European Commission

JRC TECHNICAL REPORT

Mw 7.2 Earthquake and Tsunami in Haiti and Tropical Cyclone Grace - Situation Update

Technical assessment

as of 17 August 2021 at 12:00 UTC

Annunziato A., Proietti, C., Abad Perez J., Lentini, A., Lorini, V., Gerhardinger, A., Dalmasso, S., Joubert Boitat, I., Kamberaj J., Salvitti V.

2021

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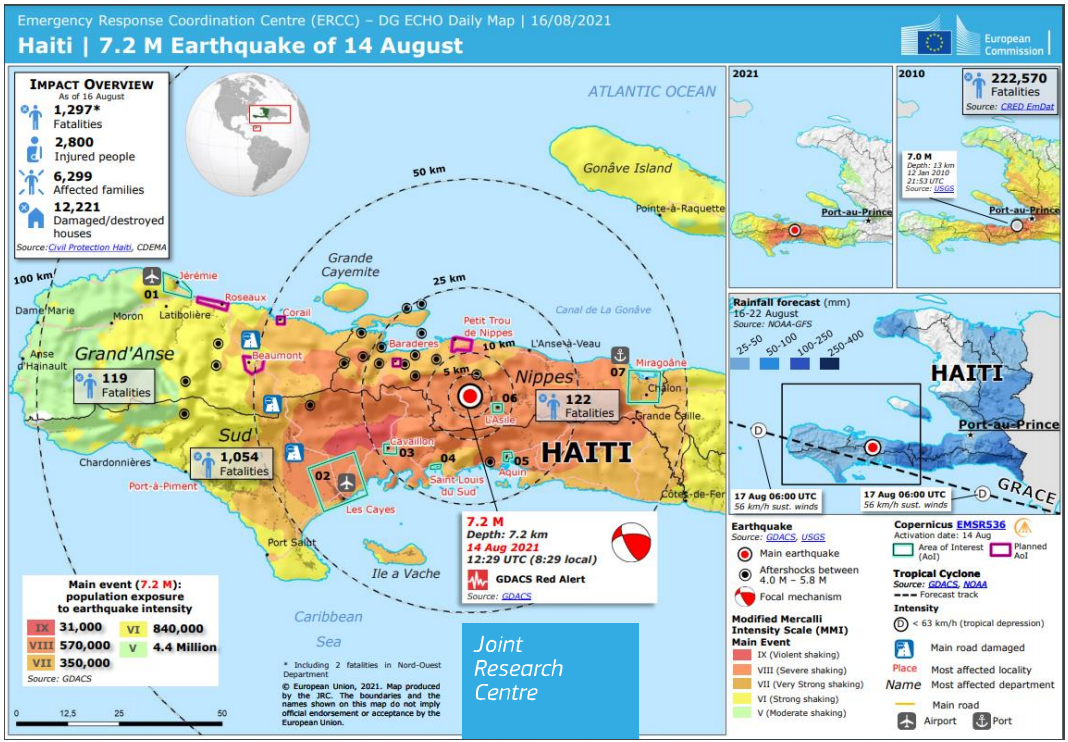

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1 Executive Summary

- The current report is a Situation Update, documenting the changes to the crisis situation that have been recorded since the previous Flash Report
- As a consequence of the M7.2 earthquake that hit Nippes Department (southern Haiti) August 14th, the Haitian Civil Protection reports **1,419 fatalities**. The Department most affected is Sud with 1,133 fatalities, followed by Grand Anse (162), Nippes (122) and Nord Ouest (2). In addition, more than 6,900 people have been injured and more than 83,000 houses have been damaged or destroyed.
- The passage of the **Tropical Storm GRACE over the affected area is complicating the rescue emergencies** and the situation of the displaced people. Today, 17 August, heavy rain is ongoing over southern Haiti and media report already **floods in parts of southern Haiti**. TC GRACE is crossing western Tiburon Peninsula (southern Haiti), moving west-northwest, and on 17 August at 6.00 UTC, its centre was about 45 km southwest of Port-à-Piment (southern Haiti), with maximum sustained winds of 65 km/h (tropical storm). The **Peligre dam**, located north-northeast of Port Au Prince should be monitored, as could be overfilled by the intense precipitation.
- On the 16th August the Haitian Government sent a **Request for Assistance** to the European Union, and the EUCPM has been activated. The UNDAC team coordinated by UN OCHA has been deployed and is already onsite.
- The **EU Copernicus Emergency Mapping Service** was activated to support the damage assessment (EMSR536) and six maps have been produced so far. The number of the Area of Interest for the satellite damage assessment increased to cover the most affected areas
- The **Social Media analysis** performed by JRC in the aftermath of the event allowed to identify the most affected places and to retrieve relevant information about damages.

2 Situation Overview

On August 14th 2021, 12:29 UTC (08:29 local time), a **M 7.2 earthquake occurred in the Hispaniola island** with an epicentre approximately 125 kilometres west of Port-au-Prince, 13 km south-east of Petit Trou de Nippes (Nippes Department) and mostly impacted the Haiti southern peninsula and in particular the Grand Anse and Sud provinces. Several aftershocks occurred, worsening the situation (as of 17 August, 11.00 UTC, 20 M>4 aftershocks have been recorded, the strongest of which with M=5.8).

Haiti was hit by a similar Mw. 7.0 earthquake on 12 Jan 2010 that caused an estimated 200.000 fatalities. The epicentre was near the town of Léogâne, Ouest department, approximately 25 kilometres west of Port-au-Prince. The large number of victims in that case was determined by the large soil liquefaction that caused entire buildings to collapse.

Although the 14 Aug 2021 earthquake was a stronger and shallower earthquake than the 12 Jan 2010, the emerging situation appears less severe in terms of human casualties and physical damage. This is probably due to a smaller high intensity area present in the current event, limited to the Tiburon peninsula in the South of the country while in 2010 event it involved a larger, more populated area, including Port-au-Prince and surroundings. The effect of liquefaction of the sedimentary soil of Port-au-Prince exacerbated the consequences.

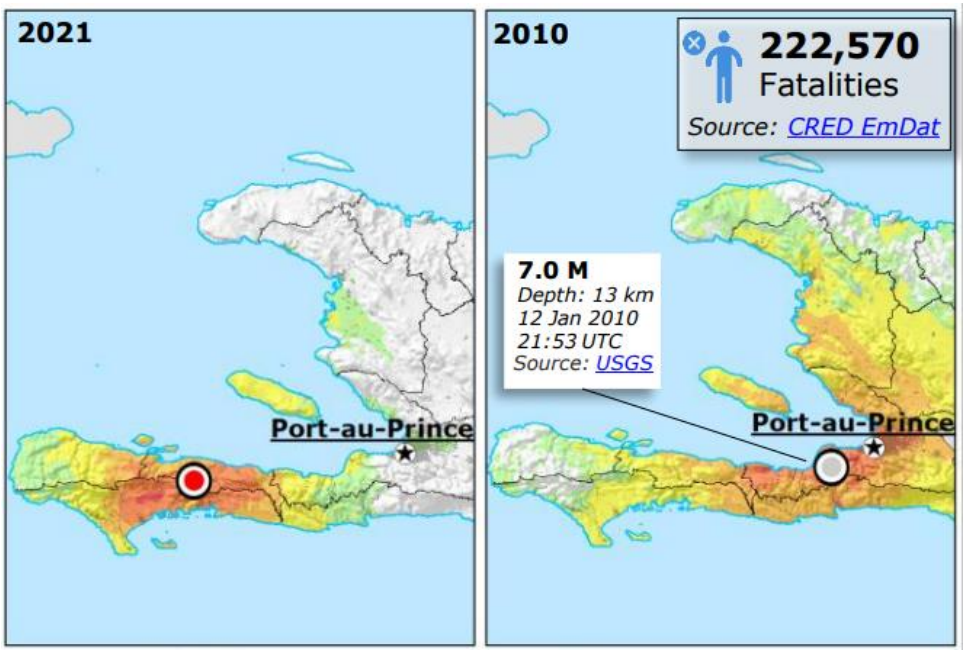


Fig. 1 - Shakemap comparison of the 2 events (source: ERCC-DG ECHO Daily Map 16/08/2021).

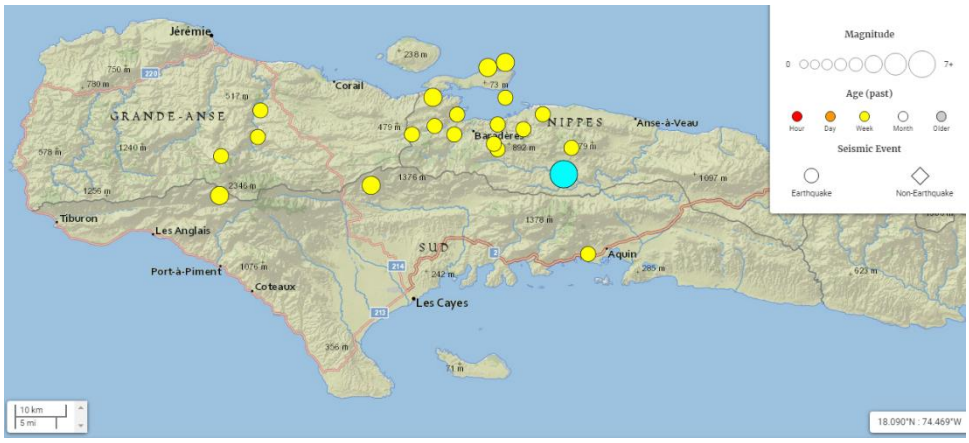


Fig. 2 – Main earthquake and aftershocks as of 17/08/2021 11:00UTC (source: USGS).

2.1 Physical impacts

The principally affected regions are the Nippes, Sud and Grand'Anse departments, all of which have experienced intensity VIII shaking.

At the time of reporting, the number of fatalities reported by the Haitian Civil Protection authorities is **1419** and the number of injured people is more than **6900**. These numbers are expected to grow as search and rescue operations continue.

The earthquake has also generated several landslides, with the Massif de La Hotte mountain range being prone to ground instabilities. **New landslides and ground instabilities might also happen in the following days triggered by heavy rainfall from the incoming tropical storm Grace**. As of this report, the landslide the had caused a blocade of National Route #7 (the road that connects departmental capitals Le Cayes and Jeremie) at Riviere Glace had been partially cleared, making the road practicable again (Fig. 3).

Fig. 3 – Haitian Civil Protection clearing the landslide that blocked RN#7 (source: Civil Protection facebook page).

There are still no reports of earthquake-induced liquefaction, although this was a major source of damage in the Port-au-Prince event in 2010. However, it is likely that this is due to underreporting at this stage.

Due to the passage of TC GRACE, heavy rainfall are ongoing and media report already news of floods in parts of southern Haiti[1] (figure below)

[1] https://www.reuters.com/article/us-haiti-quake/storm-brings-floods-as-haitians-seek-help-at-overloaded-hospitals-after-quake-idUSKBN2FH1FY

Fig. 4 –Floods in Marigot (Jacmel) on the southern coast (source: https://twitter.com/deronneth_deus)

2.1.1 Meteorological situation

Situation

Tropical cyclone GRACE is crossing western Tiburon Peninsula (southern Haiti), moving west-northwest, and on 17 August at 6.00 UTC, its centre was about 45 km southwest of Port-à-Piment (southern Haiti), with maximum sustained winds of **65 km/h** (tropical storm). Heavy rainfall are currently affecting the area of the earthquake.

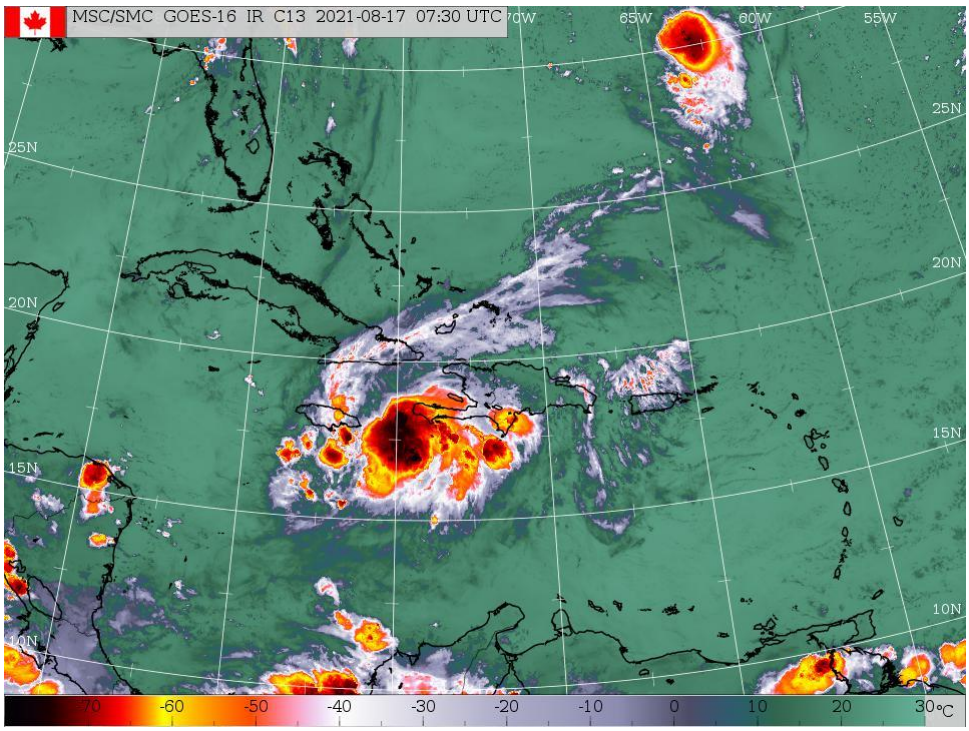


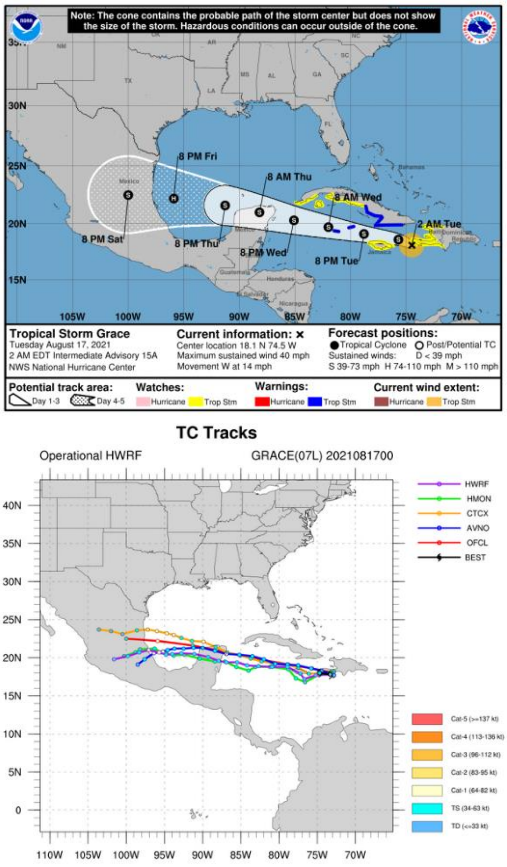
Fig. 4 – Tropical cyclone GRACE is crossing western Tiburon Peninsula (southern Haiti), moving west-northwest. *Source:* *https://www.meteo-haiti.gouv.ht/data/satellite/goes_carc_1070_l_2021@08@17_07h30m.jpg*

GRACE will continue to move close to the Tiburon Peninsula of Haiti during the next couple of hours and then move between southeastern Cuba and Jamaica on 17 August

afternoon. After that, it will approach the Cayman Islands on 18 August, and then it could reach the Yucatan peninsula of Mexico on 18-19 August.

A Tropical Storm Warning is in effect for the southern coast of the Cuban provinces of Santiago de Cuba, Granma, Las Tunas, and Camaguey, and for the Cayman Islands. Strong winds and heavy rainfall are forecast over Haiti, the Dominican Republic, Cuba, Jamaica, and the Cayman Islands on 17-18 August

This is the situation from the NOAA National Hurricane Center (www.nhc.noaa.gov) :



WIND: Tropical storm conditions are possible in Haiti early this morning, and in Jamaica this afternoon. Tropical storm conditions are expected along the southern coast of Cuba within the warning area this afternoon and evening, and over the Cayman Islands beginning tonight into early Wednesday. Tropical storm conditions are possible along the southern coast of Cuba within the watch area tonight and Wednesday.

RAINFALL: Grace is expected to produce the following rainfall amounts: Over Haiti and the Dominican Republic...5 to 10 inches of rain with isolated maximum totals of 15 inches are expected across the southern terrain areas through today. This heavy rainfall may lead to flash and urban flooding, and possible mudslides. Over far southern Cuba, Jamaica, and the Cayman Islands....2 to 4 inches of rain with isolated maximum totals of 6 inches are expected through Thursday. This heavy rainfall may lead to flash and urban flooding. Over the northern Yucatan Peninsula...3 to 6 inches of rain with isolated maximum totals of 10 inches are expected Wednesday into Thursday, which may lead to areas of flash and urban flooding.

SURF: Swells generated by Grace will continue to affect portions of Hispaniola over the next day or so, and will spread westward to Jamaica, the Cayman Islands, the southern coast of Cuba, and the Yucatan Peninsula of Mexico. These swells are likely to cause life-threatening surf and rip current conditions. Please consult products from your local weather office.

Fig. 5 - Left: Tropical cyclone tracks from the NOAA-NHC web site (top left) and from NOAA-HWRF Forecast Guidance (bottom left, *https://www.emc.ncep.noaa.gov/gc_wmb/vxt/HWRF/*). Right: Key messages from the NOAA National Hurricane Center regarding Tropical Storm GRACE (source: NOAA - *www.nhc.noaa.gov*).

GDACS initially identified this as an Orange alert, due to the high population possibly involved in the Dominican Republic (https://www.gdacs.org/report.aspx?eventid=1000814&episodeid=7&eventtype=TC)y, but currently switched the alert level to Green as the storm moves away from Haiti and towards Mexico.

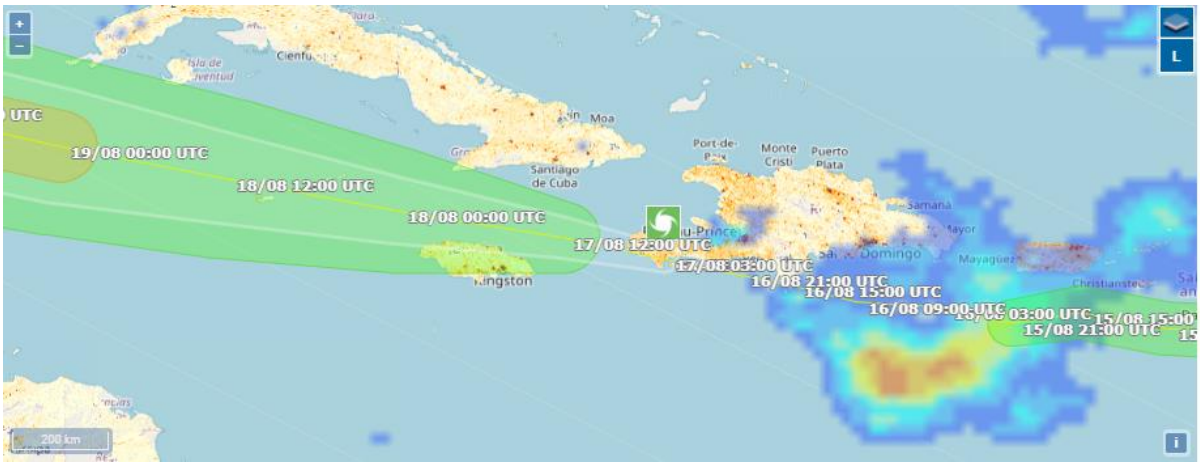


Fig. 6 - GRACE track (NOAA) and last 24h rainfall accumulation (NASA GPM)

The rainfall accumulation over the GRACE track is shown in the figure below. It indicates that a rather severe flooding is expected over the Tiburon peninsula for the passage of the cyclone. Some attention should be raised to the **Peligre dam**, located north-northeast of Port-Au_prince that could be overfilled by the intense precipitation, considering also the local political situation[2].

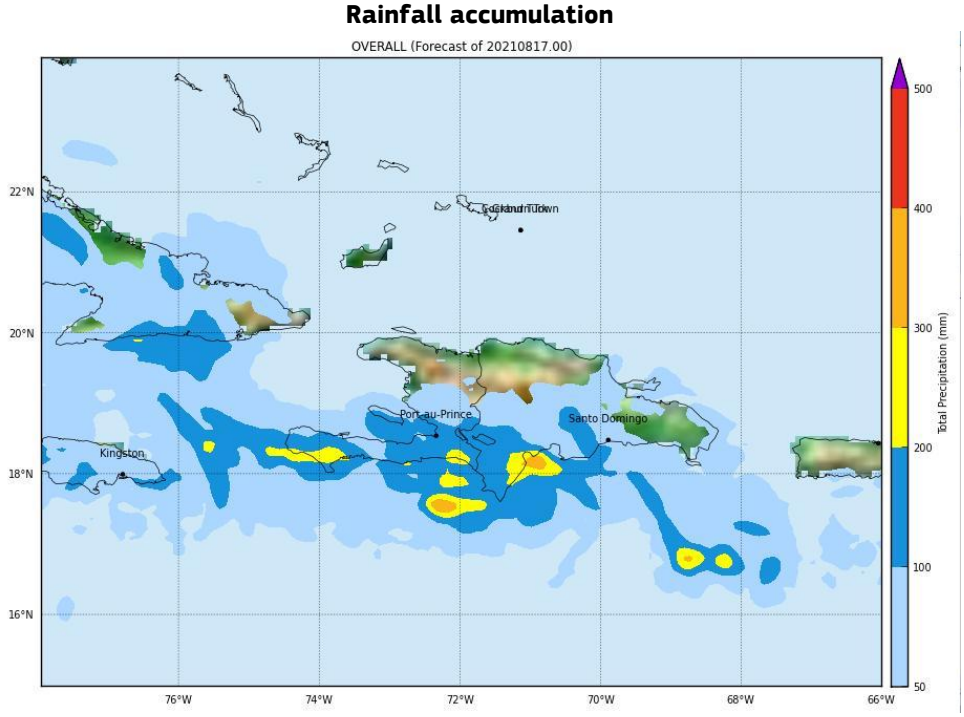


Fig. 7 - Rainfall accumulation including previous rainfall starting 13th of August and forecasted rainfall up to 72h (data source: ECMWF)

[2] https://apnews.com/article/haiti-business-4ac25ab44cdcda1c3acdcd3315cd5bd0

Fig. 8 - Location of the Peligre Dam in Haiti

Sea level

The storm surge expected in the area is not very relevant. At the moment the only available instrument is located in Barahona, south coast of Dominican Republic. It shows (pink curve) that the cyclone has passed but the maximum surge is very limited. The peak is expected in the next day or so (blue curve).

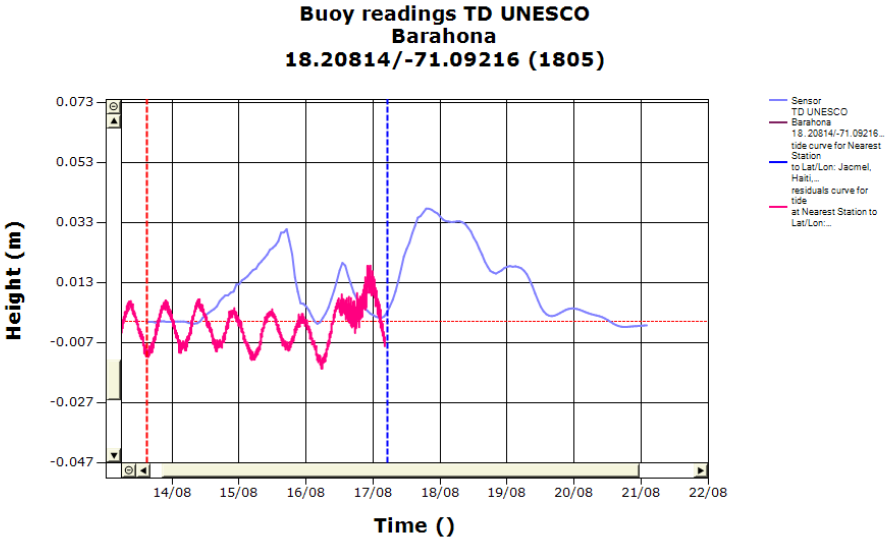


Fig. 9 – Storm surge (Sea level minus expected tide), curve pink; JRC-HYFLUX estimation of storm surge at the same location (blue curve)

2.2 Humanitarian impact

As a consequence of the M7.2 earthquake that hit Nippes Department (southern Haiti) August 14th, the Haitian Civil Protection reports 1,419 fatalities. The Department most affected is Sud with 1,133 fatalities, followed by Grand Anse (162), Nippes (122) and Nord Ouest (2). In addition, more than 6,900 people have been injured and more than 83,000 houses have been damaged or destroyed.

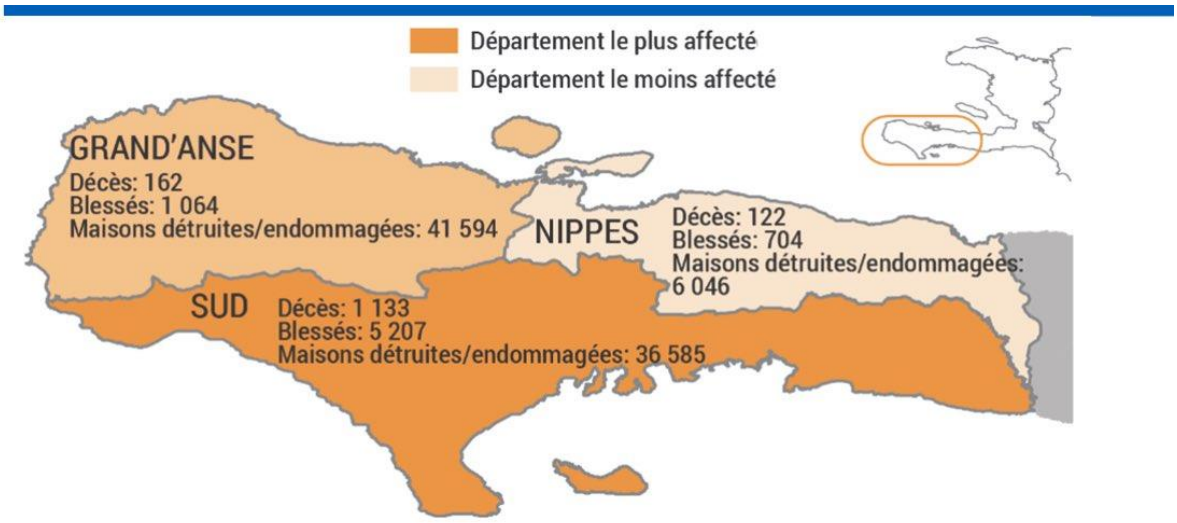


Fig. 10 – Humanitarian impact as of 17 August at 9:00 UTC (source: Haitian Civil Protection[3])

According to the last Situation report of the Haitian Civil Protection (Rapport de situation #4)
"*...many public buildings (hospitals, schools, hotels, churches, private companies, etc.) suffered damage or collapsed. More than 75,000 affected families have already registered in the 3 most affected departments, while assessments are continuing.*

Twenty-five health structures are affected over the three departments. The seriously injured were referred to Port au Prince and the light and moderate injuries were taken care of by a team of around 80 health personnel deployed to the area. (translation)".

The passage of the Tropical Storm GRACE over the affected area is complicating the rescue emergencies and the situation of the displaced people. Today, 17 August, heavy rain is ongoing over southern Haiti and media report already floods in parts of southern Haiti.

As communicated by the Haitian civil protection: "…*The Directorate General of Civil Protection is urging all local authorities and the media to ensure that the entire population continues to receive accurate information about the hurricane that is expected to hit us this afternoon and to help each person take the necessary measures to protect himself or herself*…."[4] (translation)

[3] https://twitter.com/Pwoteksyonsivil/status/1427394105991172098?s=20

[4] https://protectioncivile.gouv.ht/direksyon-jeneral-pwoteksyon-sivil-mande-popilasyon-pou-li-kontinye-fe-solidarite-pandan-pasaj-depresyon-twopikal-grace-sou-preskil-sid-peyi-a/

Fig. 11 –Floods in Jacmel on the southern coast (source: https://twitter.com/Franceatpresso2/status/1427439978771095554?s=20)[6])

Prime Minister Ariel Henry declared a one-month **national state of emergency**. Government has requested specific international assistance for urban search-and-rescue, stating that additional support will not be requested until the extent of damages is known (source: UN OCHA - Virtual OSOCC).

On the 16th August the Haitian Government sent a **Request for Assistance to the European Union**, and the EUCPM has been activated. The UNDAC team coordinated by UN OCHA has been deployed and is already onsite.

[5] https://twitter.com/Pwoteksyonsivil/status/1427394105991172098?s=20

[6] https://twitter.com/Pwoteksyonsivil/status/1427394105991172098?s=20

3 JRC involvement

3.1 GDACS alert

For the involvement in the Earthquake please refer to Part 1 of this report, https://www.gdacs.org/Public/download.aspx?type=DC&id=213

At the moment, the role of GDACS is mostly focused on the analysis of the GRACE-21 Tropical Cyclone dynamic and its evolution over the Caribbean area.

https://www.gdacs.org/report.aspx?eventid=1000814&episodeid=16&eventtype=TC

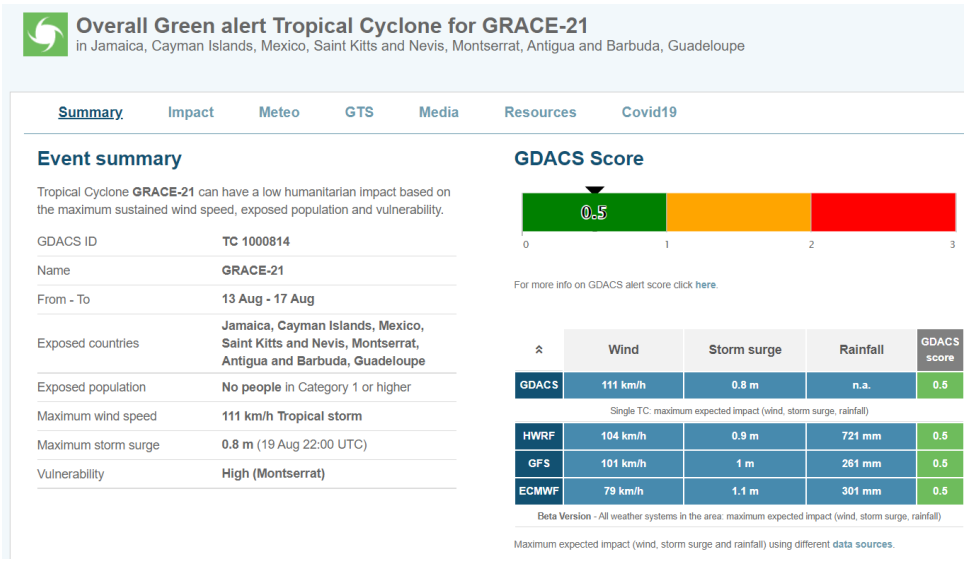


Fig. 12 –GDACS alert for TC GRACE

3.2 Copernicus activation

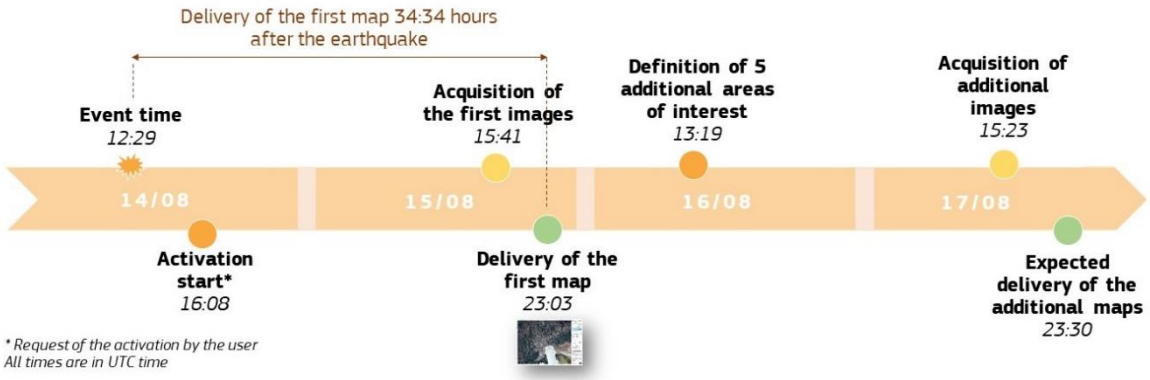


Fig. 13 –Timeline of the Copernicus EMS activation.

The Copernicus EMS Rapid Mapping was activated (Activation ID: EMSR536) on the 14th of August at 4pm (UTC time), that is 03:39 hours after the earthquake, to assess the damages over seven Areas of Interest (AOI). Following the delivery of the first maps on the 15th, five additional AOIs were defined for which maps will be published on the 17th (given the good weather conditions).

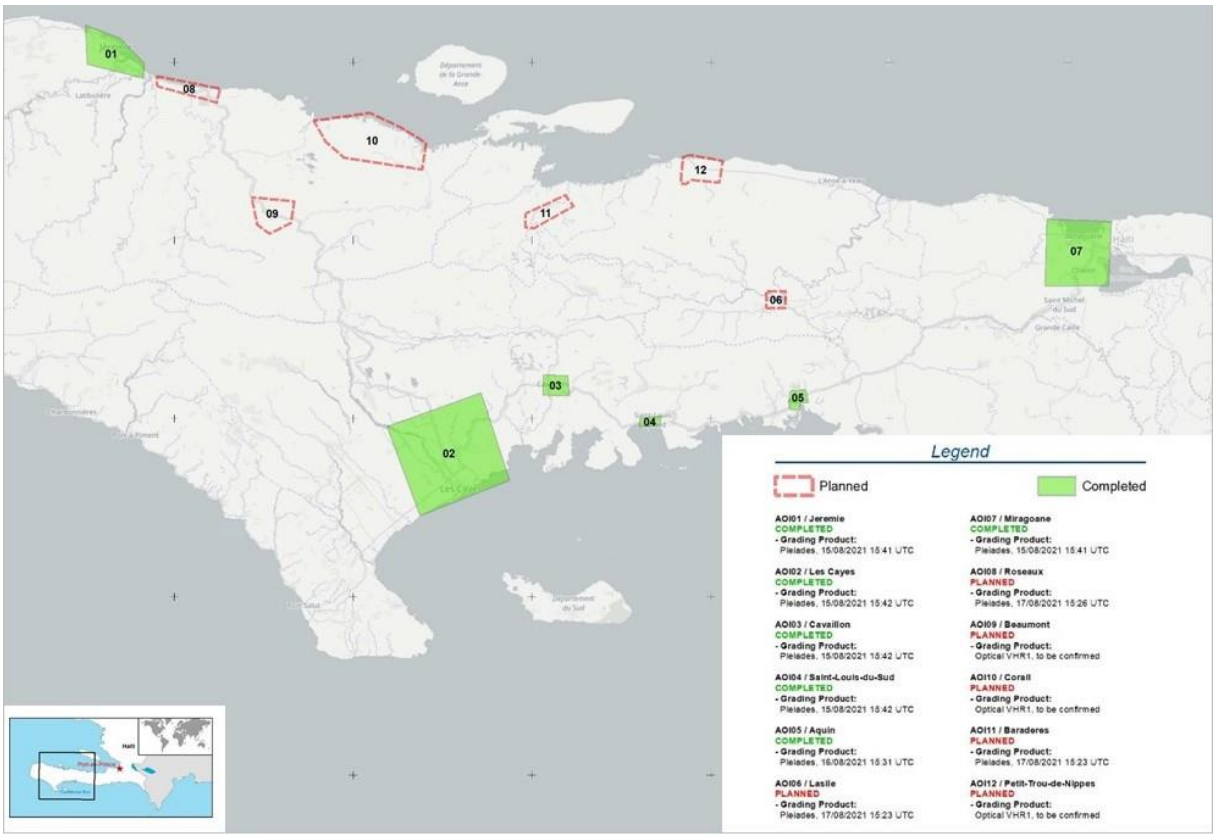


Fig. 14 - EMSR536 Activation Extent Map as of 17 August, showing the areas of interest already analysed (6) and the areas planned to be analysed (6)

The first Very High Resolution optical images were acquired on the 15th around 3pm (UTC). Based on these images, six grading maps were produced and delivered during the night of the 15th. The first damage assessment was sent to the user 34:34 hours after the earthquake. In total, 308 buildings (mostly residential) and 0.5km of road were identified as affected.

Table 1 – Summary of the impacts on the assets in the seven initial AOIs (situation as of 15/08/2021)

Area of Interest (AOI)		**Total affected ***	
ID	**Name**	**Built-up (No.)**	**Transportation (km)**
1	Jeremie	45	0
2	Les Cayes	218	0.2
3	Cavaillon	11	0.1
4	Saint-Louis-du-Sud	5	0
5	Aquin	9	0.1
6	Lasile	NA**	NA**

7	Miragoane	20	0
	TOTAL	**308**	**0.5**

*Sum of assets identified as Destroyed, Damaged and Possibly damaged
**Because of cloud cover the satellite image acquired could not be analysed. A new attempt is scheduled on 17/08

Additional imagery will be acquired on the 17th around 3pm. Given good weather conditions, six more maps are expected to be delivered on the same day around 11.30pm.

The production plan and the products are available at:

https://emergency.copernicus.eu/mapping/list-of-components/EMSR536.

In parallel, the International Disaster Charter was activated and Rapid Mapping requested access to the collaboration platform in order to maximise the availability of data.

The JRC is providing technical management and support for the activation.

3.3 JRC Social Media analysis

JRC implemented a platform for collecting annotating geocoding texts and images during natural disasters by analysing social media and in particular Twitter messages. The following graphs are an extract of the analysis carried out using multilingual Machine Learning models. Source are not authoritative and therefore the analysis is better validated using the above sections of the report; however, they can provide suggestions on where the large part of the damage may be.

Social media users might be concentrated in different density in different areas, thus incrementing information from main areas.

The platform processed circa 110K texts and images (110K texts and 10K images) posted during the 2 days following the event (from 2021-08-14 11:00 UTC to 2021-08-16 12:00). After the machine learning analysis, the relevant texts were 23.268 and the relevant images were **3192**. Each of the images indicated below have been geolocalized and we know quite precisely where they have been performed.

Disclaimer:

This work fulfils all the law obligations according to the Terms of Services of social media platforms and uses material extracted according to a fair-use. Given that (i) Its purpose is scientific research (ii) The nature of the work is factual (iii)The purpose is non-commercial.

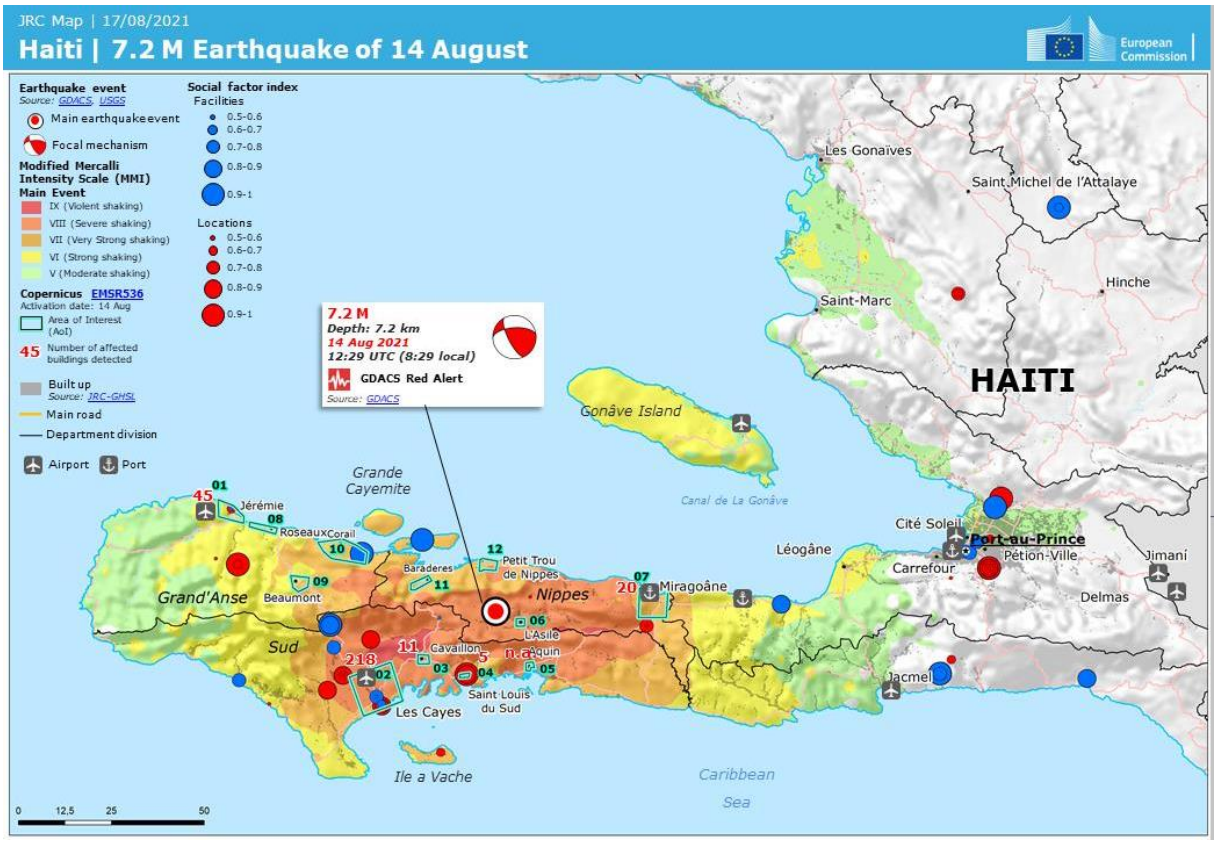


Fig. 15 - Geo-located text information about impacts on Facilities (Blue symbols) and Locations (Red Symbols). The figure contains also the shakemap and the locations AOI of the Copernicus EMS

Selection of relevant images

Fig. 16 – Selection of relevant images from the JRC Social Media analysis (Disclaimer: This work fulfils all the law obligations according to the Terms of Services of social media platforms and uses material extracted according to a fair-use. Given that (i) Its purpose is scientific research (ii) The nature of the work is factual (iii)The purpose is non-commercial.)

3.4 JRC technical report

A first technical report was issued on 15th Aug 12:00 UTC and was delivered to the JRC hierarchy, DG-ECHO ERCC and UN-OCHA. The report was also published in the GDACS web site:

https://www.gdacs.org/Public/download.aspx?type=DC&id=213

4 Involvement with other services of the European Commission, the EEAS or other institutional stakeholders

4.1 ERCC Emergency

ERCC is following the events in close collaboration with the local ECHO offices. ERCC activated the ARISTOTLE analysis system that produced several reports on the event.

JRC sent an information email to ERCC to raise alert on the event and provided a first estimate of the possible AOIs useful for the Copernicus activation.

Moreover, the JRC produced the following ECHO daily map upon request of the ERCC, as well as the daily updates on the ongoing emergency for the ECHO Daily Flash.

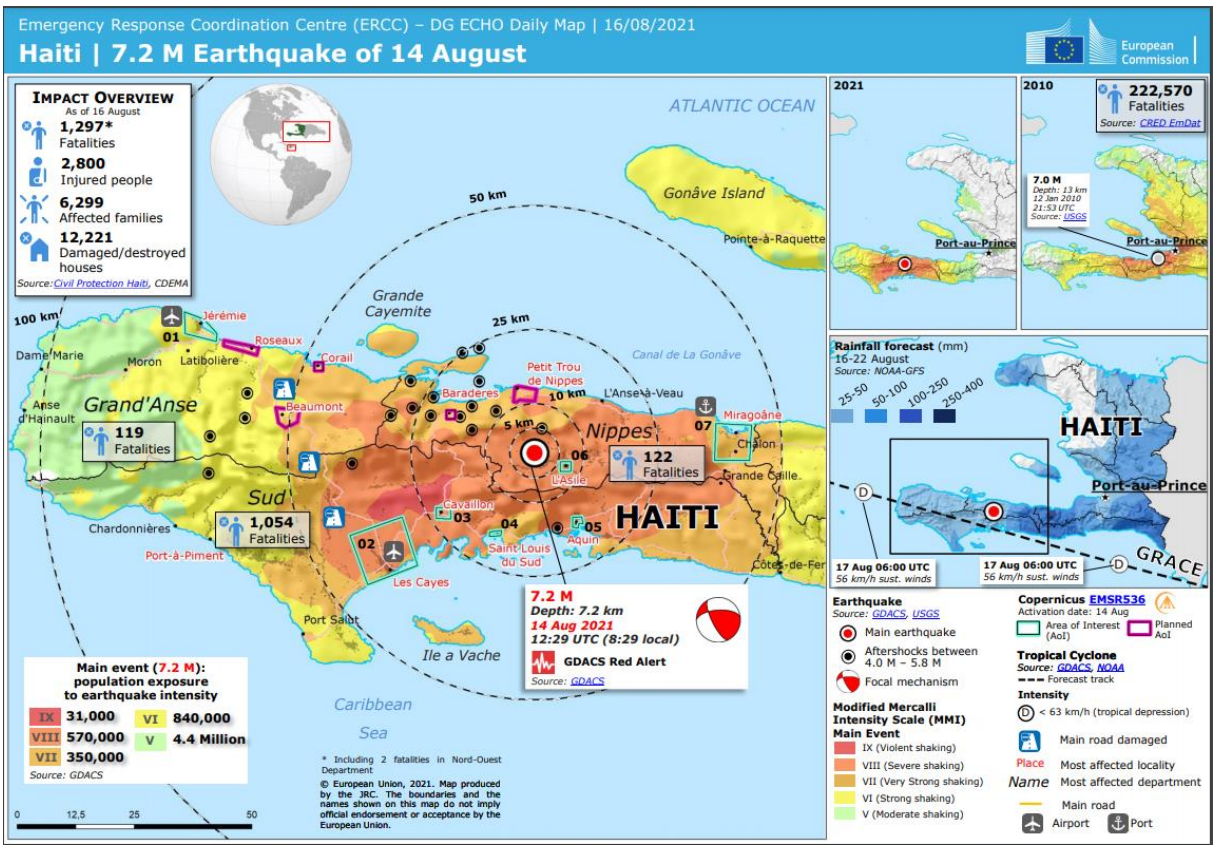


Fig. 17 – DG ECHO daily map produced by JRC upon request of ERCC.

4.2 EUCPM activation

On 16 August, Haiti requested assistance through the EU Civil Protection Mechanism for emergency medical teams, water health and sanitation (WASH) needs and shelter items.

4.3 VOSOCC Activation

The GDACS coordination tool managed by UN OCHA (the Virtual On Site Coordination Centre - VOSOCC) has been activated a few minutes after the GDACS alert has been issued and the humanitarian stakeholders are sharing information about their contribution to the response activities. The UNDAC team coordinated by UN OCHA has been deployed and is already onsite.

5 Expected Updates

An updated version of the report will be developed if important changes to the situation will be shown.

6 References and further information

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

- GDACS: www.gdacs.org
- ERCC portal: http://erccportal.jrc.ec.europa.eu/
- Copernicus: http://emergency.copernicus.eu

Relevant Links

GDACS reports:

Earthquake:
http://www.gdacs.org/report.aspx?eventid=1281677&episodeid=1391652&eventtype=EQ

Tropical Cyclone:

http://www.gdacs.org/report.aspx?eventid=1000814&episodeid=7&eventtype=TC

Copernicus maps - https://emergency.copernicus.eu/mapping/list-of-components/EMSR536

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