



EUROPEAN COMMISSION
JOINT RESEARCH CENTRE

12 February 2018

Tropical Cyclone GITA – Tonga

GDACS Tropical Cyclone Red Alert

09 Feb 2018 - ongoing

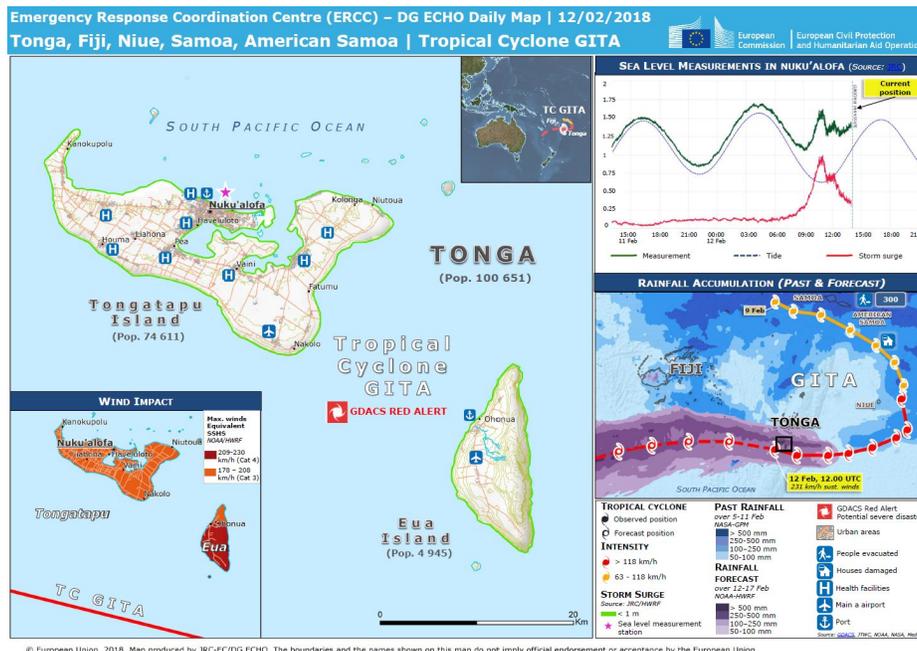


Figure 1 - TC GITA in Tonga (as of 12 Feb, 12.00 UTC)

1 Executive Summary

- Tropical Cyclone GITA passed near the islands of Eua (pop. 4 900) and Tongatapu (pop. 74 600, most populous island of Tonga) on 12 February morning (UTC), as an intense Tropical Cyclone with max. sustained winds of 230 km/h. **Very strong winds**, heavy rains and storm surge (up to **1 m** in Nuku'alofa) affected the islands of **Eua** and **Tongatapu**, including the capital **Nuku'alofa**.
- Over the next 24 h, GITA is forecast to continue moving west, passing near Ono-I-Lau island (Lau islands, Fiji) on 13 February morning (UTC), still as an intense Tropical Cyclone. **Very strong winds**, heavy rains and storm surge could also affect the southern Lau islands, especially **Ono-I-Lau** (pop. 470) and **Vatua** (pop. 250).
- The government of Tonga has declared a **state of emergency**.

- The Joint Research Centre (JRC) is following the event through the information automatically collected and analysed in the Global Disasters Alerts and Coordination System (GDACS). GDACS issued a RED alert for TC GITA in Tonga on 11 February, providing situation maps and compiling this report.

2 Situation Overview

2.1 Meteorological Situation

Tropical Cyclone GITA

- Tropical Cyclone **GITA** formed over the Southern Pacific Ocean on 9 February, close to Wallis and Futuna, and started moving east-southeast, strengthening. It passed near Samoa and American Samoa on 9 February and east of Niue on 10 February. Heavy rainfall affected these islands during its passage, causing floods, especially in Samoa.
- On 11 February, TC GITA started turning west, moving towards the capital of Tonga, Nuku'alofa, strengthening. Its center passed very close to the islands of Eua (pop 4 900 people) and Tongatapu (pop. 74 600, most populous island of Tonga) on 12 February morning (UTC), as an intense Tropical Cyclone with max. sustained winds of 230 km/h. **Very strong winds**, heavy rains and storm surge (up to 1 m in **Nuku'alofa**) affected the islands of **Tongatapu**, including the capital **Nuku'alofa**, and **Eua**.
- On 12 February at 12.00 UTC its center was located approx. approx. 50 km southwest of Nuku'alofa (Tongatapu island) and it had max. sustained winds of **231 km/h** (equivalent to a **Category 4** in the Saffir-Simpson Scale, SSHS, see Annex).
- Over the next 24 h, GITA is forecast to continue moving west, passing near Ono-I-Lau island (**Lau islands, Fiji**) on 13 February morning (UTC), still as an intense Tropical Cyclone with max. sustained winds of **210-220 km/h**. **Very strong winds**, heavy rains and storm surge could affect the southern Lau islands, including Ono-I-Lau and Vatoa.
- After the passage of the tropical cyclone in Tonga, an improval of weather conditions is expected from Wednesday onwards. Based on the ECMWF high-resolution model and ensemble prediction system, partly cloudy to cloudy conditions are forecast with light / moderate rain with the probability of local thunderstorms and showers. Winds mainly from northern / northeastern directions with 25 to 35 km/h gusting temporarily up to 55 km/h. Maximum temperatures will be reaching 28 to 30 deg Celsius with minimum locally at 25 to 27 deg Celsius.

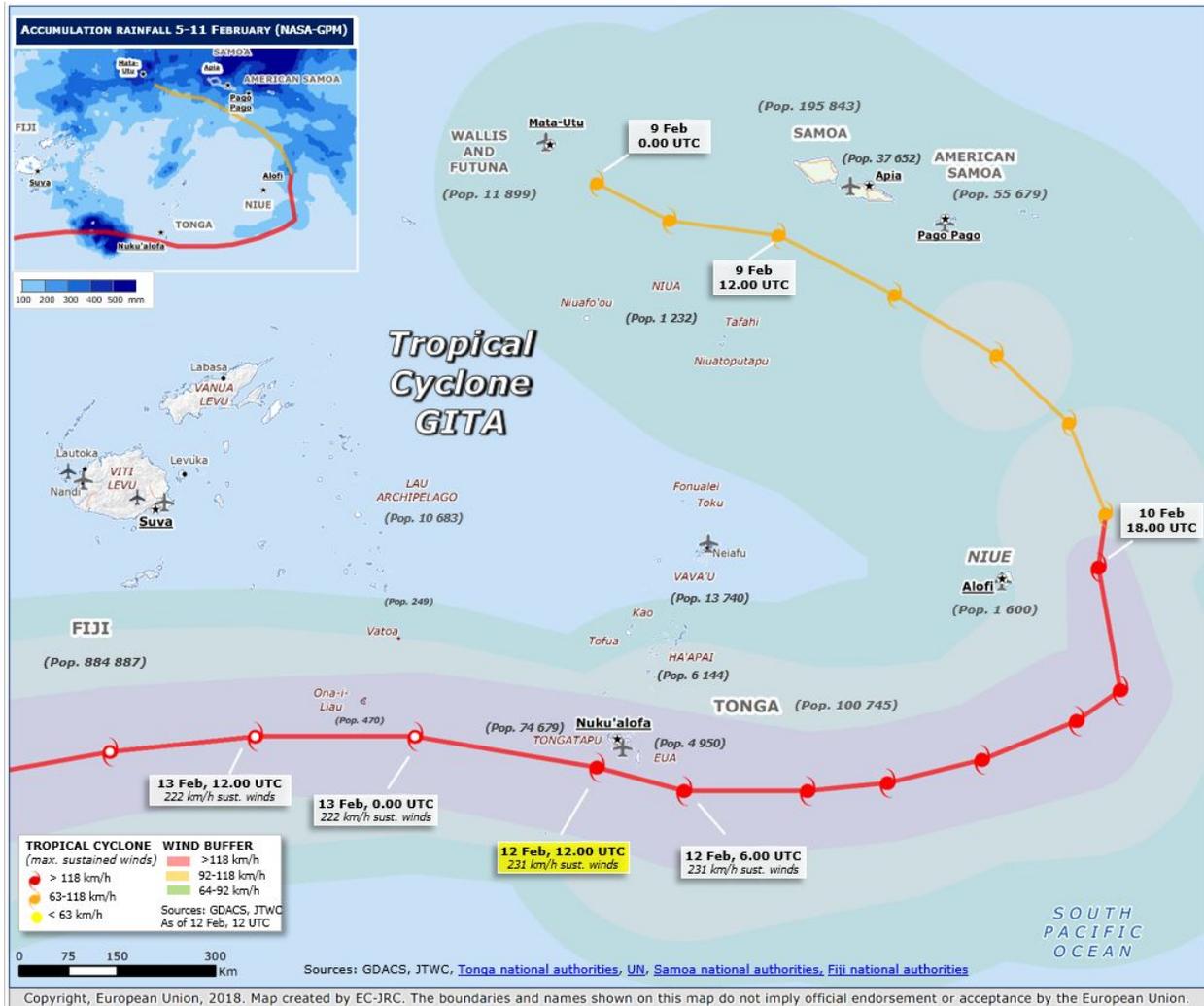


Figure 2 - TC GITA in the southern Pacific Ocean (as of 12 Feb, 12.00 UTC).

Warnings in effect

As of 12 February morning, there were the following warnings in effect:

Tonga ([Tongan Meteorological Service](#), as of 12 Feb morning UTC):

A tropical cyclone warning is in force for Vava'u, Ha'apai and 'Eua.

Fiji ([Fiji Meteorological Service](#), as of 12 Feb afternoon UTC)

- A Hurricane Warning remains in force for **Ono-I-Lau** and **Vatoa**.
- A Storm Warning remains in force for the rest of southern Lau group
- A Gale Warning remains in force for Matuku, Totoya, Moala, Kadavu and nearby smaller islands, Lakeba and Nayau.
- A Strong Wind Warning is in force for the rest of Fiji.

2.2 Humanitarian impact

Samoa, American Samoa, Niue

Before reaching Tonga, on 9-11 February TC GITA has affected other islands of the southern Pacific Ocean causing damage and floods, especially in Samoa.

- Samoa: 300 people have been evacuated in the capital Apias (Samoa), several houses have been damaged and roads have been flooded.
- American Samoa: several damaged houses and flooded roads
- Niue: Situation of the impact not yet clear at the moment

Tonga

- Damage not yet reported
- The government of Tonga has declared a **state of emergency** for the whole country ([Tonga Gov](#)).
- The Pacific Humanitarian Team, through its partners, stands ready to support the people and governments of the countries affected by Tropical Cyclone Gita should a request be made for international assistance ([UN OCHA Flash Update 1](#))

Exposed Population

GITA is forecast to reach Eua and Tongatapu islands in the morning of 12 February, with max. sustained winds of 230 km/h (equivalent to a Category 4 in the SSHS). Tongatapu is the country's most populous island with 74 611 people and the location of its capital Nuku'alofa, while Eua has a population of 4 945 people. The populations of Tonga and for each island divisions according to the Tonga National Population and housing census 2016 - Preliminary results (Statistics Department Tonga) are shown in the table below.

Island Division	Population
TONGA	100,651
Tongatapu	74,611
Vava'u	13,738
Ha'apai	6,125
'Eua	4,945
Ongo Niua	1,232

Table 1 - Population in Tonga (as of 2016, Census - Preliminary Results)

Source: Statistics Department Tonga <http://tonga.prism.spc.int/>

3 JRC involvement

3.1 GDACS alert

JRC is responsible for the operation of GDACS (www.gdacs.org) that plays a major role in alerting the international community to humanitarian emergencies during natural disasters. The alerts of GDACS (Green, Orange, Red) are elaborated based on the severity of the event, the population involved and the vulnerability of the countries (see Annex). GDACS also sends e-mail and SMS alerts to subscribed recipients.

The JRC is closely following this event because of the strength of this Tropical Cyclone and the vulnerability of the country. The present report was done at the request of the ERCC.

Event alert

GDACS has issued the first **ORANGE** Alert for this event in Tonga on 9 February and it has increased the alert level to **RED** on 11 February. According to the latest bulletin (12 February, 12:00 UTC), the GDACS alert level is still **RED** (for high winds) for this event in Tonga, with more than 80000 people potentially affected by cyclone strength winds (> 120 km/h). The possible impact due to winds, rainfall and storm surge are shown below, while the automatic GDACS report for TC GITA can be found at this address: <http://www.gdacs.org/report.aspx?name=GITA>.



Figure 3 - Automatic GDACS impact estimation (as of 12 Feb, 12.00 UTC).

JRC Emergency Reporting - Activation #001 - 11 Feb 2018

Bulletin Timeline

Advisory Alert color	Date (UTC)	Category	Wind speed	Wind gusts	Population affected by cyclone winds (>120km/h)	Location (lat, lon)
	12 Feb 2018 06:00	Category 4	231 km/h (143 mph)	km/h (mph)	82000 people	-21.8, -174.3
	12 Feb 2018 12:00	Category 4	231 km/h (143 mph)	km/h (mph)	83000 people	-21.5, -175.5
	13 Feb 2018 00:00	Category 4	222 km/h (138 mph)	km/h (mph)	<1000 people	-21.1, -178
	13 Feb 2018 12:00	Category 4	213 km/h (132 mph)	km/h (mph)	no people	-21.1, 179.8
	14 Feb 2018 00:00	Category 3	204 km/h (126 mph)	km/h (mph)	no people	-21.3, 177.8
	14 Feb 2018 12:00	Category 3	194 km/h (120 mph)	km/h (mph)	<1000 people	-21.6, 176
	15 Feb 2018 12:00	Category 2	176 km/h (109 mph)	km/h (mph)	<1000 people	-22.6, 172.4
	16 Feb 2018 12:00	Category 2	157 km/h (98 mph)	km/h (mph)	no people	-24.5, 169
	17 Feb 2018 12:00	Category 1	130 km/h (80 mph)	km/h (mph)	no people	-26.6, 166.8

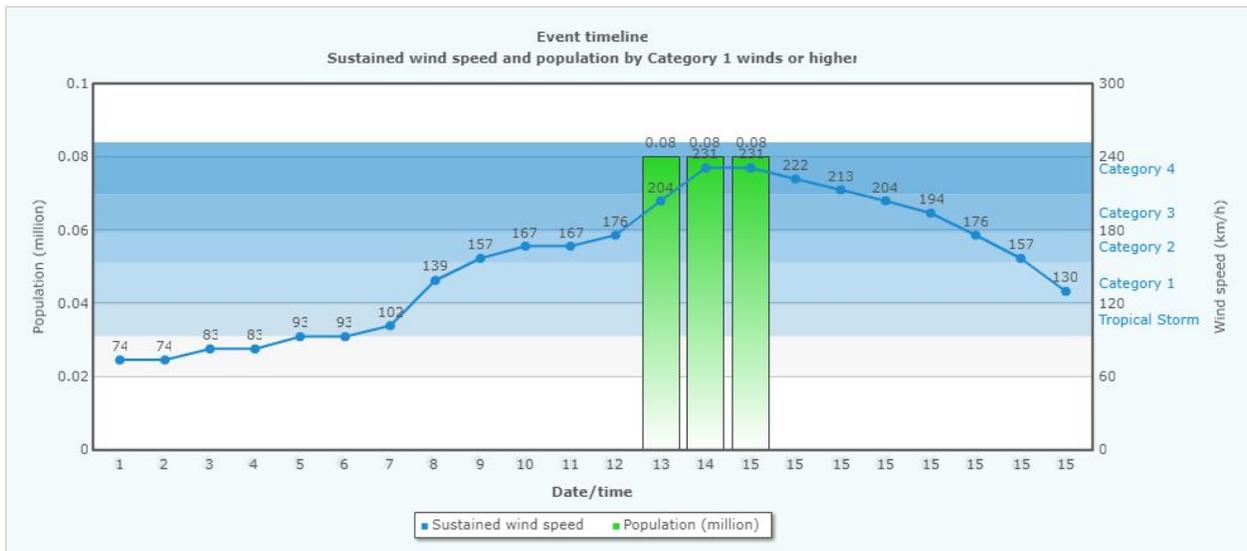


Figure 4 - GDACS Alert for Tropical Cyclone GITA - Event Timeline, population affected, max. sustained winds (the Category is based on the SSHS, see Annex)

Impact estimation

Summary of the expected impact

- Wind: max. 1-min sustained winds of 230 km/h (equivalent to a Category 4 in the SSHS), with higher wind gusts. Population potentially affected by damaging winds: > **80 000**.
- Rainfall: total accumulation over 250 mm/126h (NOAA-HWRF) in Tuku'alofa and Eua (Tonga) and in Ono-I Lau island (Lau islands, Fiji). Population potentially affected by **heavy rainfall** (more than the monthly average): > **66 000**
- Storm Surge: storm surge measurement: **1 m in Nukualofa**.

Wind

- TONGA: The center of GITA passed near the islands of Eua and Tongatapu on 12 February morning (UTC), with max. sustained winds of 230 km/h (equivalent to a Category 4 in the SSHS). **Very strong winds** (up to 230 km/h, with higher gusts) affected these islands, including the capital **Nuku'alofa**.
- FIJI: GITA is forecast to continue moving west, passing near Ono-I-Lau island (**Lau islands, Fiji**) in the morning of 13 February, still as an intense Tropical Cyclone with max. sustained winds of **210-220 km/h**. Based on this forecast, **very strong winds** up to 220 km/h, with higher gusts) could also affect the southern Lau islands, especially **Ono-I-Lau** (pop. 470) and **Vatoa** (pop. 250).

Rainfall

TC GITA it is expected to continue producing heavy rains (more than 250 mm/126h, HWRF) in southern Tonga and southern Fiji on 12-14 February, with the risk of floods and flash floods.

The islands potentially mostly affected are:

- TONGA: **Tongatapu**, including the capital Nuku'alofa, and **Eua island**
- FIJI: **Ono-I Lau island** (Lau islands)

The total rainfall accumulation produced by TC GITA is expected to be above the monthly average rainfall of February that is about 200 mm in this area (Tuku'alofa Tonga: nearly 200 mm, Ono-I Lau (Fiji): nearly 180 mm)

Storm Surge

Storm surge forecasts indicate a maximum of **0.8-1.0 m** on the coasts of Eua and Tongatapu on 12 Feb at 13:00 UTC; however as at this time low tide is forecasted, and considering that in general the tide amplitude is in the order of 2.5 m, this storm surge should not pose large problems.

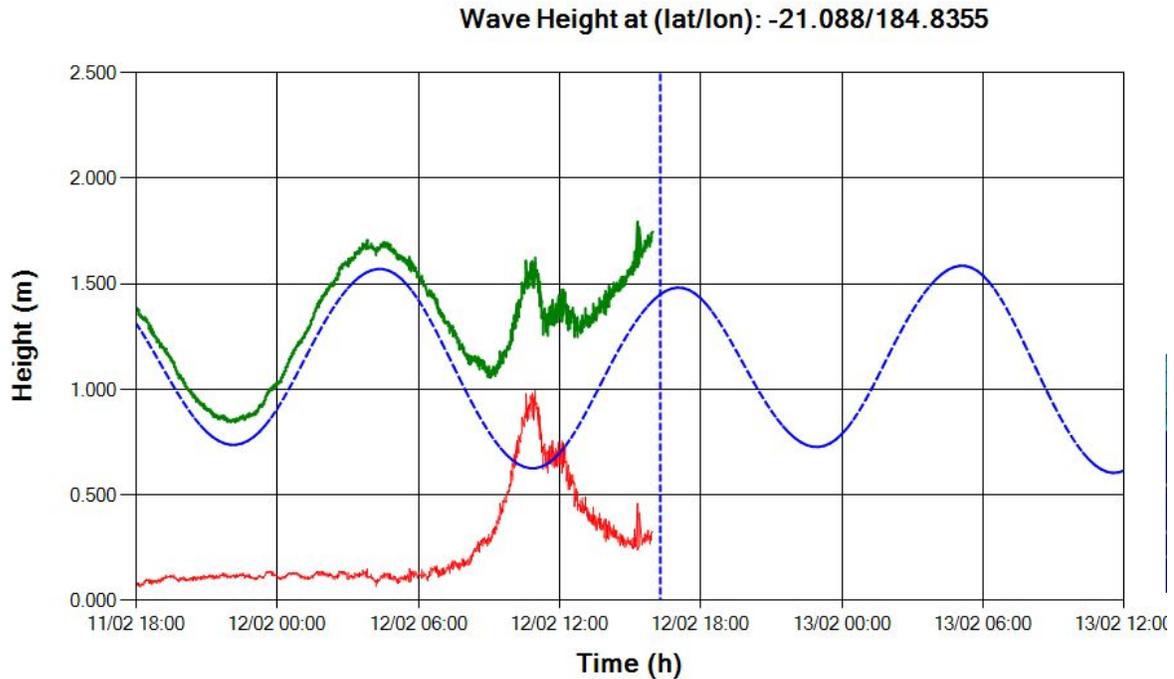


Figure 5 - Sea level measurement in Tonga.

The JRC storm surge calculations are shown in the figure below, where several models used for the calculations show similar maximum height. The maximum estimation is in good agreement with the measurements that, as of 10:30 AM UTC shows a maximum value in the same order of magnitude, about **1 m**.

Note: It is important to note that the JRC storm surge calculations don't include wave, tide and river effects. In the area of a delta river, bays, the storm surge may be higher. The torrential rains that may affect the areas during the passage of a Tropical Cyclone may increase the river flow and its outflow could be blocked by the incoming storm surge. This could create floods in the surrounding areas of the cities close to a delta river. In this case the maximum of the storm surge in Tonga coincides with a minimum of the astronomical tide and therefore no major impact is expected due to storm surge.

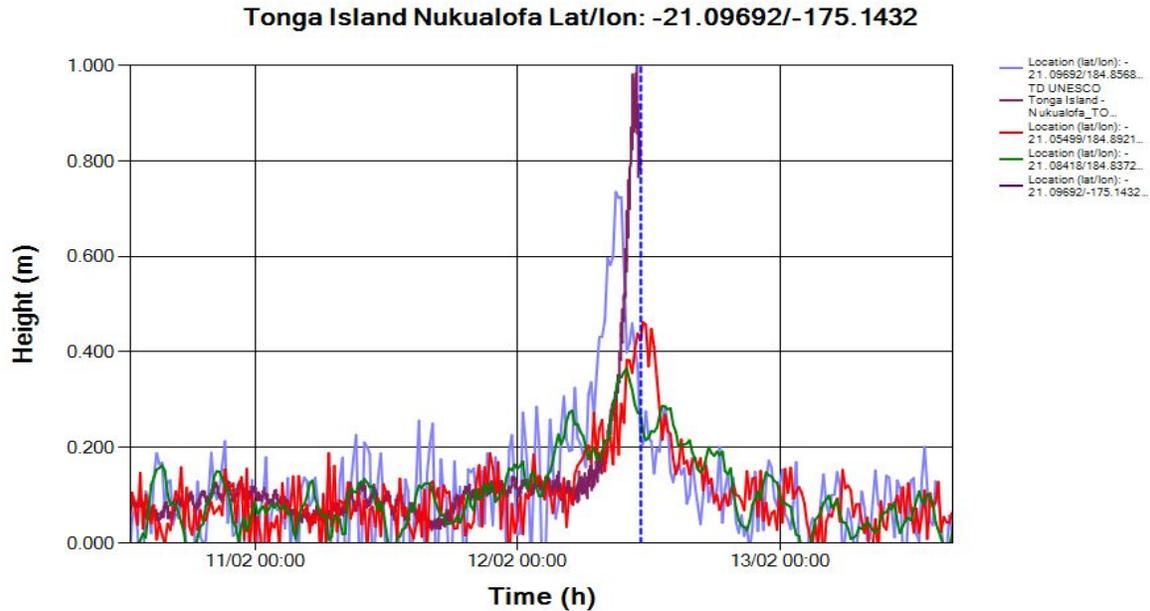


Figure 6 - Sea level expected by various global models in Nukualofa, Tonga (blue HWRf, red ECMWF and green is GFS), compared with the measured value (violet curve).

Before reaching Tonga, on 9th Feb the cyclone invested Samoa islands and the effect on the storm surge is visible in the plot below. The blue curve is the estimate using HWRf and Delft3d code and the red curve is the measurement. About 30 cm surge were measured and correctly forecasted..

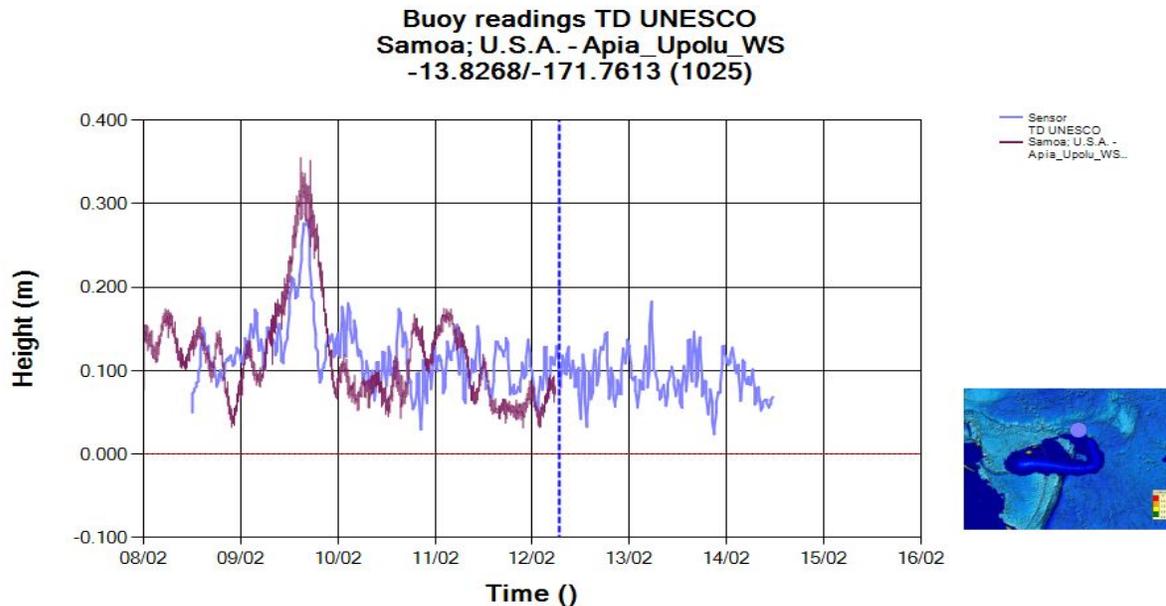


Figure 7 - Sea level in Samoa

3.2 Copernicus EMS activation

No activation of Copernicus EMS system up to now. Possible pre-tasking on the islands of Tonga archipelagus would be possible.

4 Other activities in support to ERCC

4.1 JRC Support to ERCC

In the period after the end of ARISTOTLE services and the beginning of the new 24h service that is being prepared, JRC supplies ERCC with a similar service during working hours. This is the first report for this event.

The JRC provides updated information on TC GITA since 9 February in its ECHO Daily Flash reports, available at <http://erccportal.jrc.ec.europa.eu/ECHO-Flash>. Moreover The JRC is preparing a daily map with the situation update. These are published on the ERCC Portal and distributed to all Member States and are available at <http://erccportal.jrc.ec.europa.eu/Maps/Daily-maps>

4.2 Virtual OSOCC Activation

A new breaking emergency discussion has been initiated in VOSOCC web site.

UN-OCHA is following the situation but for the moment there has been no request for pre-positioning of an UNDAC team. OCHA FCSS is in touch with the OCHA Regional Office in Suva, Fiji, who are closely monitoring the Cyclone.

4.3 International Charter activation

UNOSAT Rapid Mapping Service is activated for this event and UNOSAT requested an activation of the space charter.

5 Expected Updates

The report will be updated if relevant changes will be identified.

6 References and contact points within JRC

Contact points within JRC: Disaster Risk Management Unit
- Ian Clark, ian.clark@ec.europa.eu

- Alessandro Annunziato, alessandro.annunziato@ec.europa.eu
- Pamela Probst, pamela.probst@ec.europa.eu

For updated information on the disaster, please consult the following web sites:

- GDACS: <http://www.gdacs.org/media.aspx?eventid=1000436&eventtype=TC>
- ERCC portal: <http://erccportal.jrc.ec.europa.eu/>
- Copernicus: <http://emergency.copernicus.eu/mapping/list-of-components/>
- Tonga Meteorological service <http://www.met.gov.to/> (site very busy, not accessible at the moment)
- Fiji Meteorological Office <http://www.met.gov.fj/index.php>
- NOAA-HWRF:
http://www.emc.ncep.noaa.gov/gc_wmb/vxt/HWRF/tcall.php?selectYear=2018&selectBasin=Southern%20Hemisphere&selectStorm=GITA09P

Annex 1 - Detailed Map on the Tropical Cyclone



Annex 2 - GDACS Alerts

JRC is responsible for the operation of GDACS, that plays a major role in alerting the international community to humanitarian emergencies during natural disasters. The alerts of GDACS (Green, Orange, Red) are elaborated based on the severity of the event, the population involved and the vulnerability of the countries. GDACS also sends e-mail and SMS alerts to subscribed recipients. A detailed description of GDACS can be found in the GDACS Guidelines available at: http://www.gdacs.org/Documents/GDACS%20Guidelines%202014_-_FINAL.PDF

GDACS ALERTS		
	GREEN ALERT	Moderate event, International Assistance not likely
	ORANGE ALERT	Potential local disasters, International Assistance might be required
	RED ALERT	Potentially severe disasters, International Assistance is expected to be required

Tropical Cyclones have three dangerous effects (strong winds, storm surge and heavy rain).

Wind

The GDACS alert levels for the TCs are based on the risk formula that includes:

- TC wind speed (hazard)
- Population affected
- Vulnerability of the affected country

The overall alert for a Tropical Cyclone comes from **wind effects**.

Storm Surge

Storm surge is an abnormal rise of water above the predicted astronomical tides, generated by strong winds and by a drop in the atmospheric pressure. It was implemented in the HyFlux2 code, routinely used in GDACS to model inundation due to tsunami run-up.

The GDACS alert levels are based on the maximum storm surge height:

- Green when the storm surge is below 1.0m;
- Orange when the storm surge is between 1.0m and 3m;
- Red when the storm surge is above 3m.

It should be noted that the estimation of the sea level is strongly dependent on the initial data for the wind velocity and direction and the sea level change according to each bulletin that was available

JRC is preparing a new alert system that will include all the effects.

TC Classification used in GDACS

The equivalent Category based on the Saffir-Simpson Hurricane Wind Scale (SSHS) is also indicated in GDACS. The SSHS is the official scale used by NOAA-NHC for the North Atlantic TC basin and is a scale from 1 to 5, based on the hurricane's 1-min sustained wind speed and it estimates the potential property damage (see table below).

Saffir-Simpson Hurricane Wind Scale (SSHS)		
Hurricane CATEGORY	1-min sustained winds (km/h)	Types of Damage Due to Hurricane Winds
Cat. 1	119 - 153	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
Cat. 2	154 - 177	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks
Cat. 3 <i>Major Hurricane</i>	178 - 208	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes
Cat. 4 <i>Major Hurricane</i>	209 - 251	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
Cat. 5 <i>Major Hurricane</i>	≥ 252	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months

TC Classification (Saffir-Simpson Hurricane Wind Scale)
see NOAA-NHC: <http://www.nhc.noaa.gov/aboutsshws.php>

Annex 3 - TCs in Tonga

TC season

From 1 November to 30 April

The peak time for the occurrence of tropical cyclones in Tonga is from January to March with most events occurring in **February** (source: [Met Tonga](#)). It should be noted that tropical cyclones have occasionally formed outside this period e.g. Tropical Cyclone “Keli” which affected Northern Tonga in June 1997.

Significant Past TCs in the area:

- **2016 WINSTON:** it pass near Tonga (Vava'u Group) as a Tropical Storm. Media reported approximately 2 500 people inside evacuation centres, with 10 houses destroyed and another 200 damaged. Agriculture sustained significant damage, with 85–95 percent of the banana crop and most of the vanilla crop on Vava'u lost.
- **2014 IAN:** it passed directly over the Ha'apai Group on 11 Jan 2014 as an intense TC (220-230 km/h equivalent to a Cat 4 in the SSHS), causing extensive damage. 5 000 people were affected, 2335 displaced, one person was killed and another 14 were injured. In Ha'apai 800 houses were destroyed, 30 commercial and government building as well as hundreds of schools were damaged, and 95 % of crops were damaged. Prime Minister declared a state of emergency for Ha'apai on 11 January 2014 .
- **2011 WILMA:** it passed over Ha'apai Islands with max sustained winds of 140 km/h (equivalent to a Cat 1 in the SSHS), causing strong winds, heavy rain and coastal flooding to the Ha'apai Islands. Its passage coincided with high tide, causing a significant amount of damages to infrastructure, housing, health and sanitation, education and tourism sectors.
- **2010 RENE:** it passed over Vava'u, Ha'apai and Tongatapu Islands with max sustained winds of 150-170 km/h (equivalent to a Cat 1-2 in the SSHS), bringing heavy rain, sea swells and flooding and disrupting electrical and communications services on these islands. Food crops were severely affected and more than 127 houses were damaged.
- **2001 WAKA:** It passed directly over Vava'u islands with max. sustained winds of 180-190 km/h (equivalent to a Category 3 in the SSHS). It was one of the most destructive tropical cyclones ever to affect the South Pacific Kingdom of Tonga, devastating the North Island groups (the Niuas, Vava'u and part of Ha'apai), wrecking its commercial fishery, tourism facilities and agricultural farms in Vava'u.

Annex 4 - INFORM

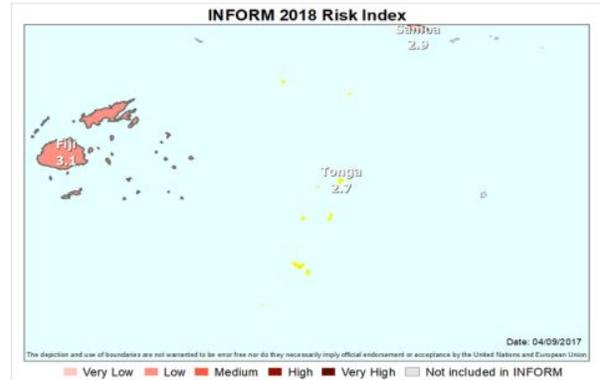
TONGA

Polynesia
Upper middle income

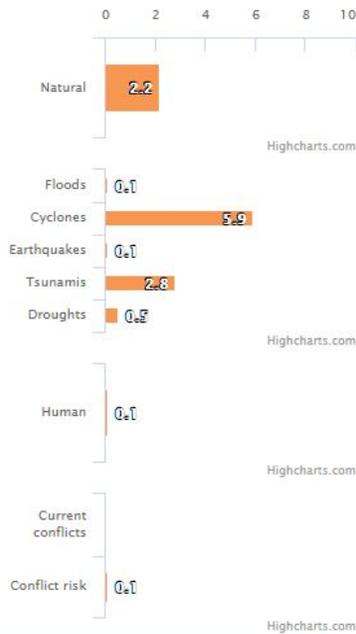
INFORM Country Risk Profile

VERSION 2018

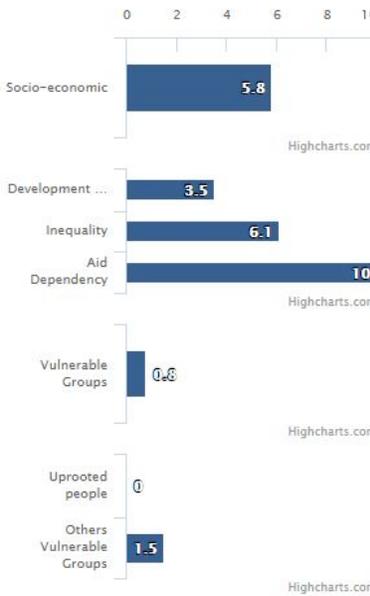
	Value	Rank	Trend (3 years)
INFORM Risk	2.7	123	➔
Hazard & Exposure	1.2	164	➔
Vulnerability	3.7	77	➔
Lack of Coping Capacity	4.6	84	➔



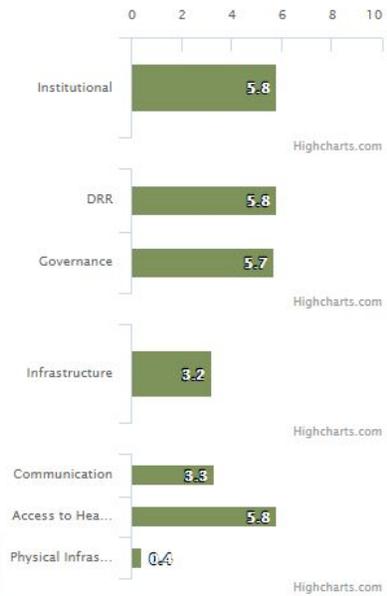
Hazard & Exposure



Vulnerability

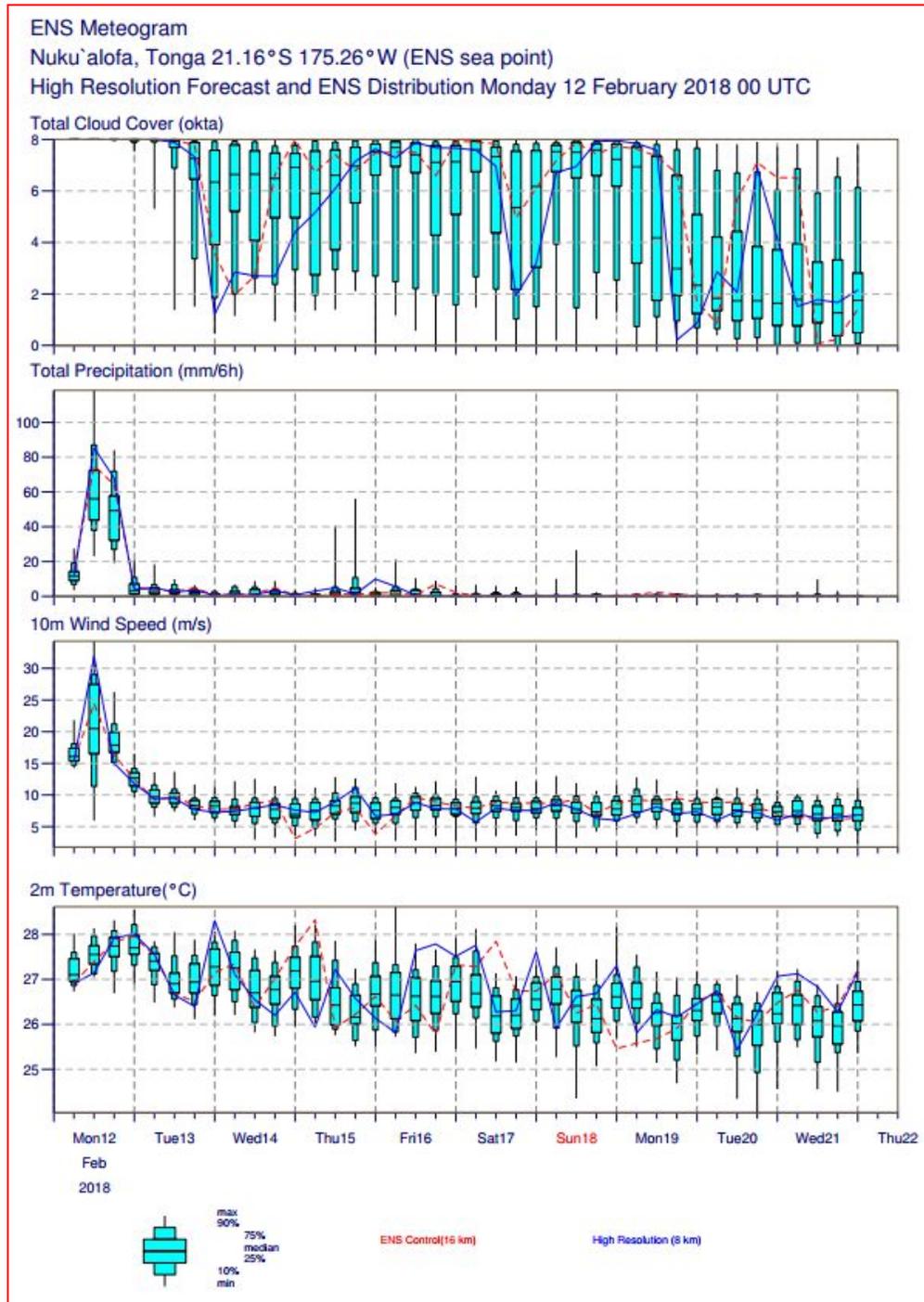


Lack of Coping Capacity



Annex 5 - Weather forecasts for Nuku'alofa

ECMWF Meteogram for Nuku'alofa of closest ensemble (sea) grid point at 7 km south west



Main points described in the meteogram

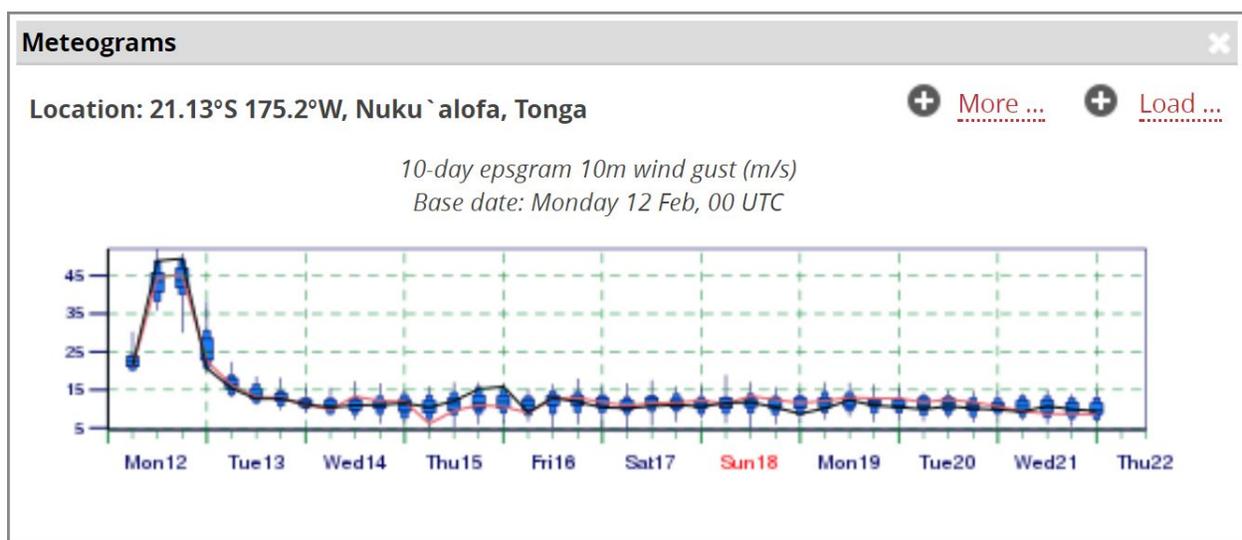
Meteograms contain information coming from both the deterministic single model high-resolution (HIRES) forecast and the Ensemble Prediction System (EPS) comprising 50 members plus one (the control forecast). The horizontal resolution of the HIRES is ~8 km whereas the resolution of ensemble members (and control) is ~16 km. HIRES is denoted by blue, whereas Control forecast (of the ensemble) is denoted by red colour. The values of the ensemble are contained in a box plot type of diagram that graphically depicts groups of numerical data through their quartiles while maximum and minimum values are highlighted by whiskers.

The first panel of the meteogram contains the total (low - medium & high) cloudiness in octas. It becomes obvious that overcast conditions are forecast for Monday and Tuesday with a temporarily breaking of the clouds from Wednesday onward.

The second panel refers to the total (convective and large-scale precipitation) utilising values estimated over 6-hour intervals. HIRES seems to forecast higher values than the control although there exist ensemble members overtopping 110 mm/6h values due to the passage of the tropical cyclone.

The third panel refers to the instantaneous (averaged over 10 minutes) wind speed with HIRES values overtopping 30 m/s (~108 km/h) while there seems to exist ensemble members overshooting 35 m/s (~125 km/h). Focusing over winds the gusty (gust factors) components are plotted also (see diagram below) where HIRES gusts (denoted by black colour) forecast values well over 46 m/s (~165 km/h) being supported by a considerable number of ensemble members as well.

ECMWF pinpoint forecast of wind speed gusts at 10 meters for Nuku'alofa

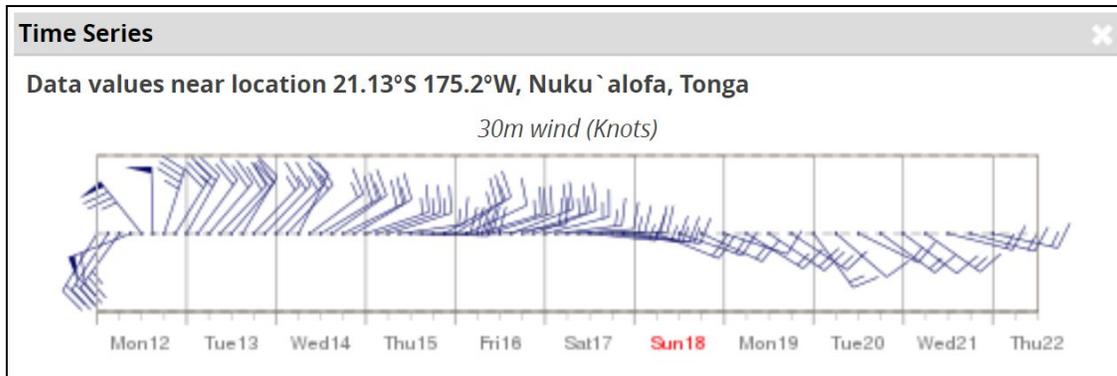


JRC Emergency Reporting - Activation #001 - 11 Feb 2018

The fourth panel refers to the temperature at 2 meters that seems not to be affected significantly by the passage of the tropical cyclone.

Additional diagrams are added below referring to wind direction and speed at the height of 30 meter height. The probability of precipitation type is also presented (last diagram).

ECMWF pinpoint forecast of wind speed and direction at 30 meters for Nuku'alofa



ECMWF pinpoint forecast of probability of precipitation type for Nuku'alofa

