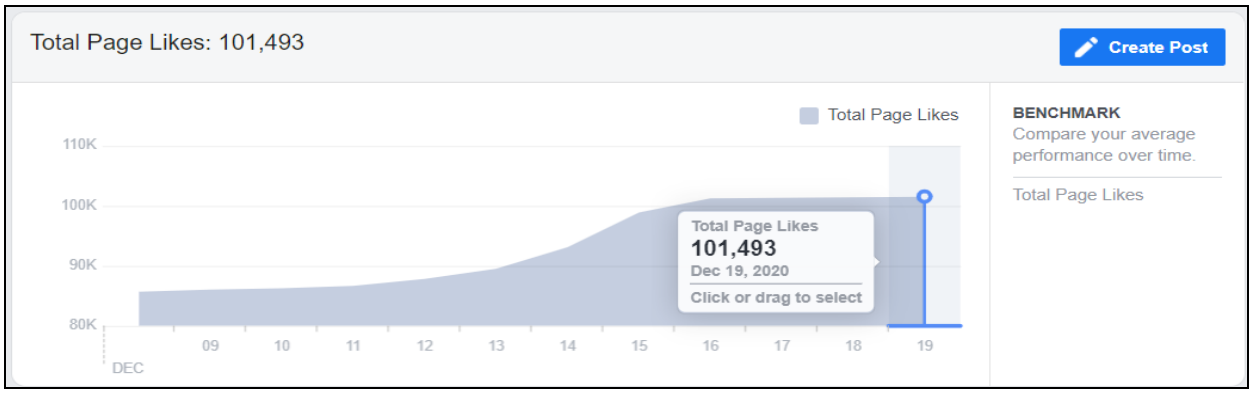
6. Social Media Analytics

FACEBOOK ANALYTICS FOR TC YASA FROM 8TH December, 2020 TO 19TH December, 2020(Period covers from the monitoring of the two lows until exit of TC Yasa from Fiji Waters**)**

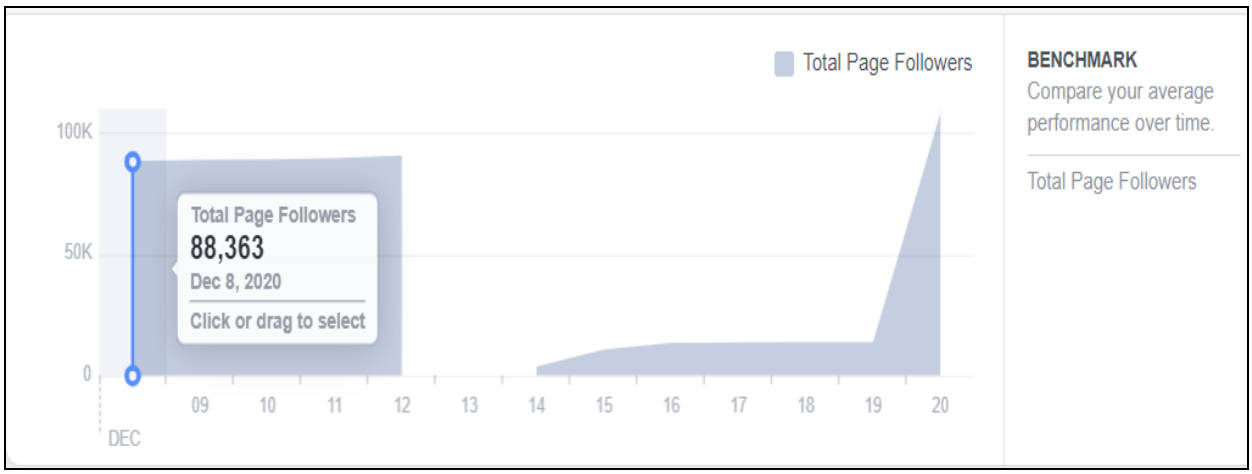
Total Page Likes on Tuesday 8th December, 2020 (When FMS started posting about two tropical lows (one near Rotuma and another low near Samoa)



Total Page Likes on Saturday 19th December, 2020 when TC Yasa exited Fiji Waters

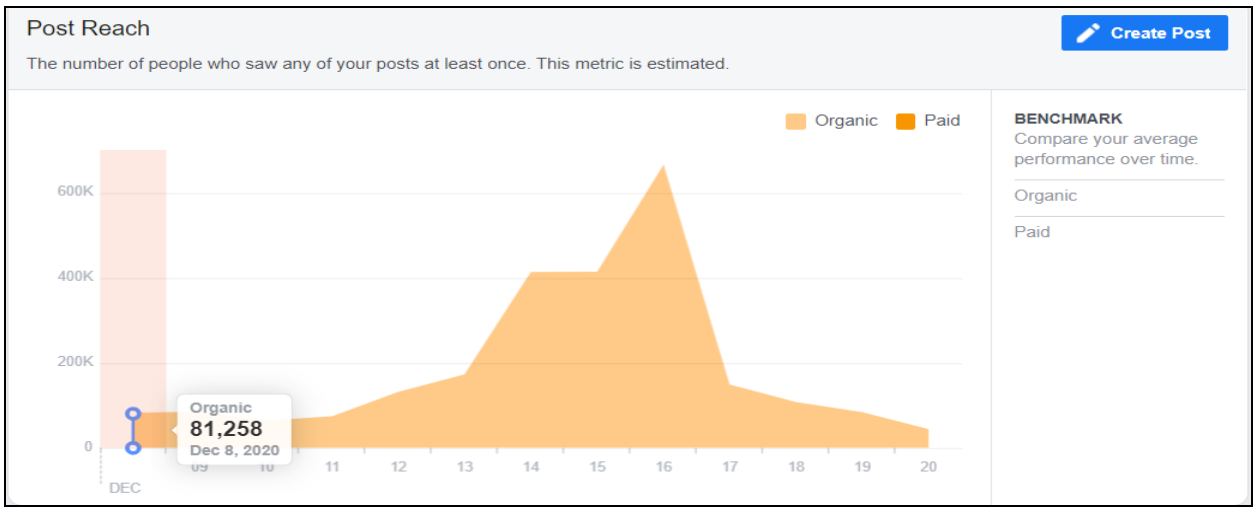


Total Page Followers on 08/12/20 (When FMS started posting about two tropical lows (one near Rotuma and another low near Samoa)

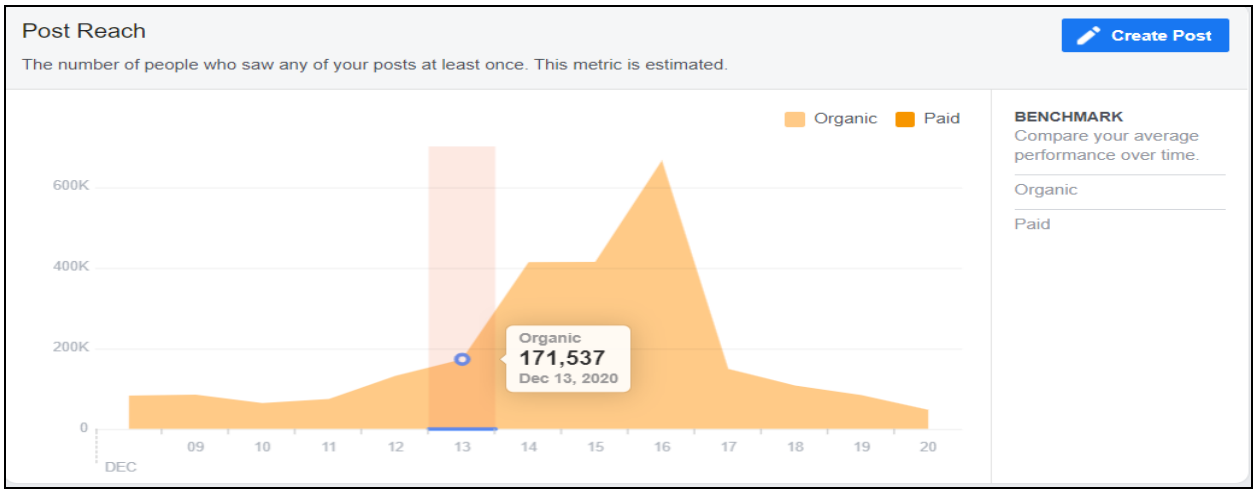


Total Page Followers on Saturday 19th December,2020 when TC Yasa exited Fiji Waters

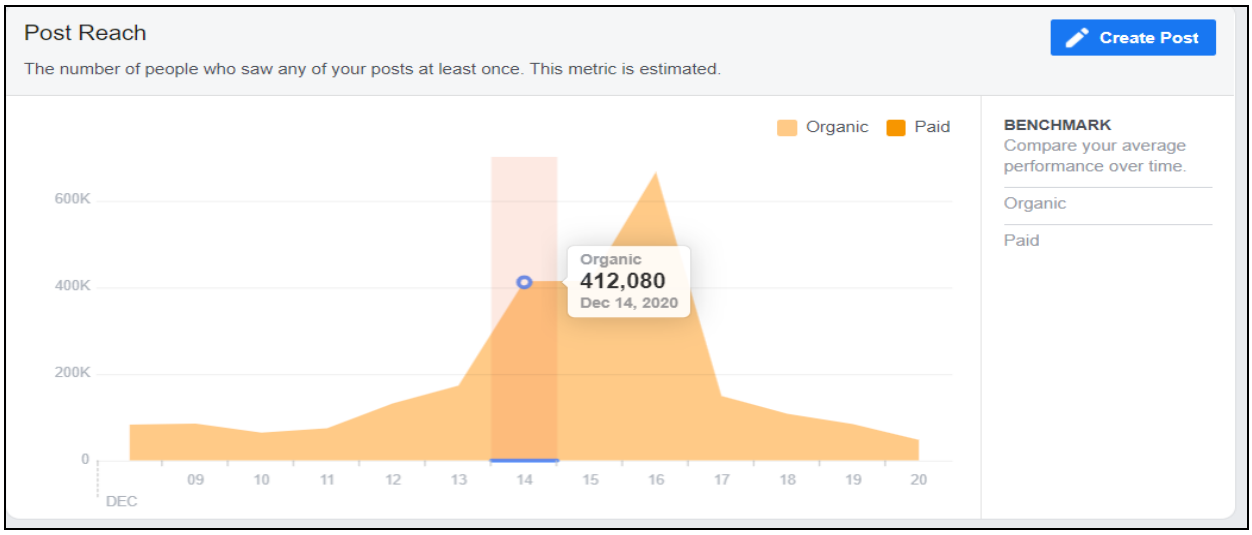
Total Number of People Reached on Tuesday 08/12/20 (When FMS started posting about two tropical lows (one near Rotuma and another low near Samoa)



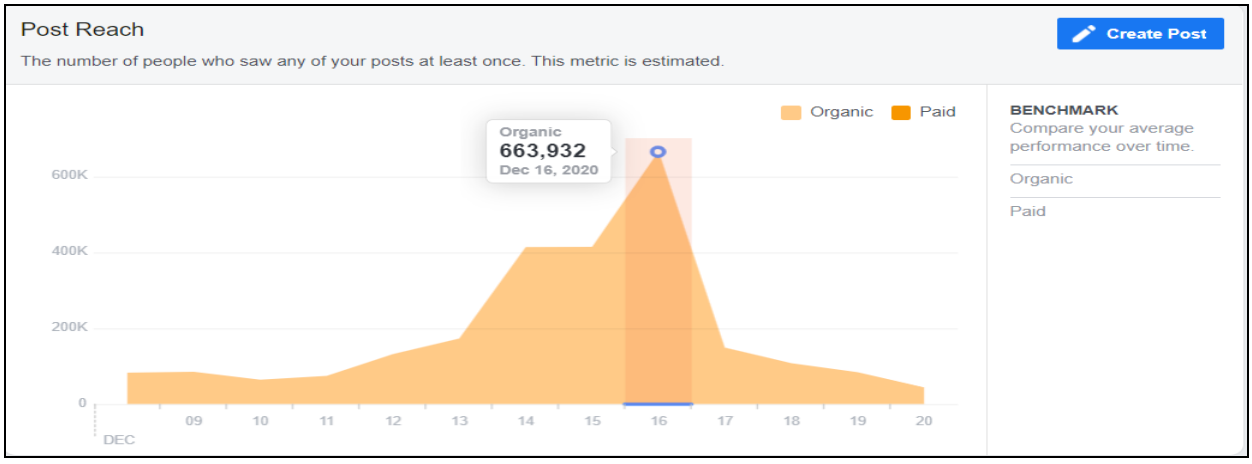
Number of People Reached-Peak 1 on 13 December,2020



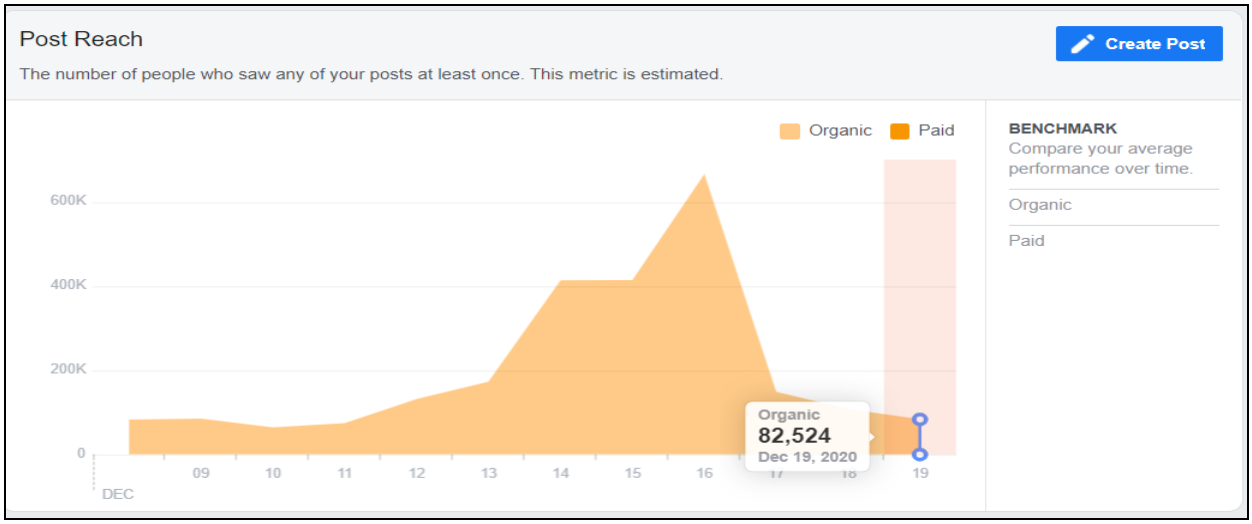
Number of People Reached-Peak 2 on 14 December,2020



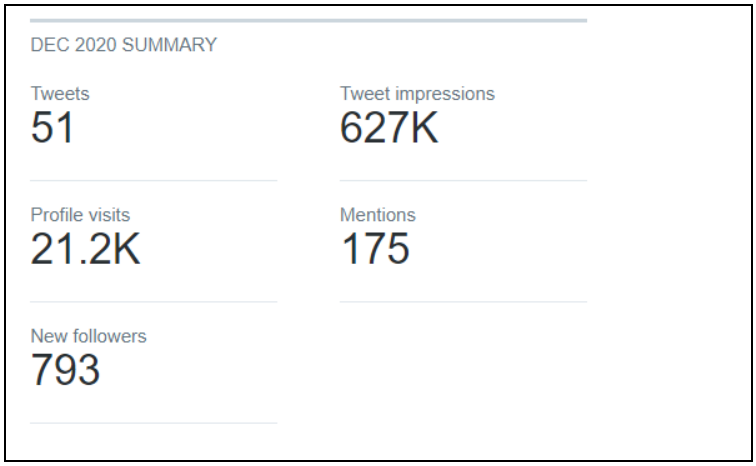
Number of People Reached-Highest Peak on 16 December,2020



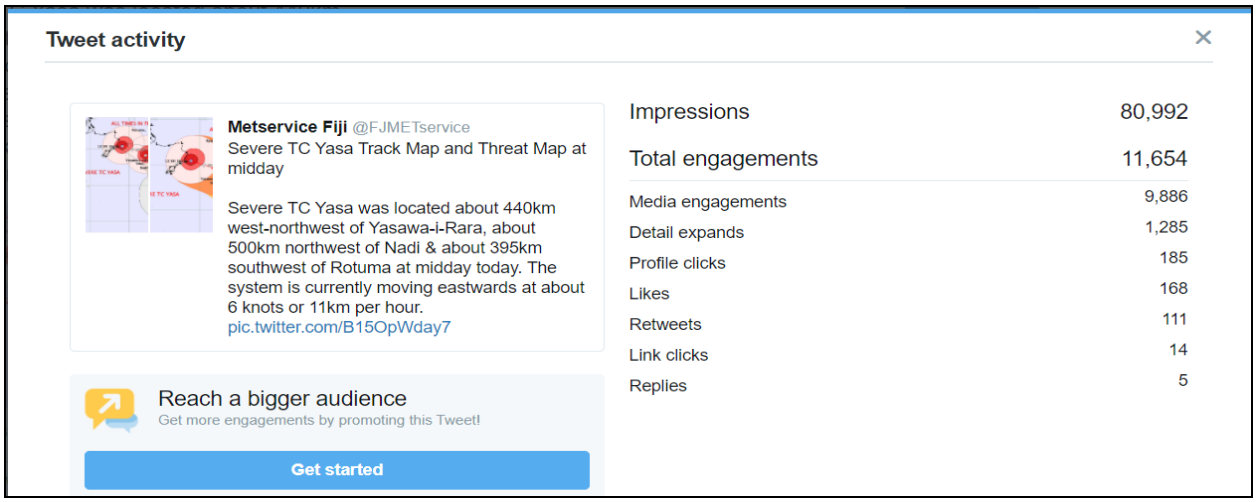
Total Number of People Reached on Sunday 08/12/20 when TC Yasa exited Fiji Waters



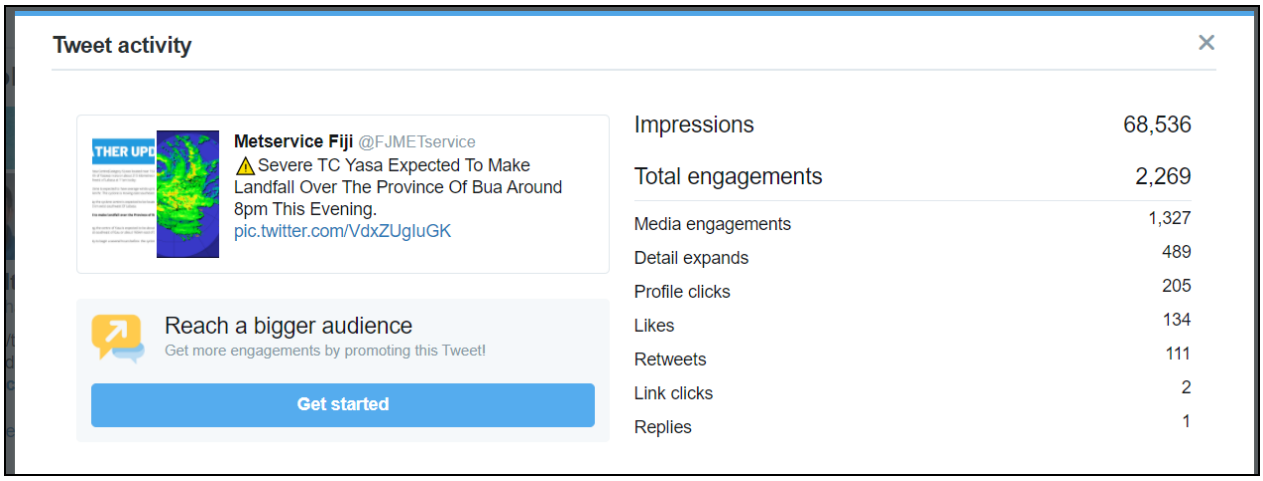
TWITTER ANALYTICS FOR TC YASA FROM 8TH December, 2020 TO 19TH December, 2020(Period covers from the monitoring of the two lows until exit of TC Yasa from Fiji Waters**)**



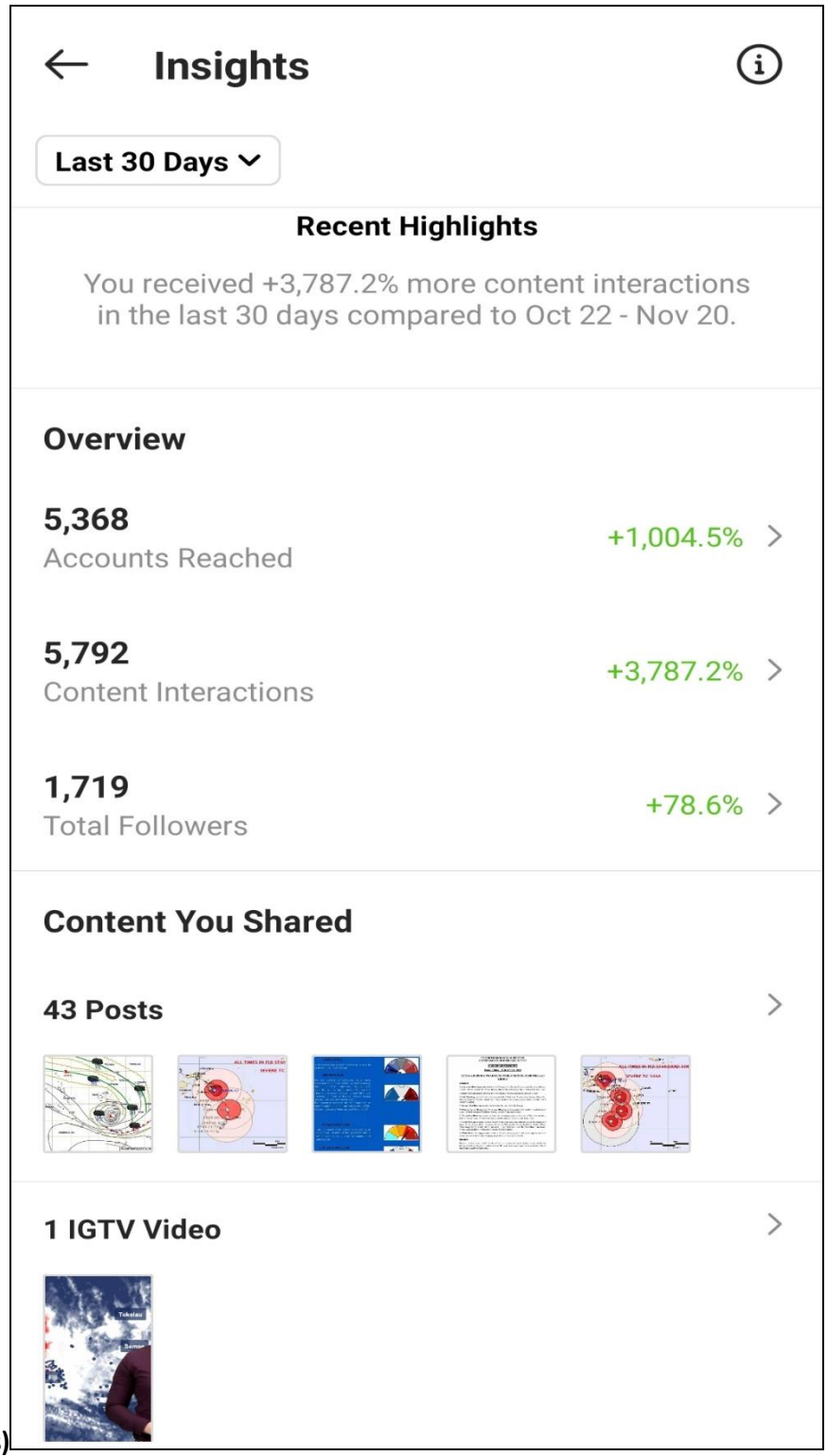
Tweet with the most impressions (tweet with the most views and engagements)



Tweet that was second most engaging and with second most views



INSTAGRAM ANALYTICS FOR TC YASA FROM 8TH December, 2020 TO 19TH December, 2020(Period covers from the monitoring of the two lows until exit of TC Yasa from Fiji Waters)



7. News Coverage

Web Links

https://www.newshub.co.nz/home/new-zealand/2020/12/weather-cyclone-yasa-hours-away-from-fiji-could-wipe-islands-off-map.html

https://www.aljazeera.com/news/2020/12/18/cyclone-yasa-slightly-weakens-but-leave-damage-in-fiji

https://www.rnz.co.nz/international/pacific-news/432964/fiji-met-service-warns-of-destructive-power-of-cyclone-yasa

https://www.fbcnews.com.fj/news/natural-disaster/tc-yasa-to-intensify-to-a-category-four-system-by-friday/

https://fijisun.com.fj/2020/12/08/fiji-met-monitor-two-tropical-lows/

https://www.fbcnews.com.fj/news/tc-yasa/tc-yasa-to-pass-through-bligh-waters/

https://fijisun.com.fj/2020/12/09/brace-for-more-rain-fiji-met/

https://www.fijitimes.com/met-take-warnings-seriously/

https://fijisun.com.fj/2020/12/03/heavy-rain-warning-for-the-weekend/

https://www.fijitimes.com/tc-yasa-people-downstream-of-waterways-advised-to-take-precaution/

https://www.fijitimes.com/tropical-disturbance-poses-no-direct-threat-to-fiji/

https://www.fbcnews.com.fj/news/tc-yasa/tc-yasa-upgraded-to-category-five/

https://www.fijitimes.com/weather-watch-strong-wind-warning-remains-6/

https://fijisun.com.fj/2020/12/17/severe-tc-yasa-expected-to-make-landfall-over-bua-in-a-few-hours/

https://fijisun.com.fj/2020/12/11/tropical-disturbance-td01f-intensifies-into-a-depression-and-remains-to-the-north-of-fiji/

https://www.fijitimes.com/tc-yasa-fijians-along-coastal-areas-advised-to-move-to-higher-grounds/

https://www.canberratimes.com.au/story/7058160/fiji-braces-for-cyclone-yasa/

https://www.rnz.co.nz/international/pacific-news/413732/severe-tc-harold-now-being-felt-in-parts-of-fiji

https://www.fbcnews.com.fj/news/natural-disaster/tropical-cyclone-yasa-may-follow-tc-harold-track/

https://www.fbcnews.com.fj/news/tc-yasa/tc-yasa-upgraded-to-category-five/

https://www.fbcnews.com.fj/news/tc-yasa/tc-yasa-could-be-as-strong-as-tc-winston/

https://www.fijivillage.com/news/TC-Yasa-downgraded-to-CAT-4-as-its-currently-over-the-Lau-Group-8f45xr/

https://www.fbcnews.com.fj/news/tc-yasa/weather-to-worsen-tonight-says-atalifo/

https://www.fijivillage.com/news/Yasawa-currently-feeling-the-impacts-of-TC-Yasa-84rfx5/

Newspaper Articles

Fiji Sun

Sun

What does TC Yasa mean for Suva?

The Fiji Sun is published on behalf of the proprietors by Peter Lomas at 20 Gorrie Street, Suva, Fiji.

Publisher/CEO
Peter Lomas
(M) 998 0712
peterl@fijisun.com.fj

Managing Editor News
Jyoti Prabhita
(M) 998 2077
jyotip@fijisun.com.fj

Managing Editor Business Section
Maraia Vula
(M) 902 7634
maraia.vula@fijisun.com.fj

Managing Editor Digital and Readership Development
Ros Developski
(M) 999 0171
ros.developski@fijisun.com.fj

Managing Editor Sport
Leone Cabenatabua
(M) 991 0730
leonec@fijisun.com.fj

Advertising and Business Development Manager
Rachna Lal
(M) 926 0980
rachnal@fijisun.com.fj

Finance Manager
Jyotshna Chand
(M) 999 0731
jyotsc@fijisun.com.fj

Print Centre Manager
Joana Bueta
(M) 964 9651
joana.bueta@fijisun.com.fj

Acting Circulation Manager
Soko Vakacegu
(M) 9992042
snkov@fijisun.com.fj

Suva headquarters
Credit Union Towers
20 Gorrie Street, Suva.
(P) 3307555

North office
Labasa 1151 Sangam Building,
Shop 4 Main Street, Naseakula
Road, Labasa
(P) 8815611

Nadi office
Shop No 2, Ground Floor, 163
Queens Road, Main Street, Nadi
(P) 6708088

Lautoka office
Shop No. 5, Yakabala St (Opposite
Lautoka Bus Stand)
(P) 6665001

TC *Yasa* will affect the whole of Fiji. However, this will really test Suva's resilience.

Suva has thankfully been spared the worst of any cyclones in recent years.

Last big storm Suva faced was Cyclone *Kina* back on New Years eve of 1993.

Twenty three people were killed during this ordeal.

What does TC *Yasa* mean for Suva? When TC *Kina* had hit, we did not have so many people occupying the informal settlements especially along the Lami-Nausori corridor.

One of the major concerns will no doubt be flying debris. This could include roofing iron, tree branches etc. Looking back at Cyclone *Kina*, people had died after being hit by flying objects. This is why tying down roofs and trimming of tree branches is really important.

We still have a few more hours to prepare. Prepare your emergency kits, know your nearest evacuation centres.

By texting in EC to 13287 you will be able to know where your nearest evacuation centres are.

Any text message to this number is free. This is now available at your new Digicel Tips. Make use of this service. Do not get caught out.

Prepare your emergency kits with non-perishable items. On that note, it is good of the Consumer Council of Fiji to issue an advisory on price gouging.

The Council has reminded traders to refrain from increasing prices during natural disasters as this amounts to unfair trade practices under Section 66 and 76 of the Fijian Competition and Consumer Commission Act 2010.

Chief executive officer, Seema Shandil, in a timely statement has also urged members of the public to report any instances where they feel traders have unfairly increased prices of items which are in demand right nowsuch as candles, matches, bottled water.

Consumers who come across instances of price gouging are urged to contact the Consumer Council on the tollfree number on 155 or email them on *complaints@consumerfiji.ord*.

Alternatively, consumers can download their Mobile App on *Google Playstore* for ease of lodging a complaint.

JYOTI PRATIBHA

[email: jyotip@fijisun.com.fj]