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Hurricane Beryl – JRC Emergency Report

Situation as at 09 July 2024 and comparison with past hurricanes
Report coordinated by the European Crisis Management Laboratory (ECML)

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Abstract

- The Atlantic hurricanes season has just started and Hurricane Beryl has set a record for being the earliest Category 5 hurricane in recorded history.
- At the time of writing Beryl has weaken to a Category 1 hurricane and has made landfall in Texas, after having impacted several countries (Haiti, Grenada, Jamaica, Trinidad and Tobago, Saint Vincent and the Grenadines, Mexico, Belize, United States). In Jamaica UNICEF reports two fatalities and 1,876 evacuated people (160 shelters). UN OCHA reports ten fatalities, 2 362 evacuated people (62 shelters), 30 injured people and two missing across Grenada and St. Vincent and the Grenadines. In Texas, FEMA reports 127 evacuated people (seven shelters).
- This JRC emergency report provides, upon request of the Emergency Response Coordination Centre (ERCC), a "Comparison between impacts of Hurricane Beryl and other multi-island hurricanes in the Caribbean" to inform the calibration of the European Union response and funding to partners in the area. Moreover, a **situational assessment** of the ongoing hurricane and its related impact is provided, combining modelling outputs and in-field and remote observations.
- Hurricane Beryl impact assessment is still ongoing, combining satellite mapping products (from Copernicus EMS–Rapid Mapping and the GloFAS-Global Flood Monitoring service, UNOSAT, and the International Charter) and information from the surveys in the field, which just started.
- With regards to the exposed population to the three TC combined effects, the **flood**-related figures are derived from the GloFAS-Global Flood Monitoring service and the Copernicus EMS Rapid Mapping, the **storm surge** modelling provides the water height at the coast, and the NOAA buffers of **wind speed** are combined with information on the exposed population from the Global Human Settlement Layer.
- An overview of anticipatory and response actions of the international community is provided, as well as a quick summary of the Atlantic hurricane season forecast which is expected to be above normal.
- The comparative analysis of the most impactful Atlantic hurricanes over the period 1988 – 2024, further confirms that Beryl is the earliest Category 5 Atlantic hurricane in the analysed period.
- The present report includes also an assessment of the crisis severity in countries exposed to Tropical Cyclone Beryl-24 within INFORM framework, highlighting that six out of eight countries should have acceptable coping capacities. Haiti and Mexico are considered instead at high risk, due to other ongoing crises.
- The outcomes of the monitoring of the health-related news about Hurricane Beryl from the Epidemic Intelligence from Open Space (EIOS) system is provided in this report, with a list of diseases of major concern (leptospirosis, dengue fever, and malaria) and other relevant health-related issues.
- An anticipatory analysis of the potential consequences of Beryl on the water and health sectors is also provided, together with the outcomes of the Semantic data analysis conducted via the SciWalker-MAATrica tool.

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1 Introduction

Hurricane Beryl set a precedent for what is predicted to be an extremely active hurricane season for the entire Atlantic basin. This hurricane intensified at an explosive rate to become the earliest Category 5 (on the Saffir Simpson scale) Atlantic hurricane on record. From 01 July to 09 July, when it made landfall in Texas, this hurricane changed from a Category 4 strength on the Saffir Simpson scale to a Category 1. It is expected to weaken rapidly according to WMO Regional Specialized Meteorological Centre Miami[1].

As at 09 July Beryl has impacted several countries on its path: Haiti, Grenada, Jamaica, Trinidad and Tobago, Saint Vincent and the Grenadines, Mexico, Belize, and the United States.

According to the Global Disaster Alert and Coordination System (GDACS) the estimated exposed population to Category 1 or higher is 9 million. The latest snapshot from UN OCHA (#4, as of 8 July) reports that *"Authorities and humanitarian partners' response efforts are focusing on Carriacou, Petite Martinique and northern Grenada in Grenada; Bequia, Canouan, Mayreau, Mustique and mainland Saint Vincent in Saint Vincent and the Grenadines; and the Clarendon, Manchester, Saint Catherine and Saint Elizabeth parishes in southern Jamaica*"[2].

On 05 July the ERCC has requested a JRC emergency report on the "Comparison between impacts of Hurricane Beryl and other multi-island hurricanes in the Caribbean". In particular, this comparative analysis looks at hurricanes which followed a similar track as Beryl, such as Irma and Maria (2017), Dean (2007), Emily (2005), Ivan (2004), Mitch (1998), Gilbert (1988).

This report presents the outcomes of the requested analysis, aimed at contributing to a better calibration of the European Union response and funding to partners operating in the area. In addition to the requested topics, this report includes an overview of the current situation, preparedness and response actions ongoing (from anticipatory measures to needs assessment), information about the Atlantic hurricane seasonal forecast and an analysis of the potential consequences of Hurricane Beryl on the water and health sectors.

[1] https://wmo.int/media/news/record-breaking-hurricane-Beryl-threatens-caribbean

[2] https://reliefweb.int/report/grenada/latin-america-caribbean-2024-atlantic-hurricane-season-snapshot-4-8-july-2024

2 Hurricane Beryl, system evolution since 01 June 2024

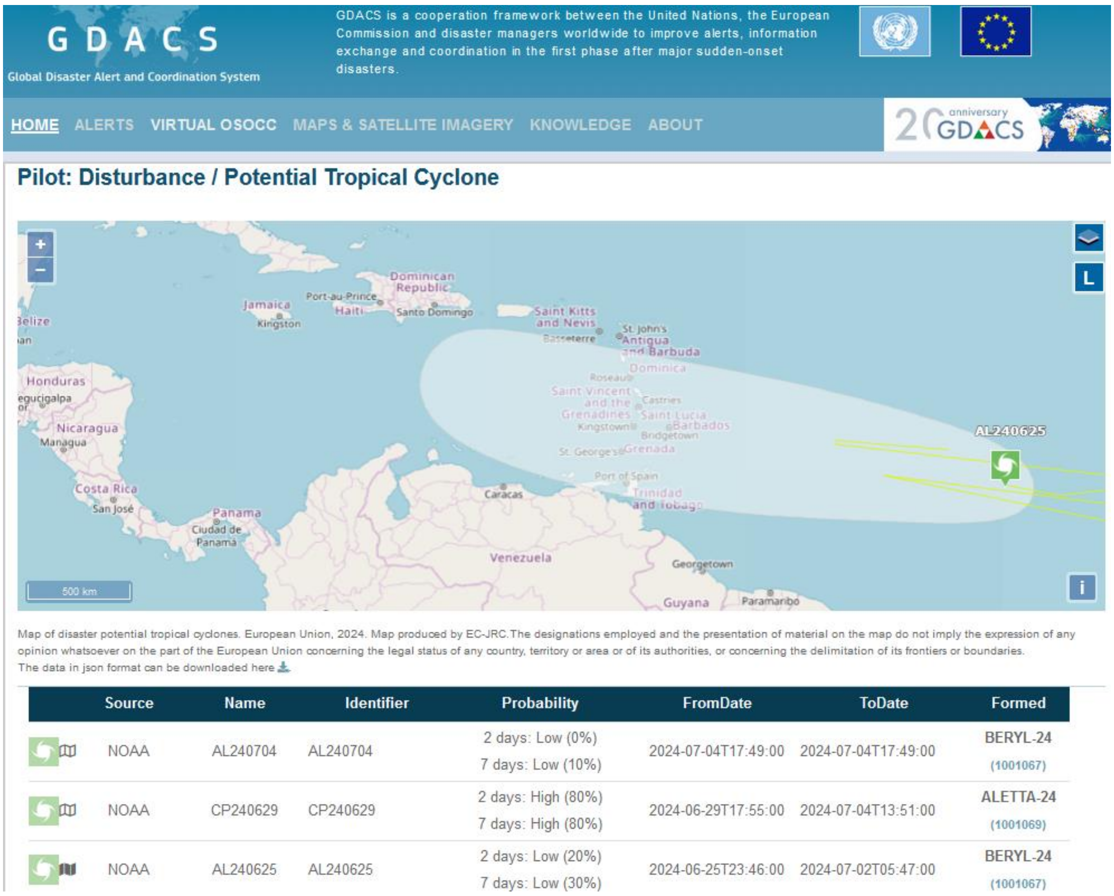
2.1 Disturbance monitoring

Potential tropical cyclone (TC) monitoring provides important preliminary information to organisations, enabling them to prepare and respond effectively. Upon request of the World Food Programme (WFP), the JRC's European Crisis Management Laboratory (ECML) initiated a pilot project in 2023 for automatic detection and visualisation of TC's disturbance formation in GDACS, aiming at the timely provision of critical information to inform anticipatory action for events that are potential earliest stages of the TC genesis. This pilot activity is in alignment with the requests from various humanitarian agencies, crystallised during the Technical Meeting "Tropical Cyclone impact estimation for humanitarian preparedness and response: Joining the dots" organised during the 2020 Humanitarian Networks and Partnerships Week (HNPW) and the HNPW 2024 Technical Meeting on "Learning from Anticipatory Action in Tropical Cyclones: How early can we make decisions?" both organised by WMO, EC-JRC and UN OCHA.

The prototype functionality, currently under test in GDACS (not yet publicly available), detected the disturbance later associated with Hurricane Beryl already on 25 June across the central North atlantic basin, 3-days ahead of the cyclone formation on the 28 June, as a tropical depression close to the Windward Islands.

The GDACS prototype functionality for the early detection of disturbances that could evolve in tropical cylones, issued the first episode of Beryl on 25 June at 23.46 UTC, after the first textual advise (not a usual structural bullettin as for already formed cyclone) released by NOAA. One of the main features of the GDACS prototype is the capability to detect the so-called "potential tropical cyclone formation" advise issued by NOAA and to put the relevant information into the system, following the same structure of the main GDACS site. Thus, Beryl as a disturbance (before NOAA assigned to it an official name), was promptly and already detected on 25 June with identifier, time interval (from date, to date) and the representation of the uncertainty cone for the next 5-days. In addition, the related GDACS event id once the cyclone is formed, is immediately available in the GDACS prototype, in order to relate the monitored disturbance with the formed cyclone.

Figure 1. Disturbance related to Hurricane Beryl as monitored by the GDACS disturbances monitoring prototype



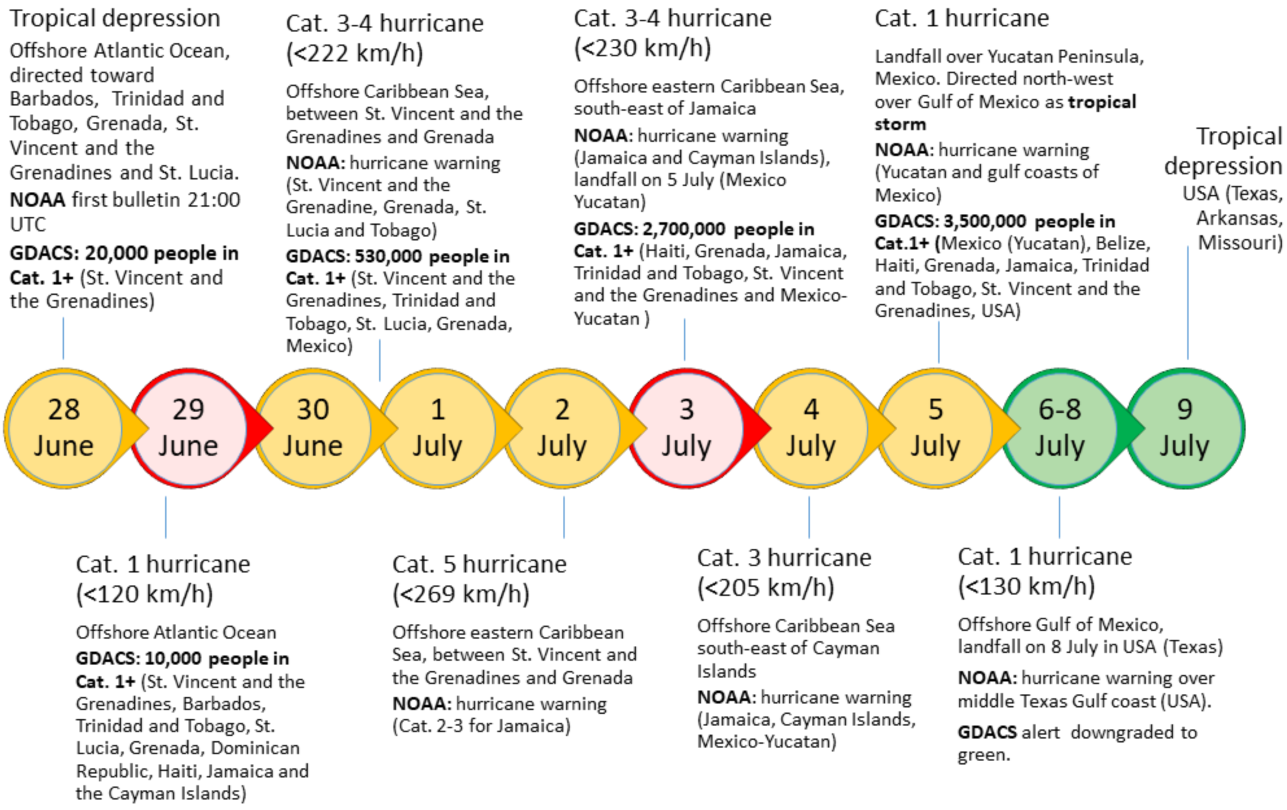
Source: JRC E1

2.2 Hurricane Beryl, current situation and daily monitoring

The Hurricane Beryl is the earliest Cat. 4 (wind speed 210-254 km/h) on record, since it is the strongest hurricane formed already during the month of June with this intensity. Thus, it is classified as major hurricane (Cat. 3-5, wind speed > 178 km/h). After it reached Cat. 4 with maximum sustained winds of 213 km/h on 30 June in the evening (UTC), it further strenghtened and reached the Cat. 5 with maximum sustained winds of 269/km/h on 02 July in the morning (UTC). The NOAA National Hurricane Center (NHC) and GDACS promptly issued hurricane warnings (NOAA) and red and orange alerts (GDACS) following the track of the hurricane.

Detailed timeline description can be found in **Annex 1**.

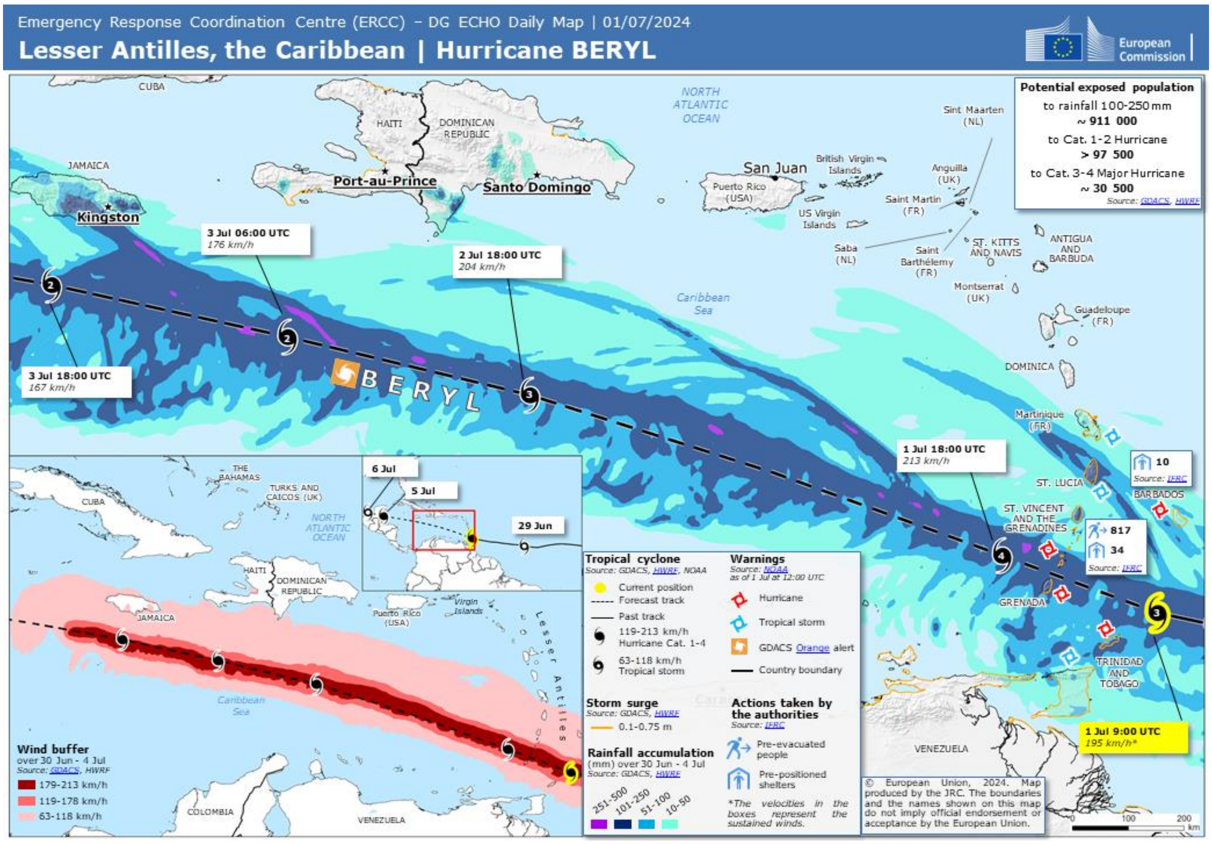
Figure 2. Hurricane Beryl Timeline



Source: JRC E1

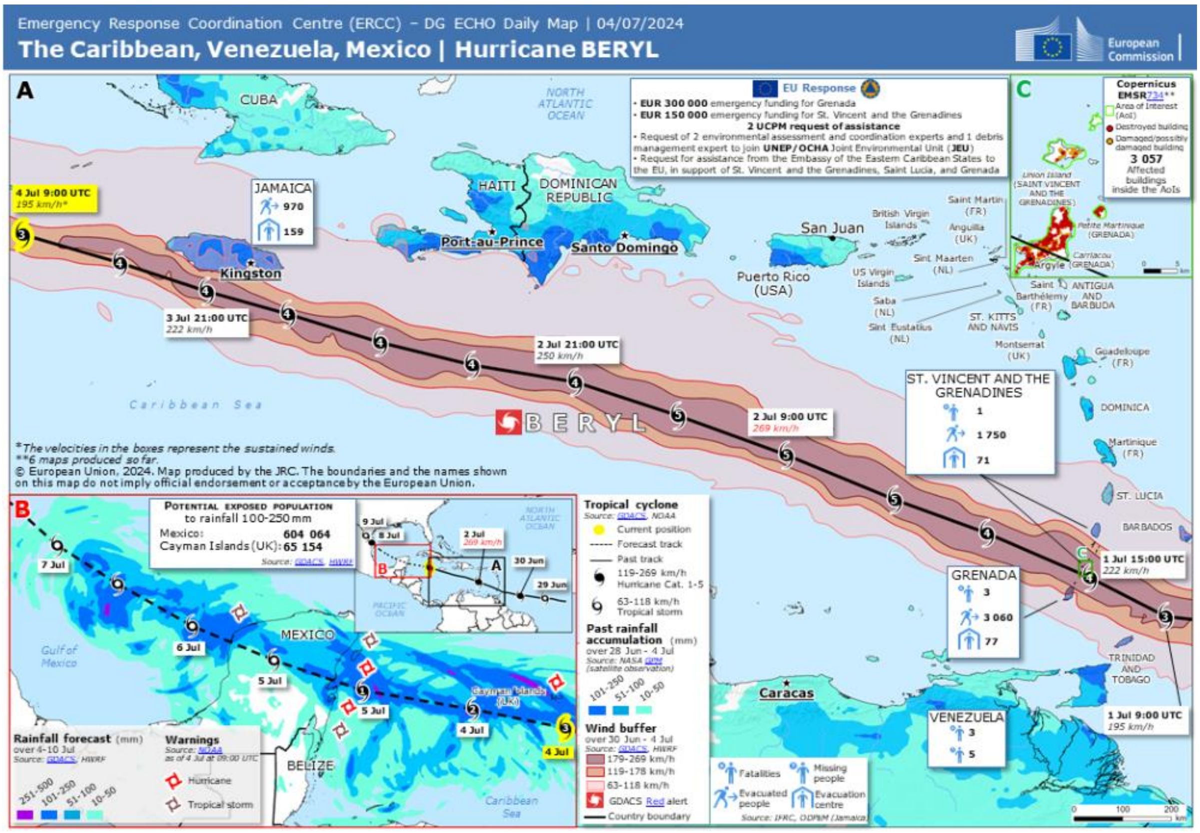
Here below, in the Figures 3 and 4, the overall situation of the Hurricane Beryl is represented by means of two consecutive ECHO Daily Maps requested to and produced by the JRC ECML team. The first map was published on 01 July, while the second one soon after, on 04 July. It is important to highlight that a third ECHO Daily Map of the series on the Hurricane Beryl is forseen for 10 July, in order to better depict the situation after the UCPM activation of 04 July and to provide the most updated figures on the impact.

Figure 3. ECHO daily map of 01 July 2024



Source: JRC, DG ECHO

Figure 4. ECHO daily map of 04 July 2024



Source: JRC, DG ECHO

3 Impact of Hurricane Beryl

3.1 Known impact as at 09 July 2024

As at 09 of July the exposure within the areas of interest of the Copernicus EMS-Rapid Mapping activation has been estimated by satellite observations as follows (Figure 5 and Figure 6):

Figure 5. Exposure within the areas of interest

Source: CEMS

Figure 6. Detailed exposure table

Area of Interest (AOI)		Observed Event		Affected or potentially affected		
ID	Name	Latest observations [ha]	Max. extent [ha]	Built-up [No.]	Roads [km]	Population [No.]
AOI01	Kingston	N/A	N/A	N/A	N/A	N/A
AOI02	Carriacou	N/A	N/A	2 529	N/A	N/A
AOI03	Petite Martinique	N/A	N/A	384	1.9	N/A
AOI04	Union Island	N/A	N/A	1475	9.4	N/A
AOI05	Bridgetown	N/A	N/A	N/A	N/A	N/A
AOI06	Mayreau	N/A	N/A	253	0.03	N/A
AOI07	Canouan	N/A	N/A	736	N/A	N/A
AOI08	Mustique	N/A	N/A	8	1	N/A
AOI09	Bequia	1.2	1.2	125	0.3	N/A
AOI10	Saint Vincent					
AOI11	Grenada	N/A	N/A	N/A	N/A	N/A
AOI12	Salt Savannah	N/A	N/A	1 447	37.1	N/A
AOI13	Cancun Beach					
AOI14	Cancun City					
AOI15	Merida	N/A	N/A	N/A	N/A	N/A
AOI16	Progreso	N/A	N/A	N/A	N/A	N/A
AOI17	Campeche	29.7	29.7	N/A	0.8	N/A
AOI18	Ciudad del Carmen	N/A	N/A	N/A	N/A	N/A
AOI19	Matamoros					
	Total	30.9	30.9	6 957.0	50.5	0

Source: Copernicus EMS-Rapid Mapping

Damage assessments for the 19 potentially affected areas included in the areas of interest of the mentioned Copernicus activation are still being evaluated. The preliminary figures (Figure 7) indicate:

Figure 7. Damage assessment within the areas of interest

Source: Copernicus EMS-Rapid Mapping

Table 1. Damage assessment table

Area of Interest (AOI)		Observed Event		Affected or potentially affected		
ID	**Name**	**Latest observations [ha]**	**Max. extent [ha]**	**Built-up [No.]**	**Roads [km]**	**Population [No.]**
AOI01	Kingston	N/A	N/A	N/A	N/A	N/A
AOI02	Carriacou	N/A	N/A	2,529	N/A	N/A
AOI03	Petite Martinique	N/A	N/A	384	1.9	N/A
AOI04	Union Island	N/A	N/A	1475	9.4	N/A
AOI05	Bridgetown	N/A	N/A	N/A	N/A	N/A
AOI06	Mayreau	N/A	N/A	253	0.03	N/A
AOI07	Canouan	N/A	N/A	736	N/A	N/A
AOI08	Mustique	N/A	N/A	8	1	N/A
AOI09	Bequia	N/A	N/A	N/A	N/A	N/A
AOI10	Saint Vincent					
AOI11	Grenada	N/A	N/A	N/A	N/A	N/A
AOI12	Salt Savannah	N/A	N/A	1,447	37.1	N/A
AOI13	Cancun Beach					
AOI14	Cancun City					
AOI15	Merida	N/A	N/A	N/A	N/A	N/A
AOI16	Progreso	N/A	N/A	N/A	N/A	N/A
AOI17	Campeche	30	30	N/A	0.8	N/A
AOI18	Ciudad del Carmen	N/A	N/A	N/A	N/A	N/A
AOI19	Matamoros					
	Total	30	30	6,832.0	50.2	0

Source: Copernicus EMS-Rapid Mapping

Reports on the impact of the Hurricane Beryl in term of casualties (fatalities, missing persons, injured people) population displaced and evacuated in shelters, initial were swiftly available.

On 29 June, the government of St. Vincent and the Grenadines urged the population to gather emergency supplies and to take shelters. WHO PAHO and IFRC published their first reports on the affected islands on 01 July and DG ECHO issued the Civil Protection Message nr. 1 on 04 July. During the same period UNICEF and UN OCHA published their reports, starting to indicate the number of fatalities. Finally, FEMA reported the number of evacuated people across Texas (USA) on 09 July.

On 01 July, WHO PAHO and IFRC reported 1 032 evacuated people (a number of these across 68 shelters) in St. Vincent and the Grenadines, 2 500 evacuated (40 shelters) in Grenada and 129 evacuated in Trinidad and Tobago. After these early figures, as at 04 July, IOM reported a near-total damage across parts of the Carriacou and Petit Martinique Islands (Grenada) and Mayreau and Union Islands (St. Vincent and the Grenadines).

On 05 July DG ECHO and the JRC (by means of the ECHO Daily Flash) indicated the first death toll: 10 fatalities, of which three in Grenada, three in St. Vincent and the Grenadines, three across north-eastern Venezuela (five missing persons were also reported in this country) and one more in Jamaica. DG ECHO also reported 5,780 evacuated people across Grenada, St. Vincent and the Grenadines and Jamaica.

As at 09 July at 14.00 UTC the situation is the following (still uncertain and with increasing figures).

The death toll reached 15, of which five in Granada, five in St. Vincent and the Grenadines, three in Venezuela and two in Jamaica. The total number of evacuated and displaced people is nearly 4 250 people, part of them in 222 shelters throughout the affected areas and islands in the Caribbean. Namely: 1 876 evacuated people (160 shelters) in Jamaica, 1 362 evacuated people (49 shelters) in St. Vincent and the Grenadines, around 1,000 evacuated people (13 shelters) in Grenada, 127 evacuated people in seven shelters across Texas, according to FEMA.

Moreover, 30 injured people and two missing persons were reported across Grenada and St. Vincent and the Grenadines. In addition, UNICEF reports that in Jamaica 160 000 people including 37 000 children need humanitarian assistance[3].

Table 2. Impact Overview based on available reports as at 09 July 2024

Country	Fatalities	Missing Persons	Injured People	Population Displaced	Shelters
St. Vincent & the Grenadines	5	2	28	1 362	49
Grenada	5	0	2	1 000	13
Venezuela	3	5	0	n/a	n/a
Jamaica	2	0	0	1 876	160
Trinidad & Tobago	0	0	0	129	n/a
USA (Texas)	0	0	0	127	7
TOTAL	15	7	30	4 494	229

Source: JRC E1

3.2 Impact estimation as of 09 July 2024

3.2.1 Wind

To estimate the exposed population to the wind caused by the passage of Hurricane Beryl in the period 01-09 July, the population data has been crossed with the wind speed layer classified into three categories: Tropical Storm, Hurricane, and Major Hurricane. The data is presented as total population exposed by country and wind category.

Data sources

Administrative division: at level 0 (country based)[4]
Population: JRC-GHSL population, raster file with 100 m of resolution (cite)[5]
Wind buffer: raster layer provided by NOAA-HWRF with a resolution of 1.5 km

Procedure

- The software used for this analysis is ArcGISPRO, using the Zonal Statistics tool. Total population per grid cell is agregated by wind category per each country. The results table shows the total population exposed to each wind category:Tropical Storm 63-118 km/h
- Hurricane 119-178 km/h
- Major Hurricane> 179km/h

Results

The results of the analysis shown in Table 3 highlight that there are two countries with population exposed to the Major Hurricane: Grenada with almost 8 000 exposed people and Saint Vincent and the Grenadines with more than 4 000 people. These two countries are the worst-hit by the passage of Hurricane Beryl.

Within the Hurricane class we have Grenada and Saint Vincent and the Grenadines and also Mexico and Jamaica (the later severely impacted). In Tropical Storm class we have 11 countries with exposed population: Barbados, Cayman Islands, Dominican Republic, Grenada, Haiti, Jamaica, México, Saint Lucia, Saint Vincent and the Grenafdines, Trinidad and Tobago and the USA.

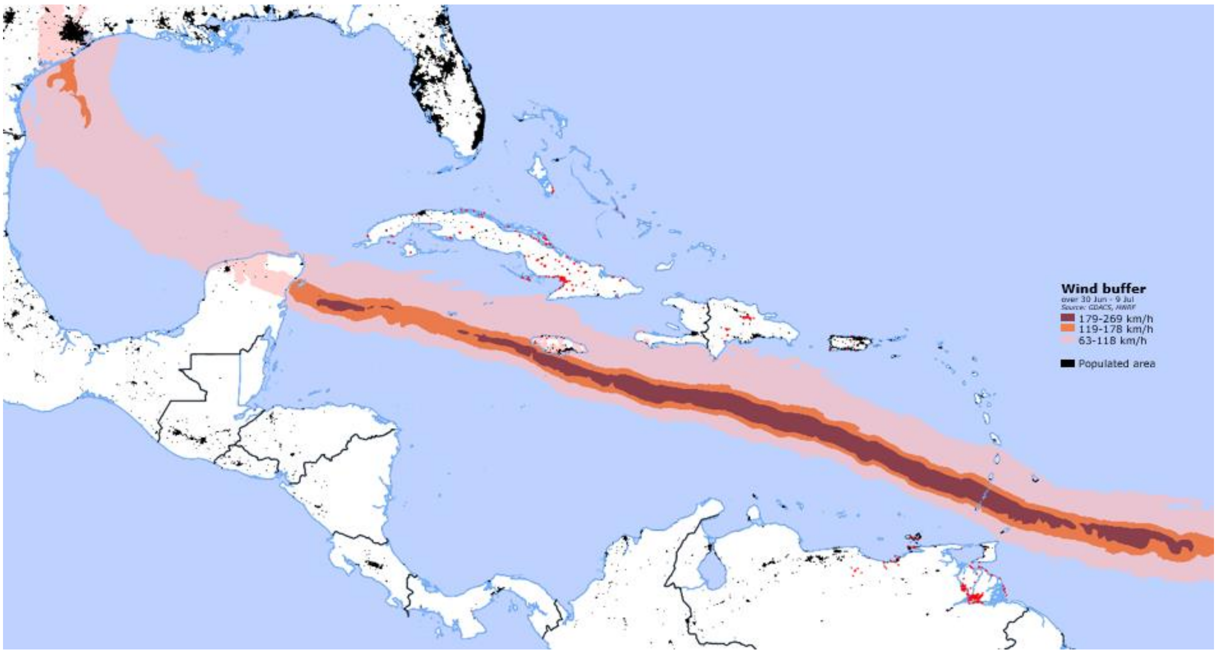
[3] UNICEF Jamaica Situation Report No. 2 (Hurricane Beryl) - 07 July 2024 - Jamaica | ReliefWeb
[4] https://gadm.org/data.html#google_vignette
[5] GHS-POP_GLOBE_R2023A for the year 2020. Schiavina M., Freire S., Carioli A., MacManus K. (2023):
GHS-POP R2023A - GHS population grid multitemporal (1975-2030).European Commission, Joint Research Centre (JRC)
PID: http://data.europa.eu/89h/2ff68a52-5b5b-4a22-8f40-c41da8332cfe, doi:10.2905/2FF68A52-5B5B-4A22-8F40-C41DA8332CFE

Table 3. List of the countries at different level classes of wind

COUNTRY	Tropical Storm	Hurricane	Major Hurricane
Barbados	243160.5983		
Cayman Islands	66672.00445		
Dominican Republic	5158.679996		
Grenada	65229.67877	49144.01986	7954.076496
Haiti	438376.4253		
Jamaica	1753792.792	21008.57846	
México	1077205.205	104450.7566	
Saint Lucia	166689.338		
Saint Vincent and the Grenadines	93592.23416	6079.31974	4406.024355
Trinidad and Tobago	70906.00106		
United States	8101302.076		

Source: JRC E1 GHSL

Figure 8. Overview of the wind buffer



Source: JRC E1 GHSL[6]

3.2.2 Floods

In order to estimate the potential population affected by the floods caused by the Hurricane Beryl the total population has been crossed with the observed flooded area. By visual inspection of the data, mostly inland lowlands areas are flooded.The most populated areas in the islands are however found along the coastline. Possible coastal floods caused by storm surged might increse the number of people exposed to floods in the affected areas.

[6] Schiavina M., Freire S., Carioli A., MacManus K. (2023): GHS-POP R2023A - GHS population grid multitemporal (1975-2030).European Commission, Joint Research Centre (JRC) PID: http://data.europa.eu/89h/2ff68a52-5b5b-4a22-8f40-c41da8332cfe, doi:10.2905/2FF68A52-5B5B-4A22-8F40-C41DA8332CFE

Data Sources:

Observed flooded area
Area: Windward Islands (southern part of Lesser Antilles, the worsth affected) and Leeward Islands (northern part of Lesser Antilles), northern Venezuela, southern tip of hispaniola Island, Jamaica, Cayman Islands and Yucatan Peninsula (central-eastern Mexico)
Provider: JRC Copernicus EMS GloFAS GFM (Global Flood Monitoring)
Period: from 01 July to 08 July
Main source: Sentinel 1 (as of tomorrow 09 July will be available the last passage of 08 July)
Population GHSL population layer 2020 (last release: 2023), 100m spatial resolution

Procedure

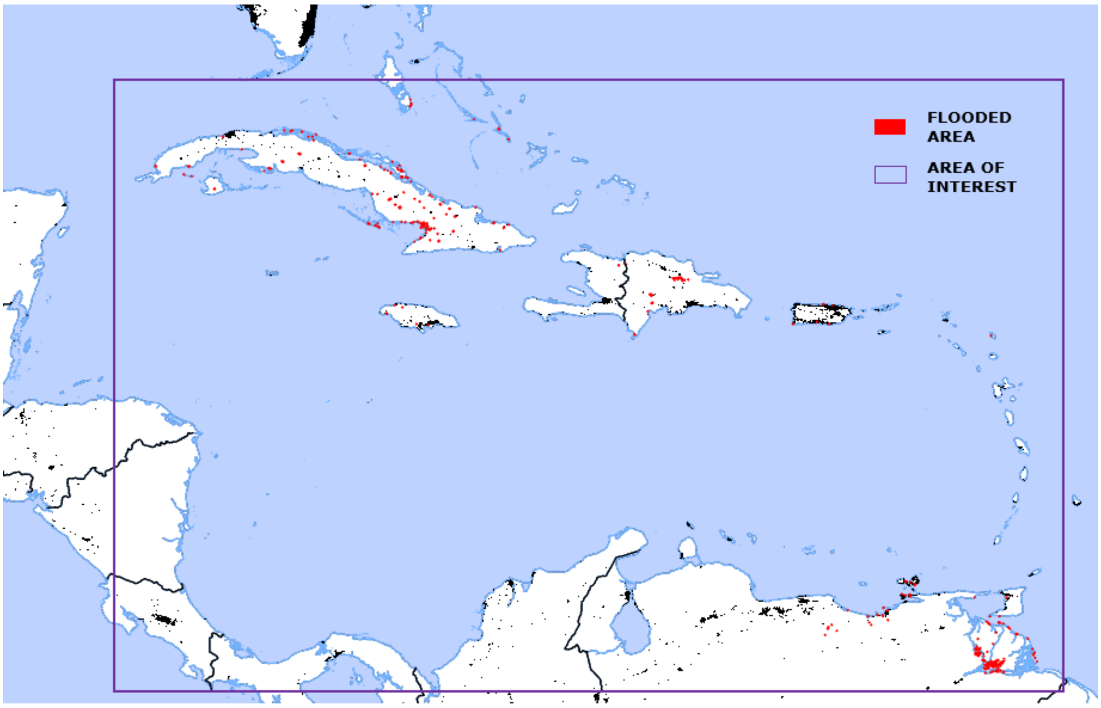
The software used for this analysis is ArcGISPRO, using the Zonal Statistics tool. Total population per grid cell is agregated using the flooded areas in each country.

Results

The results of the analysis show that only few people might be affected in Venezuela, Haiti, and Dominican Republic, the later being the most affected. However, the analysis is probably biased by the limitations of the floods obseved and the resolution of the data used.

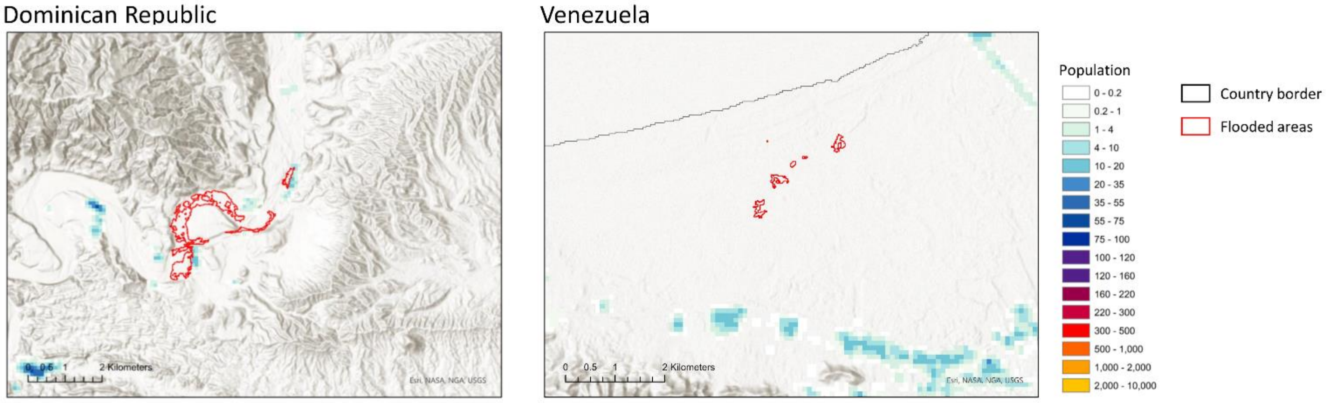
The Figure 10 shows the flooded areas within the area of interest, and in the Figure 11 the detail of some of these areas in Venezuela and Dominican Republic with the population layer. In the second, it is shown how low densely populated areas are the only affected by the floods.

Figure 9. Overview of the distribution of the flooded area



Source: JRC E1 GHSL

Figure 10. Detail of the flooded areas in Dominican Republic and Venezuela

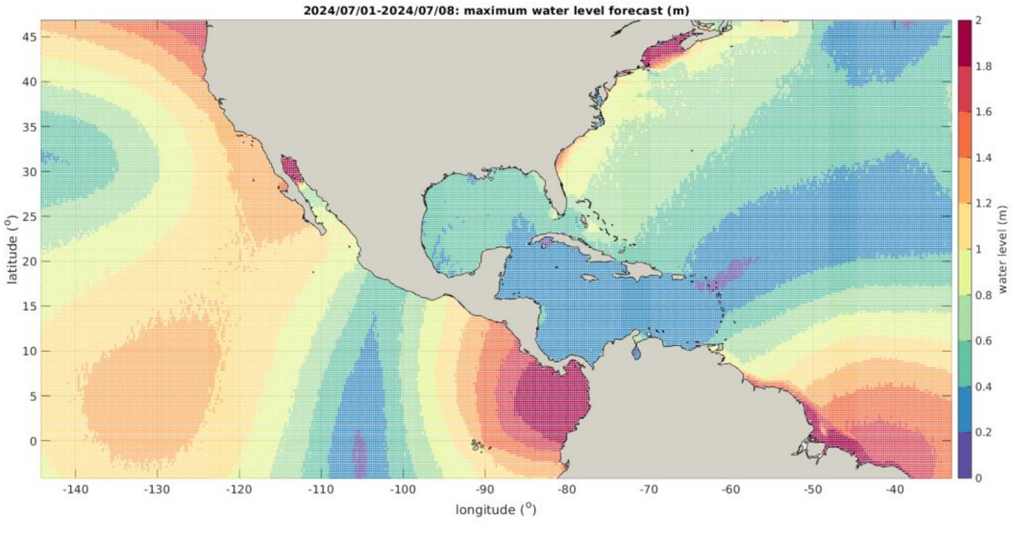


Source: JRC E1 GHSL

3.2.3 Storm Surge

Offshore water level forecasts have been derived using a probabilistic water level model, which utilises the ECMWF 51-ensemble member forecast atmospheric conditions. Based on the long-term hindcast assessment, the combined tide and meteorologically induced forecast water level is not expected to exceed the 2-5 year return period offshore water level. This estimation should be considered the lower threshold for local impact assessment studies, as local water level amplifications are expected in the nearshore coastal zone.

Figure 11. Modelling for Beryl and Storm surge hazard map



Source: JRC E1 GHSL

4 Preparedness and response: from anticipatory measures to needs assessment

4.1 Activations and anticipatory measures carried out

International mechanisms

GDACS issued its first impact estimation on 28 June, based on NOAA first bulletin on the same date at 21.00 UTC. The first GDACS orange alert was promptly issued at the same time, regarding St. Vincent and the Grenadines. On 29 June at 21.00 UTC the GDACS alert was upgraded to red for St. Vincent and the Grenadines, Barbados, Trinidad and Tobago, St. Lucia, Grenada, Dominican Republic, Haiti, Jamaica and the Cayman Islands, estimating approximately 10 000 people in Cat. 1 hurricane or higher. On 01 July at 03.00 UTC the GDACS alert was re-issued as orange for St. Vincent and the Grenadines, Grenada, Trinidad and Tobago and Mexico (this country was included for the first time), estimating approximately 530 000 people in Cat. 1 hurricane or higher. From 02 July to 03 July GDACS re-issued a red alert over Haiti, Grenada, Jamaica, Trinidad and Tobago, St. Vincent and the Grenadines and Mexico, estimating up to 2.7 million people in Cat. 1 hurricane or higher. On 05 July NOAA issued a hurricane warning over the Yucatan peninsula and the Gulf coast of eastern Mexico. Consequently, the GDACS alert was re-issued as orange but for an estimated higher number of exposed people: 3.5 million across Mexico, Belize (first time), Haiti, Grenada, Jamaica, Trinidad and Tobago, St. Vincent and the Grenadines, and the United States (first time). On 08 July NOAA has issued a hurricane warning over middle Texas Gulf coast; the overall GDACS alert was downgraded to green (see figure 2 for the timeline). The **GDACS' Virtual OSOCC** was activated on 01 July and the humanitarian organizations are sharing respective data and information. In parallel, the **GDACS' Satellite Mapping Coordination System (SMCS)** is providing organisations with monitoring and information on the satellite mapping services activated and their completed, current and future mapping activities for Beryl (see further details on this under the following sub-paragraph "Satellite mapping activations").

WMO provided regular updates and meteorological advice to the UN and humanitarian system through its WMO Coordination Mechanism (WMO_WCM), supported by the Federal Office of Meteorology and Climatology MeteoSwiss – Weather4UN Pilot Project, German Weather Service DWD and GeoSphere Austria. Regular updates on the situation are available in the WMO dedicated page for Beryl[7].

On 04 July, **UN OCHA** published the Flash Update n.3[8] mentioning that the UN Secretary-General has released USD4 million from the UN Central Emergency Response Fund to Grenada, Saint Vincent and the Grenadines, and Jamaica. OCHA is coordinating with CDEMA and regional partners and has already activated UN Disaster Assessment Coordination (UNDAC) teams that are currently deployed in Barbados and Jamaica.

The European Union has approved USD 486 600 (EUR 450 000) in humanitarian aid for Saint Vincent and the Grenadines and Grenada, in addition to more than USD 2.16 million (EUR 2 million) already allocated in 2024 to the Caribbean. The **Union Civil Protection Mechanism (UCPM)** has been formally activated on 04 July, after requests for assistance on 3 July. UNEP/OCHA Joint Environment Unit (JEU) requested experts while the Embassy of the Eastern Caribbean States & Missions to the EU requested support for Saint Vincent and the Grenadines, Saint Lucia, and Grenada. Copernicus Rapid Mapping service was activated (see details below). France provided shelter and non-food items to Grenada and Saint Vincent and the Grenadines through the UCPM. Jamaica requested assistance on 08 July including shelter, WASH, non-food items, search and rescue, and medical supplies[9].

IFRC released an emergency appeal for Saint Vincent and the Grenadines, Grenada, Barbados, and Jamaica. In line with the appeal there are going to be deployments in place and remotely.

Satellite mapping activations

The overview of the various satellite mapping mechanisms activated for the analysis of this event is available in the GDACS Satellite Mapping Coordination System (SMCS), which provides a communication and coordination platform where organisations can monitor and inform stakeholders of their completed, current and future

[7] https://wmo.int/media/news/record-breaking-hurricane-Beryl-threatens-caribbean

[8] https://www.unocha.org/publications/report/grenada/caribbean-hurricane-Beryl-flash-update-no-03-04-july-2024

[9] Lesser Antilles, the Caribbean, Mexico, USA - Hurricane Beryl, update (Copernicus EMSR, GDACS, NOAA, FEMA, WHO PAHO, UNICEF) (ECHO Daily Flash of 09 July 2024) - Mexico | ReliefWeb

mapping activities for ongoing emergencies. From this platform, all available products can be accessed via hyperlinks.

In the page dedicated to Hurricane Beryl, planned and delivered products from UNOSAT, CEMS and International Charter can be accessed (link). Below a summary of the status of these activations at the time of reporting and the preliminary results of the ongoing damage assessment efforts.

Figure 12. The overall satellite mapping activations for Beryl provided by the GDACS' SMCS.

Source: GDACS

On 01 July, **Copernicus EMS Rapid Mapping** was activated (activation EMSR734[10]) to provide flood extent and initial estimates of the damage via maps covering 19 cities/areas in the Caribbean and Central America[11]. Initially, the Copernicus EMSR734 was activated for St. Vincent and the Grenadines and Barbados and the first 3 maps of were delivered on 03 July. From 04 July to 08 July, additional maps were delivered, for a total of 12 covering the areas in table 4. By 09 July in the morning (UTC), a total amount of 14 maps were produced, showing an initial estimate of 6 832 destroyed, damaged or possibly damaged built-up units and 13.1 km of damaged roads.

[10] https://rapidmapping.emergency.copernicus.eu/EMSR734/
[11] https://rapidmapping.emergency.copernicus.eu/EMSR734/reporting

Table 4. Damage assessment table as at 09 July 2024

Area of Interest (AOI)		Observed Event		Affected or potentially affected		
ID	**Name**	**Latest observations [ha]**	**Max. extent [ha]**	**Built-up [No.]**	**Roads [km]**	**Population [No.]**
AOI01	Kingston	N/A	N/A	N/A	N/A	N/A
AOI02	Carriacou	N/A	N/A	2,529	N/A	N/A
AOI03	Petite Martinique	N/A	N/A	384	1.9	N/A
AOI04	Union Island	N/A	N/A	1475	9.4	N/A
AOI05	Bridgetown	N/A	N/A	N/A	N/A	N/A
AOI06	Mayreau	N/A	N/A	253	0.03	N/A
AOI07	Canouan	N/A	N/A	736	N/A	N/A
AOI08	Mustique	N/A	N/A	8	1	N/A
AOI09	Bequia	N/A	N/A	N/A	N/A	N/A
AOI10	Saint Vincent					
AOI11	Grenada	N/A	N/A	N/A	N/A	N/A
AOI12	Salt Savannah	N/A	N/A	1,447	37.1	N/A
AOI13	Cancun Beach					
AOI14	Cancun City					
AOI15	Merida	N/A	N/A	N/A	N/A	N/A
AOI16	Progreso	N/A	N/A	N/A	N/A	N/A
AOI17	Campeche	30	30	N/A	0.8	N/A
AOI18	Ciudad del Carmen	N/A	N/A	N/A	N/A	N/A
AOI19	Matamoros					
	Total	30	30	6,832.0	50.2	0

Source: Copernicus EMS-Rapid Mapping

UNOSAT mapping service was activated on 02 July, upon request of UNEP/OCHA Joint Environment Unit. At the time of writing, the following products and AOIs are included in the activation:

- UNOSAT Live Web map - Tropical Cyclone Beryl in the Caribbean (link to product, published on 03 July): this application provides geospatial information regarding the analysis related to the Tropical Cyclone Beryl in the Caribbean in July 2024.
- Preliminary satellite-derived damage assessment - Carriacou, Grenada - 04 July 2024 (link to product): widespread damage to structures observed in Carriacou Island (Grenada) as at 02 July 2024. The airport building is potentially damaged; the runway of Carriacou airport appears to not be damaged on 02 July 2024; potentially damaged harbour observed at Tyrrel Bay Port on 02 July 2024.
- Satellite detected water extent in Kingston, Saint Catherine and Saint Andrew Parishes, Jamaica as at 04 July 2024 (link to product) as observed from a TerraSAR-X image acquired at 06:03 local time. Within the analysed area of about 1 450 km^2, a limited extent of 5 km^2 of land appear to be affected by flood waters. This is a preliminary analysis and has not yet been validated in the field[12].
- Preliminary satellite-derived damage assessment, Kingston, Jamaica as at 04 July 2024, with potentially damaged structures observed (link to product). No major damage observed in the Port of Kingston, Jamaica as at 04 July 2024. Potentially damaged structures observed in Saint Andrew Parish, Kingston Parish and Saint Catherine Parishes, Jamaica;

[12] Flood analysis from radar images may underestimate the presence of standing waters in built-up areas and densely vegetated areas due to backscattering properties of the radar signal.

- Preliminary satellite-detected water extent in Saint Elizabeth Parish as observed from a Sentinel-2 image acquired at 10:48 local time. Within the analysed area of about 1,200 km², a limited extent of 13 km² of lands appear to be affected with flood waters (link to product).

The International Space Charter was activated for a total of 32 products (at the time of reporting), both Pre- and Post-Event Flood Maps in the area of Venezuela. All products are available in the dedicated page of the Satellite Mapping Coordination Centre of GDACS at this link.

In the meeting of the remote A&A Cell (see details below) of 08 July, the UNDAC team deployed in Jamaica requested maps on populated places in Jamaica where some communities have remained stranded.

Remote Analysis & Assessment Cell (A&A Cell)

On 04 July UN OCHA established a Remote Analysis & Assessment Cell (A&A Cell), an informal collaborative initiative which brings together experts at global level, to speed up the impact analysis of disasters and support the response efforts.

The remote A&A Cell aims to support the regional response to Hurricane Beryl. Both ECML and ERCC are engaged in this. It will remain active throughout the entire Atlantic hurricane season, with the capability to be quickly activated or deactivated based on needs, considering the critical hurricane seasonal forecast for this region.

The remote A&A Cell for Beryl is composed of the following collaborating networks: Regional Office for Latin America and the Caribbean (ROLAC); OCHA Emergency Response Sector (ERS) / UNDAC team; Caribbean Disaster Emergency Management Agency (CDEMA); OCHA Needs and Response Analysis Section *(*NARAS*)*; OCHA Filed Information Section (FIS) – Information Management support; UNOSAT; MapAction; DFS/DEEP analysis cell; REACH; IFRC; HDX; ACAPS; iMMAP.inc; Atlas Logistique; PDC; EUCPT; JRC European Crisis Management Laboratory (ECML); ERCC analytical team; Logistic cluster.

Currently the two UNDAC teams deployed, in Grenada and in Jamaica, started the in-filed needs assessments. The ongoing remote activities of the A&A Cell focus on the analysis of the assessment data, combining information derived from remote-sensing (especially critical in this first stage of the in-field assessments, to prioritise areas for the collection of data) with information from the field.

Another ongoing effort of the remote A&A Cell is to replicate the approach for the rapid estimation of the severity of impact on people, which was successfully adopted in the occasion of tropical cyclone Idai, in Mozambique (14 March 2019). The idea is to develop a composite indicator combining the following 4 variables to provide the humanitarian community with a ranking of the most affected geographical areas:

1. Impact of the wind
2. Impact of storm surge
3. Impact of flood
4. Population density figures

For Tropical Cyclone Idai, the approach used was to overlay these datasets and identify seven categories of hazard-impact, using the Beaufort Wind force Scale and including the number of people being exposed to the various categories. This approach might be revised for this event. At the moment, the various networks engaged in the remote A&A Cell are collecting the available data for the 4 variables listed above. JRC provided the following data to support this methodology:

- Observations of flooded areas from the GloFAS-Global Flood Monitoring Service (GFM) for the period from 01 - 08 July, based on Sentinel-1 satellite data (resolution 5 m).
- Calculation of the population exposed to floods using the Global Human Settlement Layer (GHSL) data (resolution 100 meters).
- Population exposed to different levels of wind (storm, hurricane, major hurricane) derived from GHSL data combined with NOAA wind buffers.

This method will provide the international humanitarian community with an initial estimation of people affected. The figures deriving from qualitative analysis -such as vulnerability indicators, lessons learnt, expert judgment, and field observations- will then be combined to the quantitative estimation to derive the severity of humanitarian needs in the different areas. The planned output is a product for further interpretive analysis and prioritisation of the humanitarian response.

Data from various sources (e.g. GFM, GHSL, CEDEMA, World Pop, World Bank, PDC) will be combined with UNDAC and in-country partners' field observations and ACAPS secondary data review and interpretive analysis to produce a joint analytical output, starting from the stand-alone, independent products of each contributing organisation, building on each other's efforts in a fully collaborative approach.

Local anticipatory measures

The following are a few examples of local anticipatory measures. However, this list should not be considered exhaustive.

In Jamaica, UNICEF prepared to deal with water and vector-borne diseases outbreaks resulting from the heavy rain. It ensured that essential supplies for disease prevention including repellent-impregnated mosquito nets and water purification tabs were available in case of need[13].

As part of the Regional Response Mechanism several teams were deployed by the Caribbean Disaster Emergency Management Agency (CDEMA) including two Rapid Needs Assessment Teams for Grenada and Saint Vincent and the Grenadines. UNDAC teams were also deployed to support CDEMA[14].

In the United States, the State of Texas pre-positioned and deployed 2 000 responders and 850 assets to support the emergency response operations.[15] The population was advised to plan for the emergency, review the hurricane evacuation routes, build emergency supplies kits, and consider reviewing flood risk and insurance coverage.[16]

[13] UNICEF Jamaica Situation Report No. 2 (Hurricane Beryl) - 07 July 2024 - Jamaica | ReliefWeb
[14] Eastern Caribbean: Hurricane Beryl - Situation Report No. 01 (As of 7 July 2024) - Grenada | ReliefWeb
[15] Acting Governor Dan Patrick Adds 81 Texas Counties to Hurricane Beryl Disaster Declaration - Lieutenant Governor Dan Patrick
[16] Governor Abbott Increases Readiness Level Of State Emergency Operations Center Ahead Of Hurricane Beryl | Office of the Texas Governor | Greg Abbott

5 Atlantic hurricane season forecast

As of 23 May 2024, NOAA predicted an above-normal 2024 Atlantic hurricane season, since La Nina and warmer-than-average ocean temperatures represents major drivers of tropical activity.

NOAA's outlook for the 2024 Atlantic hurricane season, which officially lasts from June 1 to November 30, predicts an 85% chance of an above-normal season, a 10% chance of a near-normal season and a 5% chance of a below-normal season. For the North Atlantic basin, the Caribbean Sea and the Gulf of Mexico, NOAA forecast from 17 to 25 named storms (winds ≥ 63 km/h). Of those, from 8 to 13 are forecasted to become hurricanes (cat. 1-2, winds 119-177 km/h), including from 4 to 7 major hurricanes (cat. 3-5, winds ≥ 178 km/h). Forecasters have a 70% confidence in these ranges.

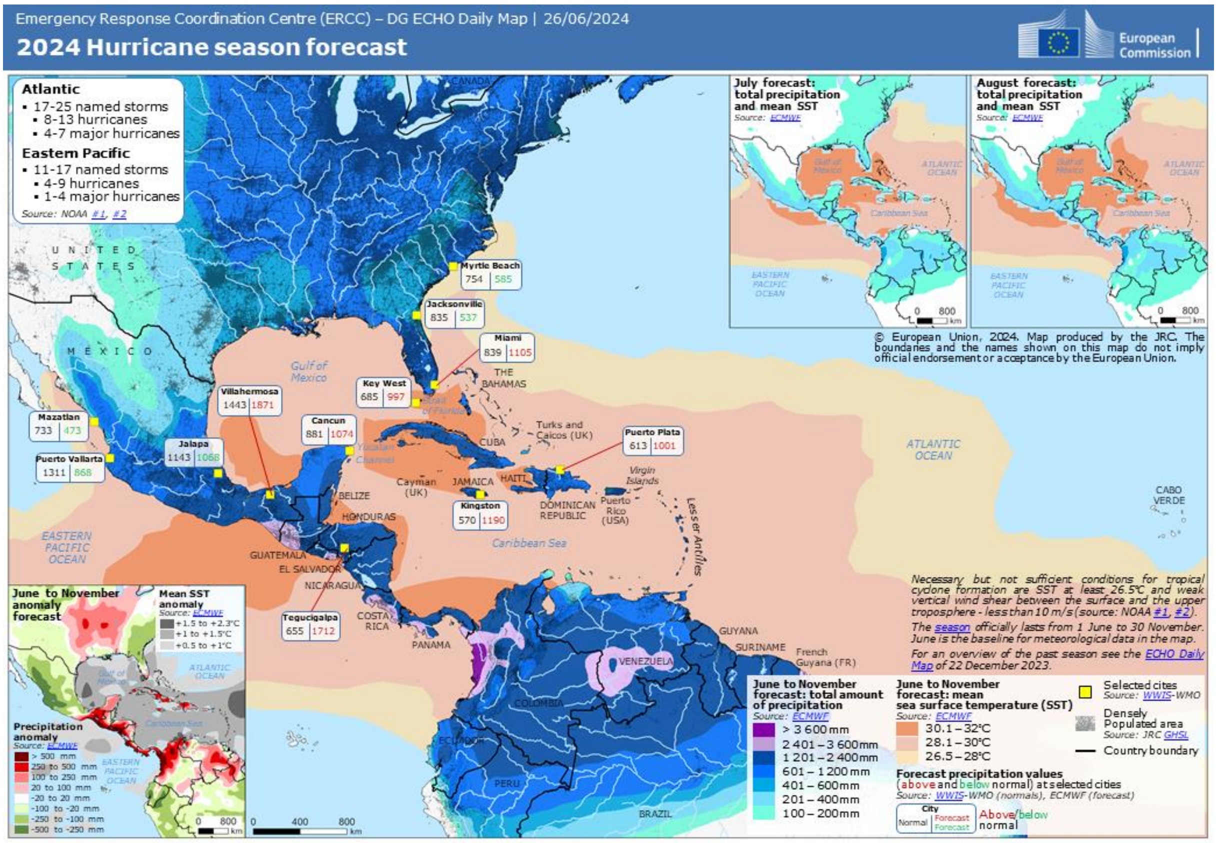
The current 2024 Atlantic hurricane season was predicted to have above-normal activity due to a confluence of factors, including near-record warm ocean temperatures in the Atlantic Ocean, development of La Nina conditions in the Eastern North Pacific basin, reduced Atlantic trade winds and less wind shear, all of which tend to enhance tropical storm formation. In particular, necessary but not sufficient conditions for tropical cyclone formation are the sea surface temperature of at least 26.5°C and weak vertical wind shear between the surface and the upper troposphere of less than 10 m/s at levels at 850 mb (about 5000 feet / 1500m above the surface) and 200 mb (about 40000 feet / 12000 m altitude). Namely, speeds up to 10 m/s are considered favourable for TC genesis, speeds between 10 and 20 m/s are deemed unfavourable to the development of TC (the probability that the phenomenon will develop to TC is very low but still possible). Finally, velocities of 20 m/s are considered a threshold above which the vertical development of TC is impossible.

Above normal rainfall is most likely during the 2024 hurricane season over the Lesser Antilles (Windward and Leeward Islands), the Virgin Island, the Bahamas, Puerto Rico, most of the Dominican Republic, Haiti and Jamaica, the Cayman Islands and the whole central America from Panama north to the Yucatan Peninsula and southern Mexico. Above normal conditions are also forecasted over most of the Caribbean coast of Colombia and Venezuela and over southern Florida (USA).

Below normal rainfall is expected over most of central and northern Mexico, the northern parts of the Gulf coast of the same Country, the neighbouring western Mexico and from the Florida panhandle north to the Carolinas (USA). Also, some areas of the central-northern Caribbean coast of Venezuela are forecasted to have below normal rainfall.

The JRC ECML team was requested to produce an ECHO Daily Map on the 2024 Atlantic hurricane season forecast. This map (published on 26 June) represents the third of a series concerning seasonal forecast at regional scale on rainy seasons and tropical cyclone seasons, produced as anticipatory analysis and requested by DG ECHO. This one (figure 13) on the hurricane season depicts the total amount of precipitation forecast over the period from June to November included (so-termed JJASON), the same data for two peak months (July and August), the precipitation anomaly forecast for the JJASON period. The map also represents the mean sea surface temperature forecast and the anomaly of the sea surface temperature over the period from June to November 2024. The source of data is ECMWF (and NOAA for some figures), using the most updated and recently published baseline (first half of June). The map also represents sample of climate data for comparison between values of the climate reference period and values of the forecast ensemble model.

Figure 13. ECHO daily map of 26 June 2024



Source: JRC, DG ECHO

6 Past Multi-Island Hurricane events

6.1 Approach to the comparative analysis

For the analysis of the more significant past Hurricanes and Tropical Storms in the Atlantic Basin (Atlantic Ocean, Caribbean Sea, and Gulf of Mexico), the major events in the last 12 years have been selected, based on the humanitarian and economic impact on the affected countries (from 2012 to 2024, considering the ongoing season). Moreover, upon request of the ERCC, additional five major hurricanes from 1988 to 2007 have been considered for this comparison.

The criteria to consider the events as relevant is that one the following factor is satisfied:

- Number of fatalities > 30
- Economic loss > 100 Million Euro
- Humanitarian economic support from UN OCHA

The tables below report the following information for all of the identified Tropical Cyclones:

Impact

- Time period: from the formation of the hurricane until its dissipation (source: NOAA)
- Storm category: this information is provided for the peak intensity (source: GDACS)
- Max. sustained winds: this information is provided for the peak intensity (source: GDACS)
- Humanitarian and economic impact: the information on the direct losses are provided, in terms of number of fatalities and direct economic losses (source: NOAA and EMDAT)[17]
- Affected area: the most affected areas (source: GDACS as of 2012, before NOAA).

The underlined Tropical Cyclones in table 5 indicate the events that impacted multiple islands in the Caribbean region.

6.2 Comparison of the impact of multi-island hurricanes in the Caribbean

In table 5 below, all the Hurricanes selected according to the criteria described in the previous section are listed.

It worth mentioning that the comparative analysis provides additional confirmation that TC Beryl-24 is the earliest Category 5 Atlantic hurricane on the analysed period and, as mentioned by WMO, on record:

"*It intensified at an explosive rate to become the earliest Category 5 Atlantic hurricane on record and sets an alarming precedent for what is expected to be a very active hurricane season with risks for the entire basin. Once again, it highlights the need for multi-hazard early warnings.*"[18]

The tracks of the listed hurricanes in table 5 are represented in the map below (figure 14). This overview map represents at a glance all the significant cyclones occurred in the North Atlantic basin, in the Caribbean Sea and in the Gulf of Mexico from 2012, compared to Hurricane Beryl. The selection follows the same criteria used for the table (i.e. fatalities > 30, economic loss > 100 million Euro, humanitarian economic support from UN OCHA). All 18 tracks are represented indicating the intensity classification as tropical depression (< 63 km/h), tropical storm (63-118 km/h) and hurricane (< 118 km/h). A total of 9 cyclones passed over the Lesser Antilles during the period of concern, of which 4 over the windward Islands (the southern part of the Lesser Antilles). For each cyclone the map also provides (by means of a synoptic table) the period of its passage, the reached maximum wind speed, the number of fatalities and the related GDACS alert.

[17] values converted to EUR from USD

[18] World Meteorological Organization, 2024 - https://wmo.int/media/news/record-breaking-hurricane-Beryl-threatens-caribbean (last access 09 July 2024)

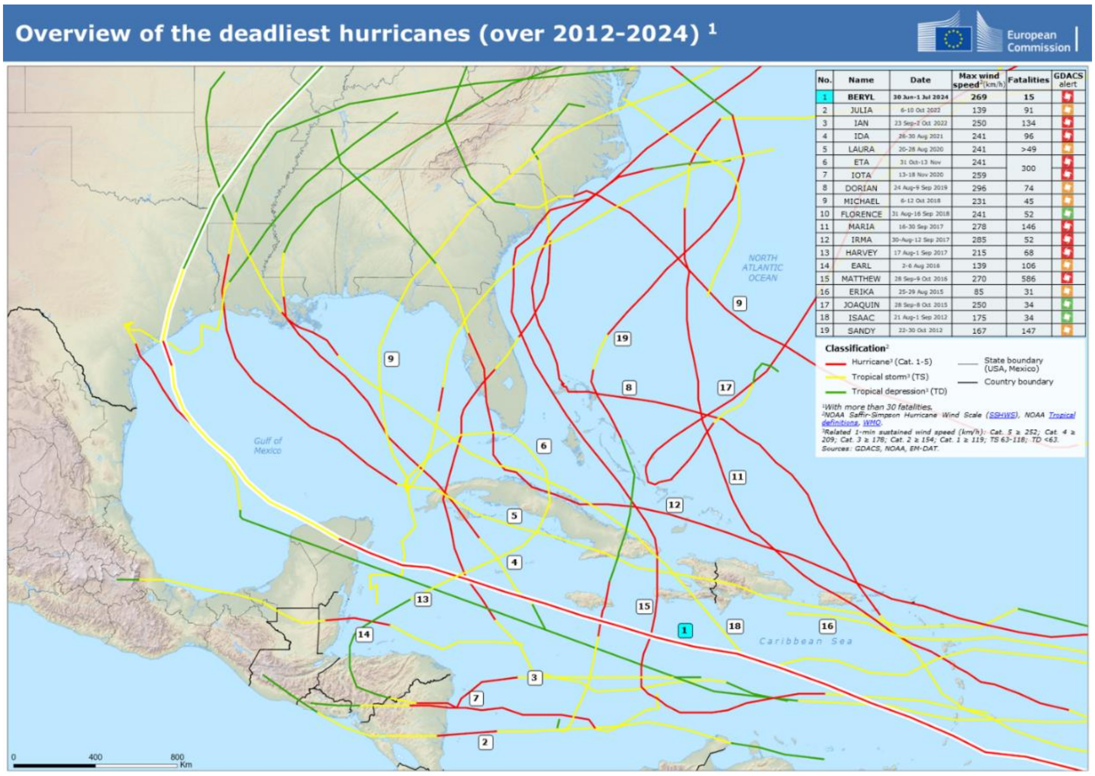
Table 5. Hurricanes in the Caribbean (names underlined in the first column indicate events that impacted multiple islands in the Caribbean region)

TC Name	Dates active	Storm category at peak intensity	Max. sustained winds (km/h)	Fatalities	Direct Economic Loss (Million EUR)	Areas mostly affected
2024 (ongoing Hurricane season)						
Beryl	June 28 – ongoing	Category 5 Hurricane	269	15 (Provisional)	na	Haiti, Grenada, Jamaica, Trinidad and Tobago, Saint Vincent and the Grenadines, Mexico, Belize, United States
2022						
JULIA	Oct 6 – Oct 9	Category 1 Hurricane	139	91	tbc	Nicaragua
IAN	Sept 23-Sept 30	Category 4 Hurricane	250	134	tbc	United States, Cuba
2021						
IDA	Aug 26 – Aug 30	Category 4 Hurricane	241	96	tbc	United States, Cuba
2020						
IOTA	Nov 13 – Nov 18	Category 5 Hurricane	259	300 (overall impact)	tbc	Honduras, Nicaragua
ETA	Oct 31 – Nov 13	Category 4 Hurricane	241			Nicaragua, United States, Honduras
LAURA	Aug 20 – Aug 28	Category 4 Hurricane	241	76	tbc	United States, Cuba, Haiti, Jamaica, Bahamas, Dominican Republic, Puerto Rico, Virgin Islands U.S., Virgin Islands British, Anguilla, Saint Kitts and Nevis, Montserrat, Antigua and Barbuda, Guadeloupe, Turks and Caicos Islands, Dominica
2019						
DORIAN	Aug 24 – Sep 09		296	74	tbc	Canada, United States, Bahamas, Virgin Islands, U.S., British, Puerto Rico, Martinique, Saint Lucia, Saint Vincent and the Grenadines, Barbados, Dominican Republic, Turks and Caicos Islands, Haiti, Dominica, Guadeloupe
2018						

MICHAEL	Oct 06 – Oct 12	Category 4 Hurricane	231	45	tbc	United States, Cuba
FLORENCE	Aug 31 – Sep 16	Category 4 Hurricane	241	52	tbc	United States
			2017			
MARIA	Sept 16 - 30	Category 5 Hurricane	280	146	78 000	Lesser Antilles(Dominica, Guadeloupe, Martinique, Saint Croix), Puerto Rico, Dominican Republic, Turks and Caicos Islands, The Bahamas, Southeastern USA, Mid-Atlantic States USA
IRMA	Aug 30 - Sept 12	Category 5 Hurricane	285	52	42000	Leeward Leeward Islands (Barbuda, Saint Martin, Saint Barthelemy, U.S. Virgin Islands), Puerto Rico, Dominican Republic, Turks and Caicos Islands, The Bahamas, Cuba, Southeastern USA (Florida and Georgia), Northeastern USA
HARVEY	Aug 17 - Sept 1	Category 4 Hurricane	215	68	107 000	Barbados, Suriname, Guyana, Windward Islands, Nicaragua, Belize, Yucatán Peninsula, Northeastern Mexico, Southern United States (Texas, Louisiana), Eastern USA
			2016			
EARL	Aug 2 - 6	Category 1 Hurricane	140	106	214	Lesser Antilles, Puerto Rico, Haiti, Dominican Republic, Jamaica, Cayman Islands, Central America, Mexico
MATTHEW	Sept 28 - Oct 9	Category 5 Hurricane	270	586 (Most of them in Haiti)	8000	Windward Islands, Leeward Antilles, Venezuela, Colombia, Jamaica, Haiti, Dominican Republic Puerto Rico, Cuba, Turks and Caicos Islands, The Bahamas, Southeastern United States, Atlantic Canada
			2015			
ERIKA	Aug 25-29	Tropical Storm	85	31	438	Lesser Antilles (Dominica), Greater Antilles, Florida
JOAQUIN	Sept 28 - Oct 8	Category 4 Hurricane	250	34	171	Turks and Caicos Islands, The Bahamas, Cuba, Haiti, Southeastern United States, Bermuda, Azores
			2013			
INGRID	Sept 12-17	Category 1 hurricane	140	23	1000.29	Mexico (Tamaulipas), Texas
			2012			

ISAAC	Aug 21 - Sept 1	Category 1 hurricane	130	34	200.67	Leeward Islands, Puerto Rico, Haiti, Dominican Republic, Cuba, The Bahamas, Southeastern United States (Louisiana), Midwestern United States
SANDY	Oct 22 -Oct 29	Category 3 hurricane	185	147	56000	Jamaica, Cuba, Haiti, The Bahamas, East Coast of the USA (New Jersey), Bermuda, Canada
2007						
DEAN	Aug 13 – Aug 27	Category 5 Hurricane		280	45	Lesser Antilles, Greater Antilles, Nicaragua, Honduras, Belize, Guatemala, Mexico, United States
2005						
EMILY	July 11 – July 21	Category 5 Hurricane		260	22	Grenada, Guyana, Lesser Antilles, Venezuela, Colombia, Greater Antilles, Honduras, Belize, Mexico, United States (Texas)
2004						
IVAN	Sept 2 – Sept 24	Category 5 Hurricane		270	124	Windward Islands (especially Grenada), Trinidad and Tobago, Venezuela, Barbados, Jamaica, Hispaniola, Grand Cayman, Cuba, Mexico, United States and Canada
1998						
MITCH	Oct 22 – Nov 5	Category 5 Hurricane		285	>11374	Central America (especially Honduras and Nicaragua), Mexico, United States (South Florida), Jamaica, Ireland, United Kingdom
1988						
GILBERT	Sept 08 – Sept 19	Category 5 Hurricane		295	318	Lesser Antilles, Puerto Rico, Venezuela, Haiti, Dominican Republic, Jamaica, Central America, Yucatan Peninsula, Mexico, Texas, South Central United States, Midwestern United States, Western Canada

Figure 14. Overview of the most significant hurricanes over 2012-2024



No.	Name	Date	Max wind speed[2](km/h)	Fatalities	GDACS alert
1	**BERYL**	**30 Jun-1 Jul 2024**	**269**	**15**	
2	JULIA	6-10 Oct 2022	139	91	
3	IAN	23 Sep-2 Oct 2022	250	134	
4	IDA	26-30 Aug 2021	241	96	
5	LAURA	20-28 Aug 2020	241	>49	
6	ETA	31 Oct-13 Nov	241	300	
7	IOTA	13-18 Nov 2020	259		
8	DORIAN	24 Aug-9 Sep 2019	296	74	
9	MICHAEL	6-12 Oct 2018	231	45	
10	FLORENCE	31 Aug-16 Sep 2018	241	52	
11	MARIA	16-30 Sep 2017	278	146	
12	IRMA	30-Aug-12 Sep 2017	285	52	
13	HARVEY	17 Aug-1 Sep 2017	215	68	
14	EARL	2-6 Aug 2016	139	106	
15	MATTHEW	28 Sep-9 Oct 2016	270	586	
16	ERIKA	25-29 Aug 2015	85	31	
17	JOAQUIN	28 Sep-8 Oct 2015	250	34	
18	ISAAC	21 Aug-1 Sep 2012	175	34	
19	SANDY	22-30 Oct 2012	167	147	

Source: JRC E1

For the hurricanes in the time period 1988-2007 the vector data formats are not available in the NOAA data collector, the related information can be accessed on the dedicated NOAA hurricane reports.[19.]

[19] DEAN https://www.nhc.noaa.gov/data/tcr/AL042007_Dean.pdf
EMILY https://www.nhc.noaa.gov/data/tcr/AL052005_Emily.pdf
IVAN https://www.nhc.noaa.gov/data/tcr/AL092004_Ivan.pdf
MITCH https://www.nhc.noaa.gov/data/tcr/AL131998_Mitch.pdf
GILBERT https://www.weather.gov/lch/1988Gilbert

7 Assessing Risk and Crisis Severity in Countries Exposed to Tropical Cyclone Beryl-24 within INFORM framework

The potential humanitarian impacts of Tropical Cyclone Beryl-24 on the exposed countries (**Haiti, Grenada, Jamaica, Trinidad and Tobago, Saint Vincent and the Grenadines, Mexico, Belize, United States**) can be assessed within INFORM framework. Six out of the eight exposed nations are classified as low to medium risk with acceptable coping capacities, suggesting they have the ability to manage the potential damage from the storm without requiring significant humanitarian assistance (Table 6). However, Haiti and Mexico face a different situation. Haiti is classified as very high risk, while Mexico is considered high risk, and both countries are currently dealing with ongoing crises. This indicates they may struggle to cope with the additional strain caused by Beryl-24 and could require targeted support to meet the humanitarian needs of affected populations and facilitate recovery efforts.

Table 6. INFORM Risk[20] and INFORM Severity[21] measures for the exposed countries to Tropical Cyclone Beryl-24

Country	INFORM Risk score (0 – 10, higher the worse)	INFORM Risk class (5 classes from very low to very high)	INFORM Severity score (1 – 5, higher the worse)	INFORM Severity class (5 classes from very low to very high)
Haiti	7.2	Very High	4	High
Grenada	2.2	Low	-	-
Jamaica	2.9	Low	-	-
Trinidad and Tobago	2.8	Low	1.7	Low
Saint Vincent and Grenadines	2.6	Low	-	-
Mexico	4.9	High	3	Medium
Belize	3.6	Medium	-	-
United States	3.2	Medium	-	-

Source: JRC E1

Haiti is highly exposed to natural disasters, especially cyclones and floods, according to the INFORM risk natural hazard profile. Data from the Emergency Events Database (EM-DAT) shows that between 2015 and 2023, the country has experienced several cyclone and flood events that have affected over 2 million people, resulted in 730 fatalities, and caused nearly 2.5 billion US dollars in damages. As of May 2024, almost 74 percent of Haiti's population (8.66 million) are affected by adverse impacts of complex crisis[22], resulting in 5.5 million Haitians in need of humanitarian assistance, according to INFORM Severity. Gang violence has devastated Haiti, affecting all aspects of everyday life, particularly in Port-au-Prince, Artibonite, and other regions. The objective challenges posed by the situation has created opportunity for non-state armed groups to wreak havoc on the population, leading to a severe humanitarian crisis with widespread displacement, food insecurity, and a breakdown in essential services[23].

Adverse impacts of Tropical Cyclone Beryl-24 could dramatically intensify the ongoing crisis in Haiti in absence of Immediate emergency relief efforts to provide shelter, food, water, and medical assistance to those affected by the storm.

Mexico is classified with the highest INFORM risk level after Haiti among the exposed countries to Tropical Cyclone Beryl-24. The natural hazard profile of Mexico indicates very high risk of cyclone and floods derived

[20] INFORM Risk is a global multi-hazard index which scores countries' risk of humanitarian crisis between 0-10 and in 5 categories from 'very low' to 'very high'. INFORM Risk has three dimensions: hazard & exposure, vulnerability and lack of coping capacity. Each dimension encompasses different categories, which are user-driven concepts related to the needs of humanitarian and resilience actors.

[21] INFORM Severity Index is a composite indicator designed to measure the severity of humanitarian crises globally, against a common scale. It aggregates data from various sources to categorise all crises into five levels of severity.

[22] Complex crisis: A crisis in which natural and/or man-made factors interact and overlap making it often impossible to isolate their impact.

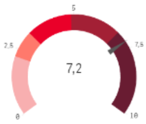
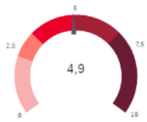
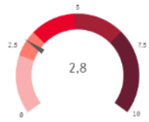
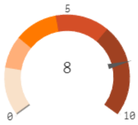
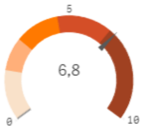
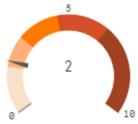
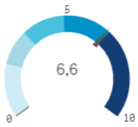
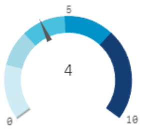
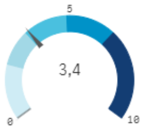
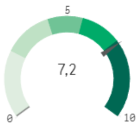
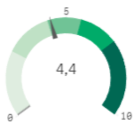
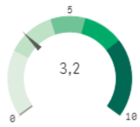
[23] https://www.unocha.org/haiti, https://www.ipcinfo.org/ipc-country-analysis/details-map/en/c/1156884/?iso3=HTI, https://dtm.iom.int/haiti

from probabilistic hazard assessment. In the period from 2015 to 2023, Mexico has faced numerous storms, cyclones, and floods, according to data from the Emergency Events Database (EM-DAT). These events have had a significant impact on the country, affecting over one million people and resulting in 366 fatalities. Additionally, the damages caused by these disasters have been estimated at nearly 15 billion US dollars. Currently, Mexico is also experiencing multiple crisis[24] driven by violence and displacement, affecting more than half a million people according to INFORM Severity. In December 2020, the impacts of Hurricanes Eta and Iota were felt in Southern Mexico, affecting an estimated 169 000 people. The storms left around 17,000 people in need of humanitarian assistance, as they caused significant damage to homes and infrastructure. Without adequate DRR and response measures in place in Mexico, Tropical Cyclone Beryl-24 could lead to substantial damage and disruption, particularly impacting the most vulnerable communities.

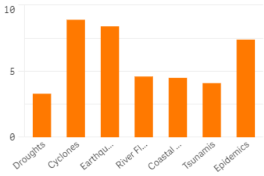
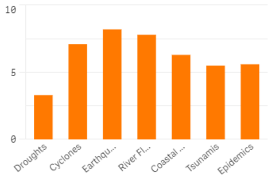
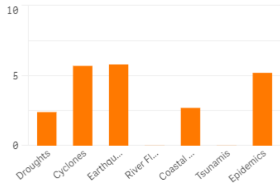
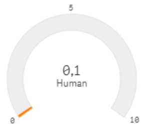
According to the INFORM Severity index, among the countries exposed to Tropical Cyclone Beryl-24 that are classified as low to medium risk, only **Trinidad and Tobago** is currently experiencing an ongoing crisis. As of May 2024, a refugee crisis has impacted over 10% of Trinidad and Tobago's population, leaving approximately 26,000 people in need of humanitarian assistance. Despite Trinidad and Tobago's high coping capacity and income level, the adverse effects of Tropical Cyclone Beryl-24 could still cause significant hardship for these vulnerable groups if a proper and timely response is not implemented.

INFORM Risk and INFORM Severity country profiles can be found in Table 7.

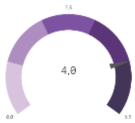
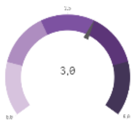
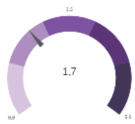
Table 7. INFORM Risk and Severity profiles for Haiti, Mexico and Trinidad - Tobago

Country	**Haiti**	**Mexico**	**Trinidad and Tobago**
INFORMRISK			
WB income group	Lower middle income	Upper middle income	High income
Risk category	Very High	High	Low
Risk score			
Hazard&Exposure			
Vulnerability			
Lack of Coping capacity			

[24] Multiple crisis: there are multiple crises within a country that affect different population groups in different geographical locations.

Natural hazard profile			
Human hazard profile			

INFORMSEVERITY

Crisis	Complex crisis	Multiple crisis	Venezuelan refugees
Drivers	Earthquake, Other seasonal event, Socio-political, Violence	Displacement, Violence	Displacement
Severity class	High	Medium	Low
Severity score			
Trend	Decreasing	Stable	Decreasing
People in need	5.5 million	-	26 thousand
People affected	8.66 million	614 thousand	212 thousand
People displaced	353 thousand	614 thousand	36 thousand

Source: JRC E1

8 Monitoring of the health-related news about Hurricane Beryl from the Epidemic Intelligence from Open Source (EIOS) system

The JRC monitored the situation with a specific filter defined in the EIOS system. Several media sources reported warnings regarding the impacts of heavy rains associated with the Hurricane Beryl on the increased risk of several diseases infections.

Jamaican and Dominican Republic authorities advise people to avoid swimming or playing in waters that resulted from flooding. Morover, they suggest to avoid food that could have been contaminated with animal urine and to wear protective clothing and footwear if they are exposed to contaminated water and soil. In addition, the use of insect repellent containing DEET is highly raccomended, as well as mosquito nets and mosquito destroyer. Finally, to prevent gastrointestinal diseases it is raccomended to regularly wash hands, especially before eating and after restroom use [25,26] .

The diseases of major concern are leptospirosis, dengue fever, and malaria. Furthermore, puncture wounds or cuts exposed to flood water could be a risk for tetanus[27]. Also regarding the Gulf of Mexico, stagnant pools of water during and after flooding may increase the incidence of insect- and waterborne diseases, such as dengue fever, cholera, and malaria. Exposure to raw sewage and other hazardous materials mixed with floodwaters poses a serious health threat[28], and the elimination of mosquito breeding sites is crucial[29].

Furthermore, in Texas, the high temperature togheter with the absence of cooling systems, due to the power shutdown, may expose people to organ damage. In particular, elderly, people with chronic conditions, and children are at higher risk for severe heat-related illnesses[30].

The eastern Caribbean Regional Security System (RSS) Executive Director, on 04 July, stated *"Currently, there is a dire need for food, water, fuel, and other essentials. To this end, the Regional Response Mechanism (RRM) has been mobilised and the RSS is currently coordinating the activities for safe, effective, and efficient deployment of resources to assist the stricken islands in providing security and relief aid in the process"*[31].

Authorities are aiding the state of Sucre, after Hurricane Beryl's floods, providing essentials like water, food, clothing, and medicine[32]. As of early 08 July, 2024, Texas authorities have declared weather emergencies in 121 counties due to the incoming storm. Corpus Christi announced a disaster situation, and Refugio County mandated an evacuation, planning to cut water and transfer hospital patients post-landfall. Voluntary evacuations are advised for specific areas in ten other counties[33]. Venezuelan Red Cross and local authorities collaborates with local authorities to set up a water treatment plant to provide clean water for the local communities[34].

In addition, it is important to take care of elderly people as well as other vulnerable groups[35,36].

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[25] https://radiojamaicanewsonline.com/local/disease-prevention-urged-after-hurricane-Beryl-health-ministry-cautions-against-leptospirosis-and-dengue-risks

[26] https://listindiario.com/la-republica/ciudad/20240708/onda-tropical-viene-lluvias-proximas-48-horas_816078.html

[27] https://www.dshs.texas.gov/news-alerts/dshs-reminds-residents-hurricane-impacted-areas-safety-precautions

[28] https://crisis24.garda.com/alerts/2024/07/gulf-of-mexico-tropical-storm-Beryl-tracking-north-northwestward-toward-texas-late-july-7-update-15

[29] https://listindiario.com/la-republica/ciudad/20240708/onda-tropical-viene-lluvias-proximas-48-horas_816078.html

[30] https://saudigazette.com.sa/article/644106/World/America/Beryl-leaves-millions-of-Texans-without-power-as-dangerous-heat-descends-on-the-region

[31] https://guyanatimesgy.com/rss-to-provide-security-relief-aid-to-hurricane-stricken-islands/

[32] https://unionradio.net/2024/07/07/autoridades-se-mantienen-desplegadas-atendiendo-a-la-poblacion-de-cumanacoa/

[33] https://crisis24.garda.com/alerts/2024/07/gulf-of-mexico-tropical-storm-Beryl-tracking-north-northwestward-toward-texas-late-july-7-update-15

[34] https://humvenezuela.com/cruz-roja-venezolana-brinda-asistencia-a-personas-afectadas-por-inundaciones-en-cumanacoa-via-el-impulso/

[35] https://jis.gov.jm/ncsc-urges-vigilance-and-care-for-senior-citizens-during-hurricane-season/

[36] https://www.dshs.texas.gov/news-alerts/dshs-reminds-residents-hurricane-impacted-areas-safety-precautions

9 Potential consequences on water and health

The aftermath of Hurricane Beryl has highlighted significant potential consequences for water quality and public health, which might cause immediate health effects that are often life-threatening, resulting in immediate injuries and long-term health consequences[37]. The exacerbation of chronic diseases, mental health issues, and the spread of infectious diseases underscores the urgent need for comprehensive response strategies which should aim to save and preserve life during emergencies and their immediate aftermath, addressing the significant loss of life, physical and psychological suffering, social disruption, and material damage caused the event. Additionally, recovery plans must incorporate robust healthcare strategies to ensure effective long-term support and resilience.

Disruptions in sanitation services and contamination of water sources are critical issues that facilitate the spread of pathogens, leading to a surge in gastrointestinal illnesses[38]. Flooding often results in standing water, creating breeding grounds for mosquitoes that transmit vector-borne diseases such as dengue fever, Zika virus, and West Nile virus. The strain on healthcare infrastructure during such crises can severely impede the management of chronic diseases, as resources are frequently redirected to emergency response efforts. Additionally, the impact on mental health is considerable, with increases in cases of anxiety, depression, and post-traumatic stress disorder (PTSD) observed among affected populations.

The immediate impact of Beryl on water infrastructure resulted in significant contamination of drinking water supplies, exacerbating the spread of waterborne diseases such as cholera, dysentery, and leptospirosis. Moreover, the destruction of healthcare facilities and the overwhelming demand for medical services during the hurricane severely hampered efforts to manage and treat these diseases effectively. The hurricane also led to prolonged power outages, which further complicated the operation of water treatment facilities and sewage systems, leading to additional public health risks.

Mental health issues were also a major concern in the wake of Hurricane Beryl. The trauma of the hurricane and the subsequent loss of homes, livelihoods, and loved ones led to a significant increase in cases of anxiety, depression, and PTSD. These mental health challenges were compounded by the lack of access to mental health services, as many healthcare providers were overwhelmed with emergency medical needs. Addressing these mental health issues requires not only immediate psychological first aid but also long-term mental health care and support to help affected individuals and communities recover[39].

Overall, wastewater surveillance emerges as a vital tool, offering early detection of pathogens, assessing outbreak scope, informing resource allocation, monitoring trends over time, identifying multiple pathogens, and facilitating public communication. Despite its benefits, challenges such as compromised infrastructure post-hurricane, such as the lack of a rigorous quantitative and continuous assessment of cyclone exposures, the great inconsistency in modelling approaches, study designs, analytical strategies and exposure window, and the potential issues in the comparability and generalizability of results, necessitate adaptive strategies and continued research to bolster advanced modelling strategy and resilience.

Addressing these interconnected health challenges requires a collaborative and interdisciplinary approach. By by utilizing advanced tools like the SciWalker-MAATrica for semantic data analysis and complementing the evidence from the Epidemic Intelligence from Open Sources (EIOS) system, we can better identify critical needs and formulate effective responses for water quality and public health protection. This approach ensures an evidence-based strategy for managing the public health challenges posed by natural disasters such as Hurricane Beryl. By anticipating and integrating scientific insights with practical strategies, policymakers and public health officials can mitigate the health impacts of hurricanes and foster resilient communities in the face of increasingly severe weather events.

[37] https://books.google.com/books?hl=en&lr=&id=IHALBxIYBGMC&oi=fnd&pg=PR5&dq=Emanuel,+K.+(2005).+Divine+wind:+the+history+and+science+of+hurricanes.+Oxford+university+press&ots=We3fuvvGfp&sig=oow33x3N5fzgfFPTp_3xNk5VEdU

[38] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3644291/

[39] https://jis.gov.jm/mental-health-advisory-coping-with-hurricane-Beryl/

10 Conclusions

This JRC emergency report, prepared at the request of the Emergency Response Coordination Centre (ERCC), provides a "Comparison between impacts of Hurricane Beryl and other multi-island hurricanes in the Caribbean" to guide the ERCC's response and funding to partners in the area. Moreover, a situational assessment of the ongoing hurricane and its impacts is provided, combining modelling outputs and both in field and remote observations.

According to the Global Disaster Alert and Coordination System (GDACS), the estimated population exposed to Category 1 or higher is nine million with a consequent RED Humanitarian Impact. The latest snapshot from UN OCHA reports that response efforts are focusing on specific areas within Grenada, Saint Vincent and the Grenadines, and southern Jamaica.

The impact assessment for Hurricane Beryl is ongoing, utilizing modelling outputs, satellite mapping products from Copernicus EMS–Rapid Mapping, the GloFAS-Global Flood Monitoring service, UNOSAT, Copernicus, and the International Charter, as well as newly initiated field surveys. Preliminary impact figures for Beryl, based on the Global Flood Monitoring service, storm surge modelling, and NOAA wind speed buffers, combined with information on the exposed population from the Global Human Settlement Layer, are forthcoming.

The comparative analysis of the most impactful Atlantic hurricanes from 1988 to 2024 confirms that TC Beryl-24 is the earliest Category 5 Atlantic hurricane over the analysed period. This report also includes an assessment of crisis severity in countries exposed to Tropical Cyclone Beryl-24 within the INFORM framework, highlighting that six out of eight countries have medium-high coping capacities, while Haiti and Mexico are at high risk due to other ongoing crises.

An anticipatory analysis of the potential consequences of Beryl on the water and health sectors is provided. Additionally, this report offers an overview of the preparedness and response actions, from anticipatory measures to needs assessments, and a summary of the above-normal Atlantic hurricane season forecast.

Hurricane Beryl's unprecedented early development and rapid intensification to a Category 5 hurricane underline the importance of enhancing crisis management strategies. The ongoing efforts to improve access to innovative services, such as advanced Early Warning Systems and impact modelling, will be crucial in supporting decision-making processes and improving disaster response and preparedness in the affected regions.

References

https://wmo.int/media/news/record-breaking-hurricane-Beryl-threatens-caribbean

https://reliefweb.int/report/grenada/latin-america-caribbean-2024-atlantic-hurricane-season-snapshot-4-8-july-2024

https://gadm.org/data.html#google_vignette

GHS-POP_GLOBE_R2023A for the year 2020. Schiavina M., Freire S., Carioli A., MacManus K. (2023): GHS-POP R2023A - GHS population grid multitemporal (1975-2030). European Commission, Joint Research Centre (JRC) PID: http://data.europa.eu/89h/2ff68a52-5b5b-4a22-8f40-c41da8332cfe, doi:10.2905/2FF68A52-5B5B-4A22-8F40-C41DA8332CFE

Schiavina M., Freire S., Carioli A., MacManus K. (2023):

GHS-POP R2023A - GHS population grid multitemporal (1975-2030).European Commission, Joint Research Centre (JRC) PID: http://data.europa.eu/89h/2ff68a52-5b5b-4a22-8f40-c41da8332cfe, doi:10.2905/2FF68A52-5B5B-4A22-8F40-C41DA8332CFE

https://wmo.int/media/news/record-breaking-hurricane-Beryl-threatens-caribbean

https://www.unocha.org/publications/report/grenada/caribbean-hurricane-Beryl-flash-update-no-03-04-july-2024

Lesser Antilles, the Caribbean, Mexico, USA - Hurricane Beryl, update (Copernicus EMSR, GDACS, NOAA, FEMA, WHO PAHO, UNICEF) (ECHO Daily Flash of 09 July 2024) - Mexico | ReliefWeb

https://rapidmapping.emergency.copernicus.eu/EMSR734/

UNICEF Jamaica Situation Report No. 2 (Hurricane Beryl) - 07 July 2024 - Jamaica | ReliefWeb

Eastern Caribbean: Hurricane Beryl - Situation Report No. 01 (As of 7 July 2024) - Grenada | ReliefWeb

Acting Governor Dan Patrick Adds 81 Texas Counties to Hurricane Beryl Disaster Declaration - Lieutenant Governor Dan Patrick

Governor Abbott Increases Readiness Level Of State Emergency Operations Center Ahead Of Hurricane Beryl | Office of the Texas Governor | Greg Abbott

World Meteorological Organization, 2024 - https://wmo.int/media/news/record-breaking-hurricane-Beryl-threatens-caribbean (last access 09 July 2024)

DEAN https://www.nhc.noaa.gov/data/tcr/AL042007_Dean.pdf

EMILY https://www.nhc.noaa.gov/data/tcr/AL052005_Emily.pdf

IVAN https://www.nhc.noaa.gov/data/tcr/AL092004_Ivan.pdf

MITCH https://www.nhc.noaa.gov/data/tcr/AL131998_Mitch.pdf

GILBERT https://www.weather.gov/lch/1988Gilbert

https://www.unocha.org/haiti, https://www.ipcinfo.org/ipc-country-analysis/details-map/en/c/1156884/?iso3=HTI, https://dtm.iom.int/haiti

https://radiojamaicanewsonline.com/local/disease-prevention-urged-after-hurricane-Beryl-health-ministry-cautions-against-leptospirosis-and-dengue-risks

https://listindiario.com/la-republica/ciudad/20240708/onda-tropical-viene-lluvias-proximas-48-horas_816078.html

https://www.dshs.texas.gov/news-alerts/dshs-reminds-residents-hurricane-impacted-areas-safety-precautions

https://crisis24.garda.com/alerts/2024/07/gulf-of-mexico-tropical-storm-Beryl-tracking-north-northwestward-toward-texas-late-july-7-update-15

https://listindiario.com/la-republica/ciudad/20240708/onda-tropical-viene-lluvias-proximas-48-horas_816078.html

https://saudigazette.com.sa/article/644106/World/America/Beryl-leaves-millions-of-Texans-without-power-as-dangerous-heat-descends-on-the-region

https://guyanatimesgy.com/rss-to-provide-security-relief-aid-to-hurricane-stricken-islands/

https://unionradio.net/2024/07/07/autoridades-se-mantienen-desplegadas-atendiendo-a-la-poblacion-de-cumanacoa/

https://crisis24.garda.com/alerts/2024/07/gulf-of-mexico-tropical-storm-Beryl-tracking-north-northwestward-toward-texas-late-july-7-update-15

https://humvenezuela.com/cruz-roja-venezolana-brinda-asistencia-a-personas-afectadas-por-inundaciones-en-cumanacoa-via-el-impulso/

https://jis.gov.jm/ncsc-urges-vigilance-and-care-for-senior-citizens-during-hurricane-season/

https://www.dshs.texas.gov/news-alerts/dshs-reminds-residents-hurricane-impacted-areas-safety-precautions

https://jis.gov.jm/mental-health-advisory-coping-with-hurricane-Beryl/

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Annex 1. Hurricane Beryl Detailed Timeline

28 June

Beryl formed in the North Atlantic Ocean on 28 June as a tropical depression and started moving West toward Barbados, the Windward Islands (southern part of Lesser Antilles) and the Caribbean Sea. Namely, it headed toward (from South to North) Tobago (Northern Trinidad and Tobago), Grenada, St. Vincent and the Grenadines and St. Lucia.

NOAA issued the first bullettin on the same date at 21.00 UTC. GDACS consequently issued its first episode (since NOAA is the primary source of GDACS for the Atlantic basin) and started to issue the first orange alert for St. Vincent and the Grenadines, estimating approximately 20 000 people in Cat. 1 hurricane or higher.

29 June

On 29 June Beryl continued moving westward over the North Atlantic Ocean, streghtening into tropical storm (with maximum sustained winds up to 102 km/h) and in the evening (UTC) of the same date it already reached the Cat. 1 hurricane, with maximum sustained winds of 120 km/h.

On 29 June at 21.00 UTC GDACS promptly issued its first red alert for St. Vincent and the Grenadines, Barbados, Trinidad and Tobago, St. Lucia, Grenada, Dominican Republic, Haiti, Jamaica and the Cayman Islands, estimating approximately 10 000 people in Cat. 1 hurricane or higher.

30 June – 01 July

On 30 June Hurricane Beryl continued moving West toward the Windward Islands as a Cat. 3-4 hurricane, with maximum sustained winds up to 222 km/h. On 01 July at 6.00 UTC, its centre was located over the North Atlantic Ocean approximately 285 km south-east of St. Vincent and the Grenadines and 275 km east of Grenada, with maximum sustained winds of 195 km/h (Cat. 3 hurricane). Very heavy rainfall, strong winds and storm surge were forecasted over the Windward Islands.

NOAA issued a hurricane warning over St. Vincent and the Grenadine, Grenada, St. Lucia and Tobago (Northern Trinidad and Tobago). On 01 July Beryl passed between St. Vincent and the Grenadines and Grenada with maximum sustained winds up to 222 km/h (Cat. 4) and continued moving northwestward over the Caribbean Sea, strenghtening.

On 01 July at 3.00 UTC the GDACS alert was issued as orange for St. Vincent and the Grenadines, Grenada, Trinidad and Tobago and Mexico (this country was included for the first time), estimating approximately 530,000 people in Cat. 1 hurricane or higher.

02 July

On 02 July at 6.00 UTC, the centre of Beryl was located offshore, over the Eastern Caribbean Sea, approximately 1 170 km South-East of Jamaica and 710 km South-East of Dominican Republic, with maximum sustained winds of 269 km/h (Cat. 5 hurricane). This wind speed represents the highest intensity reached by Beryl.

Since Beryl was forecasted to continue moving northwestward and to pass just South of Jamaica on 03 July in the evening (UTC), as a Cat. 2-3 hurricane, NOAA has issued a hurricane warning over Jamaica.

03 July

On 03 July at 6.00 UTC, the centre of the hurricane was located over the Caribbean Sea around 330 km South-East of Jamaica and 850 km South-East of Cayman Islands, with maximum sustained winds of 230 km/h (Cat. 4). Beryl was forecasted to to pass very close (South) of Jamaica on 03 July in the evening (UTC) as a Cat. 3-4 hurricane and South of Cayman on 4 July in the morning as a Cat. 2.

NOAA issued a hurricane warning over Jamaica and Cayman. As well, it forecasted Beryl to make landfall over the Yucatan Peninsula (Mexico) on 05 July, as a Cat. 2. From 02 July to 03 July GDACS promptly re-issued a red alert over Haiti, Grenada, Jamaica, Trinidad and Tobago, St. Vincent and the Grenadines and Mexico, estimating up to 2.7 million people in Cat. 1 hurricane or higher.

04 July

On 04 July at 6.00 UTC, the centre of Beryl was located offshore in the Caribbean Sea around 780 km South-East of the area of Felipe Carrilo Puerto town (Quintana Roo state, Yucatan Peninsula, Mexico) and 150 km South-East of Cayman Islands, with maximum sustained winds of 205 km/h (Cat. 3).

As of the same date, NOAA issued a hurricane warning over Jamaica, Cayman and the eastern Yucatan Peninsula.

05 July

On 05 July at 6.00 UTC, the centre of the hurricane was located approximately 130 km South-East of the area of Tulum city (Quintana Roo state, Yucatan Peninsula, Mexico), with maximum sustained winds of 185 km/h (Cat. 3). After that, later in the morning (UTC) of the same date, the Hurricane Beryl made landfall over the Northern Yucatan peninsula (Mexico) as a Cat. 1 hurricane and continued moving northwestward over the Gulf of Mexico, weakening (tropical storm).

NOAA issued a hurricane warning over the Yucatan peninsula and the Gulf coast of eastern Mexico. The GDACS alert was re-issued as orange but for an estimated higher number of exposed people: 3.5 million accross Mexico, Belize, Haiti, Grenada, Jamaica, Trinidad and Tobago, St. Vincent and the Grenadines, and the United States.

06-08 July

On 06-07 July, Beryl weakened and continued moving northwestward, passing over the Weastern and Northern Gulf of Mexico (far off the Eastern coast of Mexico) as a tropical storm, with maximum sustained winds up to 102 km/h. On 08 July at 6.00 UTC, its centre was located over the Gulf of Mexico, very close to the coast of Texas (USA), approximately 155 km East of the area of Corpus Christi city, with maximum sustained winds of 130 km/h (Cat. 1). After that, on 8 July in the morning (UTC), Beryl made landfall over the area of the middle Texas Gulf coast (near the Port Lavaca town, South of the Houston city area), with maximum sustained winds up to 130 km/h (Cat. 1 hurricane).

NOAA has issued a hurricane warning over middle Texas Gulf coast. The overall GDACS alert was downgraded to green.

09 July

On 09 July very early in the morning (UTC), Beryl passed inland over Eastern and North-Eastern Texas (USA), approximately 220 km East of the Dallas city area, with maximum sustained winds of 56 km/h (tropical depression). At 09.00 UTC, as of the same date, its centre was located over South-Western Arkansas, just North to the border with Texas, with maximum sustained winds of 45 km/h (tropical depression). Over the next 48 hours, as of 09 July in the morning (UTC), Beryl, now as a tropical depression, is forecasted to continue moving inland northeastward over Arkansas and South-Eastern Missouri, further weakening and dissipating. Heavy rainfall and strong winds are still forecasted over Eastern Texas, Western Louisiana, Arkansas, Southern Missouri and South-Eastern Oklahoma.

All warnings issued by NOAA are lifted.

Annex 2. Potential water related health issues that can arise

After a hurricane in the Caribbean, there are several potential health issues related to water that can arise. These issues are typically due to the disruption and contamination of the water supply by the hurricane's strong winds and flooding. Here are some of the primary concerns:

- **Contaminated Drinking Water:** flooding can compromise local water treatment facilities and contaminate water supplies with pathogens such as bacteria, viruses, and parasites. Drinking or using such water can lead to illnesses such as cholera, dysentery, hepatitis A, and typhoid fever.
- **Waterborne Diseases:** stagnant water can become a breeding ground for mosquitoes, which can transmit diseases such as dengue fever, Zika virus, and chikungunya. Other organisms that thrive in water, such as leptospires, can also cause diseases like leptospirosis when individuals come into contact with contaminated water.
- **Chemical Hazards:** floodwaters can carry toxic substances from industrial areas, agricultural runoff, or compromised household and commercial storage facilities. Exposure to these chemicals can lead to a range of health issues, including skin irritations, respiratory problems, and more severe conditions depending on the toxicity and level of exposure.
- **Mold and Dampness:** the aftermath of a hurricane usually includes wet conditions that can lead to the growth of mold in homes and other buildings. Mold exposure can cause respiratory issues, allergies, and other health problems, particularly for those with pre-existing respiratory conditions.
- **Injuries and Infections:** walking or wading in floodwater can lead to injuries, such as cuts and puncture wounds, which can become infected, especially when the water is contaminated. There is also a risk of tetanus from wounds contaminated with certain bacteria commonly found in soil and floodwaters.
- **Malnutrition and Dehydration:** the destruction of infrastructure can lead to a lack of clean drinking water and food supplies, causing dehydration and malnutrition, particularly in vulnerable populations such as children and the elderly.
- **Psychological Stress:** the stress and trauma of experiencing a hurricane and its aftermath can have significant psychological impacts, including stress-related illnesses and mental health conditions such as anxiety, depression, and post-traumatic stress disorder (PTSD).

To mitigate these risks, it's crucial for relief efforts to focus on restoring clean water supplies, providing medical assistance, controlling the spread of disease through vaccination and vector control, and ensuring proper sanitation and hygiene practices are followed as the recovery process begins.

The role of wastewater surveillance

Wastewater surveillance can be a valuable tool in the context of managing the spread of waterborne diseases such as cholera after a hurricane or similar disaster. This method involves monitoring pathogens in sewage to provide early warning of disease outbreaks and to track the spread of disease within communities. Here are some ways in which wastewater surveillance can be beneficial:

1. Early Detection: by testing wastewater for the presence of pathogens like Vibrio cholerae (the bacterium that causes cholera), public health officials can detect potential outbreaks before they are identified through clinical cases. This early warning allows for more rapid response efforts to contain and treat the disease.

2. Assessing the Scope of an Outbreak: wastewater surveillance can help determine the geographic spread and severity of an outbreak. It can provide a more comprehensive view of the situation, as not all individuals who are infected may seek medical care or get reported in health statistics.

3. Informing Public Health Decisions: the data collected from wastewater can help public health authorities make informed decisions about where to allocate resources, such as where to distribute clean water, oral rehydration salts, and antibiotics for treating cholera. It can also inform the need for vaccination campaigns or other preventive measures.

4. Monitoring Trends Over Time: regular wastewater surveillance allows for the monitoring of trends in pathogen levels over time, which can be critical for understanding the effectiveness of intervention measures and when the risk of transmission is decreasing.

5. Identifying Multiple Pathogens: wastewater can be tested for a range of pathogens simultaneously, which means that it can provide insights into the presence of other waterborne diseases beyond cholera, such as hepatitis A, typhoid fever, and norovirus.

6. Public Communication: surveillance data can be used to communicate risks to the public and to reinforce the importance of good hygiene practices, boiling or treating water, and other preventative measures that help reduce the spread of disease.

However, it's important to note that in the aftermath of a hurricane, the infrastructure for wastewater surveillance may be compromised. There may be challenges such as damaged sewage systems, limited access to affected areas, and lack of laboratory capacity for testing. Despite these challenges, where possible, integrating wastewater surveillance into the broader public health response can provide critical insights that help protect the health of affected populations. Note that we do have a direct contact with the colleagues at the US CDC, which might be in a better position for a rapid response.

Annex 3. Semantic data analysis using the SciWalker-MAATrica tool

A semantic data analysis has been conducted using the SciWalker-MAATrica tool[40] to identify critical needs for ensuring preparedness for natural disasters such as hurricanes and formulating appropriate responses for water quality and public health protection.

The system integrates advanced machine learning, text mining, and information retrieval techniques to perform semantic search analysis across diverse knowledge domains. This includes leveraging semantic concepts related to hurricanes, key health risks, and associated diseases. Complementing EIOS[41], this approach ensures a comprehensive understanding of the interrelated and interdisciplinary factors influencing water quality and public health protection in disaster scenarios.

The semantic annotation engine within SciWalker-MAATrica employs ontologies and AI-driven relationship extraction methodologies. It facilitates in context-learning techniques, precise semantic matching and name entity recognition within vast repositories of scientific literature, encompassing over 200 million full-text documents including articles, reports, and clinical trials. A preliminary analysis involved conducting a trend analysis of searches for the term "hurricane" over the past decade (2014-2024). This analysis aimed to linearly compare the prevalence and focus of research within the CORE, Medline, and PMC Open Access repositories, which encompass 108 million papers, 37 million papers, and 6.5 million papers respectively. The analysis revealed that the majority of research outputs have been found within the CORE database, with approximately a total of 100 000 hits related to hurricanes. The highest production was registered in the year 2018 (12.156 hits), while a slight general dip was observed in 2023.

Further refining the research, synonyms and related terms associated with "hurricane" and "health risks" were incorporated into the search parameters. The resulting dataset comprises a comprehensive collection of scientific literature:

- PMC Open Access: 11 523 papers
- CORE: 100 375 papers
- MEDLINE (including clinical trials): 9 305 papers

From this corpus, primary occurrences and evidence detailed in scientific papers were systematically extracted. This extraction process was facilitated by employing advanced metadata filters that utilize ontologies specifically tailored for relevant knowledge domains[42].

The dataset underwent categorization based on hurricanes' impacts, diseases, and geographical regions primarily affected, to identify significant patterns and insights.

These categories are visually depicted through pie charts (Figures 1, 2, and 3) and summarized comprehensively in Tables 1, 2, and 3.

[40] https://www.sciencedirect.com/science/article/pii/S0223523424004021
[41] Epidemic Intelligence from Open Sources, https://www.who.int/initiatives/eios
[42] https://www.sciencedirect.com/science/article/pii/S266731852300003X

Pie chart 1. Pie chart 1 provides an overview of the various health and social effects identified in the literature following the impact of a hurricane (see Table 1 for additional details).

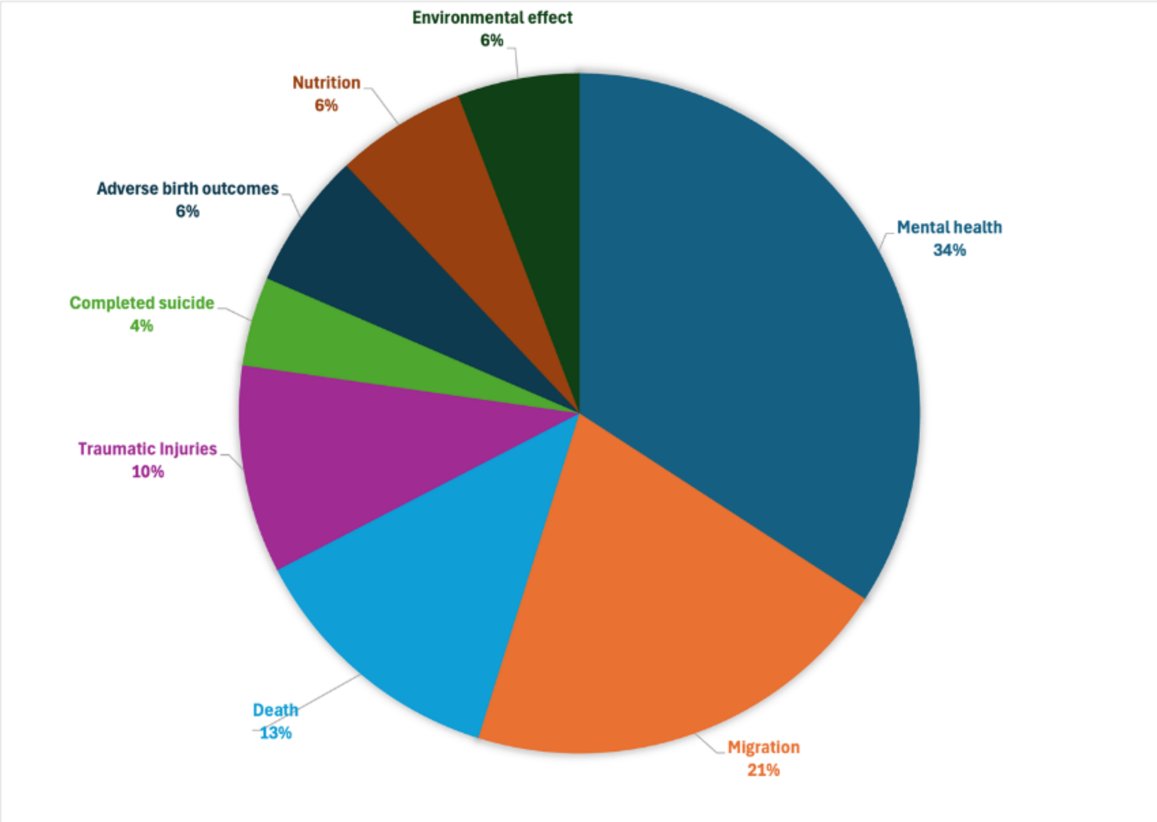


Table 1. Table 1 provides a comprehensive overview of the various health and social effects identified in the literature following the impact of a hurricane. Each row in the table represents a distinct entity, categorized by domain, with a quantification (percentage) of its prevalence in the reviewed documents and a brief description of the entity's implications.

Name entity	Domain	Average % occurrence in documents	Description
Mental health	effects	34%	Psychological impacts, including PTSD, anxiety, and depression.
Migration	effects	21%	Populations may be forced to relocate temporarily or permanently due to the destruction of homes, infrastructure, and economic opportunities
Death	effects	13%	Fatalities caused directly by the hurricane's immediate impacts
Traumatic injuries	effects	10%	Physical injuries from drowning, carbon monoxide poisoning, debris, falls, and structural collapses. Also, injuries from contact with downed power lines and electrical systems (Electrocution).
Adverse birth outcomes	effects	6%	Increased risk of preterm birth, low birth weight, and other complications in pregnant women due to stress, trauma, and limited access to prenatal care.
Nutrition	effects	6%	Due to disruptions in food supply, contamination of food and water sources, and the overall stress on affected communities.
Environmental effect	effects	6%	Damage to infrastructure, water contamination, and ecosystem disruption, leading to long-term health risks and economic challenges.
Completed suicide	effects	4%	Elevated risk of completed suicide among individuals affected by hurricane.

Pie chart 1 and Table 1 serve as a synthesis of the effects outcomes derived from the considered studies, providing valuable insights into the breadth and depth of hurricane-related impacts on individuals and communities:

- Mental Health: This entity encapsulates the psychological impacts experienced by individuals affected by the hurricane, with an average occurrence of 34% across the literature analyzed. These psychological impacts are broad and include conditions such as post-traumatic stress disorder (PTSD), anxiety, and depression, which can persist for varying durations following the event.

- Migration: With an average occurrence of 21%, migration refers to the displacement of populations that may occur as either a temporary or permanent consequence of the destruction wrought by the hurricane. The loss of homes, infrastructure, and economic opportunities compels individuals and families to seek new places of residence.

- Death: A documented 13% on average, this entity addresses the loss of life directly attributable to the immediate effects of the hurricane, such as drowning or injuries sustained during the storm.

- Traumatic Injuries: With 10% average instances noted, traumatic injuries include a range of physical harms that individuals may suffer during a hurricane. These injuries can result from drowning, carbon monoxide poisoning, encounters with debris, falls, and structural collapses, as well as from electrocution due to contact with downed power lines and compromised electrical systems.

- Adverse Birth Outcomes: This entity, occurring on average 46 times in the literature, highlights the increased risks faced by pregnant women during hurricanes, which include preterm birth, low birth weight, and other complications. These risks may be exacerbated by stress, trauma, and reduced access to prenatal care during disasters.

- Nutrition: With an average occurrence of 44% instances, the entity of nutrition concerns the challenges to maintaining adequate dietary intake due to disruptions in food supply chains, contamination of food and water resources, and the overall strain experienced by communities in the aftermath of a hurricane.

- Environmental Effect: Documented 41% on average, environmental effects encompass the damage to infrastructure and ecosystems that can result in sustained health risks and economic difficulties. This includes water contamination and the disruption of natural habitats.

- Completed Suicide: An average occurrence of 30% highlights an elevated risk of suicide among those affected by hurricanes, pointing to the profound mental health consequences that can arise from such traumatic events.

Pie Chart 2 and Table 2 outline the health outcomes associated with diseases observed post-hurricane.

Pie chart 2. Pie chart 2 provides an overview of the various diseases identified in the literature following the impact of a hurricane (see Table 2 for additional details).

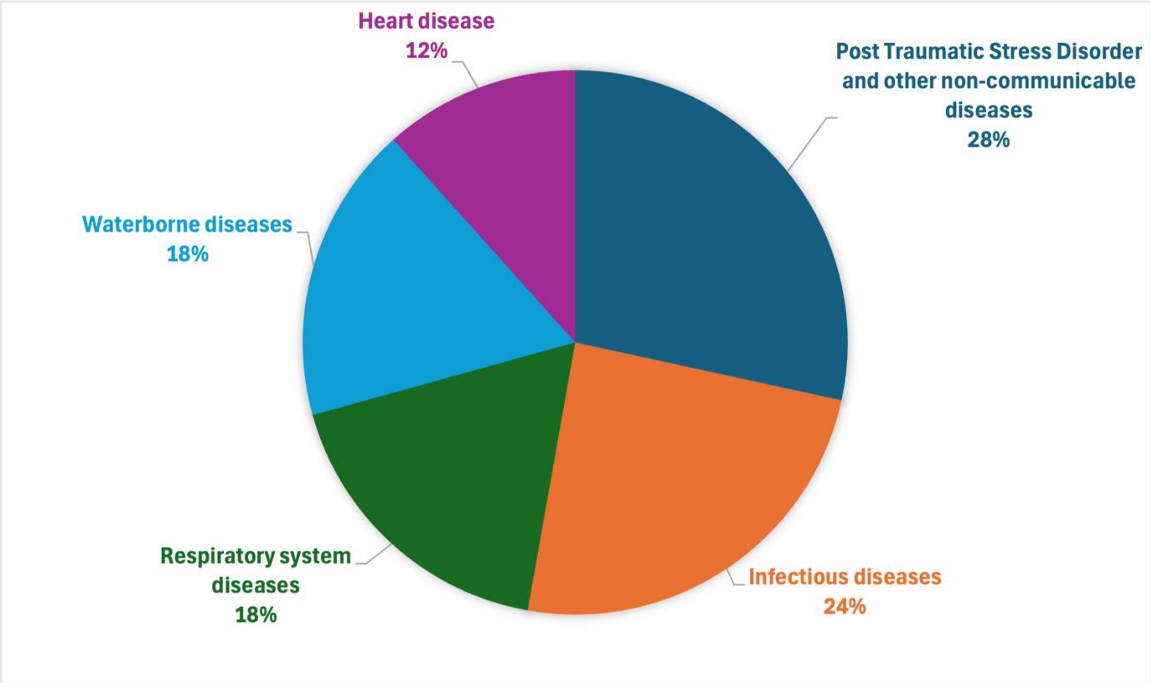


Table 2. Table 2 outlines the health outcomes associated with diseases observed in the aftermath of a hurricane, as documented in the literature. The table categorizes each health outcome by disease, providing the average frequency of mentions within the reviewed documents and offering a concise description of each health concern.

Name entity	Domain	Average % occurrence in documents	Description
PTSD and non-communicable diseases	diseases	28%	Post-traumatic stress disorder, chronic psychiatric disorder (such as schizophrenia), anxiety, depression, resulting from the trauma, loss experienced and emotional distress
Infectious diseases and emerging communicable diseases	diseases	24%	Outbreaks of diseases related to contaminated water and increased bacterial spread e.g., malaria, cutaneous leishmaniasis (parasitic disease caused by the Leishmania parasite, typically transmitted through the bite of infected sandflies), increased mosquito activity, i.e., mosquito-borne diseases, e.g., Zika Virus, Dengue fever.
Respiratory system diseases	diseases	18%	Increased respiratory diseases such as legionnaires' Disease (which can thrive in water systems that have been contaminated) and asthma attacks, mainly among children, due to mold and air quality deterioration.
Waterborne diseases	diseases	18%	In addition to the infectious diseases already mentioned, other prevalent waterborne diseases are cholera, leptospirosis (bacterial infection spread through water contaminated by animal urine) and gastrointestinal illnesses, which pose significant risks during and after hurricanes due to contamination of water sources by floodwaters and sewage.
Heart disease	diseases	12%	Exacerbation of conditions like cardiovascular diseases due to disrupted medical care and environmental changes.

Table 2 synthesizes the disease outcomes identified in the reviewed literature, providing a depiction of the various health risks posed by hurricanes. This table serves as a critical resource for understanding the potential increase in disease prevalence and the necessity for targeted healthcare interventions in the aftermath of such natural disasters:

- PTSD and Non-Communicable Diseases: With an average occurrence of 28 % in the documents, this entity includes post-traumatic stress disorder (PTSD) and chronic psychiatric conditions such as schizophrenia, anxiety, and depression. These conditions can arise from the trauma, loss, and emotional distress that individuals often endure during and after a hurricane.

- Infectious Diseases and Emerging Communicable Diseases: Documented an average of 24%, this category encompasses diseases that can surge due to conditions created by a hurricane. This includes diseases linked to water contamination and increased bacterial spread, such as malaria and cutaneous leishmaniasis, a parasitic disease transmitted by sandflies. It also covers mosquito-borne diseases like Zika Virus and Dengue fever, which can become more prevalent due to increased mosquito activity in stagnant water left by floods.

- Respiratory System Diseases: With 18 % average occurrences noted, this category refers to diseases affecting the respiratory system that may become more common after a hurricane. These include legionnaires' disease, which can proliferate in contaminated water systems, and asthma attacks, particularly in children, which may be triggered by mold and deteriorating air quality.

- Waterborne Diseases: This entity, occurring on average 18 % across the studies, highlights the risk of diseases transmitted through water, such as cholera and leptospirosis—a bacterial infection spread through water contaminated with animal urine. Hurricanes can significantly increase these risks due to the contamination of water sources with floodwaters and sewage.

- Heart Disease: Documented 12 % on average, this entity reflects the worsening of heart-related conditions, including cardiovascular diseases, during hurricanes. The disruption of medical care and changes in the environment during such events can contribute to the exacerbation of these diseases.

The semantic search extended to include regions as a metadata filter. The regions primarily affected by environmental disasters and cyclone exposure are displayed in Table 3.

Table 3. Table 3 highlights the geographic regions most significantly impacted by environmental disasters and cyclone exposure.

Name Entity	**Domain**	**Average % occurrence in documents**
Dominica	Regions	78%
United States of America	Regions	43%
Puerto Rico	Regions	40%
Bangladesh	Regions	40%
Caribbean	Regions	39%
Florida	Regions	37%
China	Regions	31%
Louisiana	Regions	30%
California	Regions	29%

Examining these regions offers a comprehensive understanding of the geographical distribution of hurricane impacts, which is crucial for tailoring public health strategies and meet the specific needs of these areas:

- Dominica: With an average occurrence of 78 % documented in the literature, Dominica has been notably affected by hurricanes, necessitating targeted interventions to address the resulting water and health challenges.

- United States of America: The USA, with 43 % average occurrences, has experienced varied impacts across different states, underscoring the need for region-specific disaster response plans.

- Puerto Rico: Documented 40 % times on average, Puerto Rico has faced significant hurricane-induced disruptions, particularly to its water systems and healthcare infrastructure.

- Bangladesh: Also with 40 % average occurrences, Bangladesh's vulnerability to cyclones calls for enhanced disaster preparedness and robust public health measures.

- Caribbean: The broader Caribbean region, with 39 % average occurrences, requires a collective and coordinated approach to manage the health risks posed by hurricanes.

- Florida: With 37% average occurrences, Florida's frequent exposure to hurricanes necessitates ongoing improvements to its emergency response and public health strategies.

- China: Noted 31 % on average, China's encounters with cyclones prompt the need for continuous refinement of its disaster management and health systems.

- Louisiana: With 30 % average occurrences, Louisiana's history of devastating hurricanes highlights the importance of resilient healthcare services and infrastructure.

- California: Documented 29 % on average, California must address both the immediate and long-term health implications of hurricanes and related environmental disasters.

Furthermore, the conducted literature analysis indicates that the effects of hurricanes are more profound among vulnerable populations, including children, older adults, women, and those from lower socioeconomic backgrounds or with pre-existing health conditions. Additionally, the growing intensity and frequency of hurricanes, driven by climate change, further complicate the public health landscape.
Scientific studies indicate that children under 5 years of age who experience one or more cyclones are at higher risk of developing mental health disorders in adulthood[43]. The adverse effects of cyclones tend to be more profound and longer-lasting among children and older adults. Although most studies report similar direct outcomes (e.g., injury) of cyclones for both females and males, women appear to be more likely to suffer psychological distress (e.g., anxiety, PTSD, gender-based violence) than men following cyclone exposures[44]. The

[43]https://www.sciencedirect.com/science/article/pii/S0277953616300065?casa_token=yopqPf3PmKMAAAAA:SasATWhHkXlWa78cTC9Z14iUTdGakaR2FBGqUOsQxAI-QR-H3mY3m6PD2P0k31x8W-0aE_tyEmsp

[44] https://www.mdpi.com/1660-4601/14/9/957

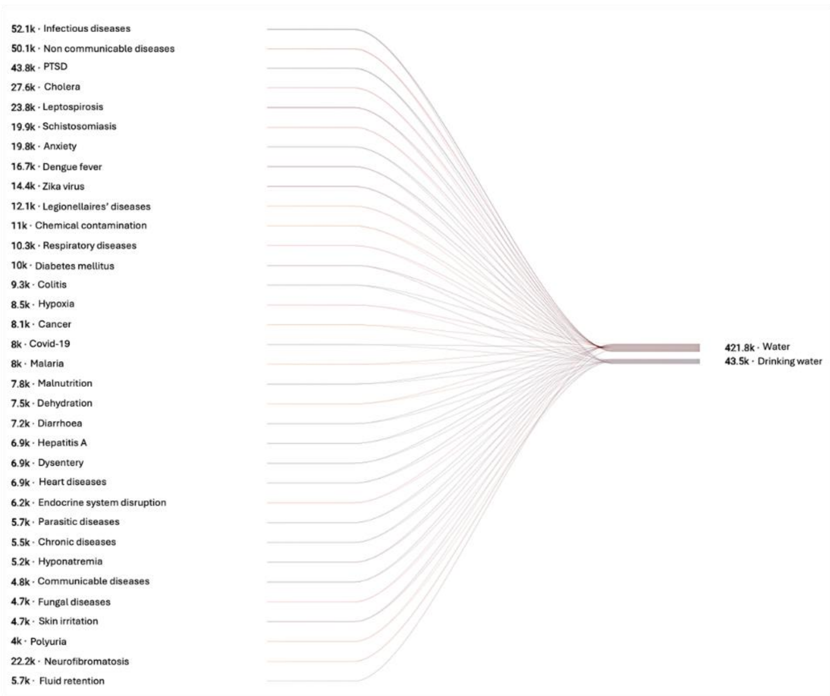
specific reasons for these disproportionate outcomes across sex and age groups remain unclear and may vary by health outcome. Potential contributing factors include differences in activity patterns (e.g., mobility levels), physiology (e.g., physical strength, health conditions), awareness (e.g., disaster preparedness), and social support[45]. Public and personal services and assistance may need to be extended beyond the immediate aftermath of the cyclone, particularly for disadvantaged populations.

Higher risks of adverse outcomes from cyclones have also been observed among lower socioeconomic brackets and people with preexisting health conditions[46]. For example, the fatality rate for people living in countries with the lowest tertile of GDP per capita was approximately 36 times greater than for those in the highest tertile of GDP per capita after experiencing high-amplitude cyclones[47]. Limited resources in low-income settings hinder efforts for effective disaster response and management, which have enormous potential to mitigate the adverse effects of cyclones[48].

Scientific literature also highlights the issue of warming climate as a primary driver of these challenges. Under a warming climate, future cyclones are expected to be more intense, with greater maximum windspeeds and heavier rainfall, thereby increasing their destructive potential[49]. This underscores cyclones as an ongoing public health concern. The issue of warming climate is also linked to mental health issues, as evidenced in recent extensive reports, such as the one from the expert workshop by the Physiological Society and Wellcome Trust titled “Bringing Mechanistic Understanding and Real-World Impact to the Link Between Extreme Heat and Mental Health”[50]. Moreover, a warming climate extends to warm ocean waters, which serve as the primary energy source for hurricanes[51]. These waters, typically above 26.5°C (80°F), provide the necessary heat and moisture to fuel storm intensity. Addressing these interconnected challenges is essential in developing effective strategies for mitigating the health impacts of hurricanes and other extreme weather events.

Additionally, a co-occurrence analysis was performed to elucidate the relationships between named entities such as water and/or drinking water and diseases, identified through the semantic processing of documents (Figure 1).

Figure 1. Co-occurrence analysis between entities “diseases” and “water”.



[45] https://www.cambridge.org/core/journals/disaster-medicine-and-public-health-preparedness/article/increased-genderbased-violence-among-women-internally-displaced-in-mississippi-2-years-posthurricane-katrina/D576CBEB73639E69823A1391B5BF160B

[46] https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(19)32596-6/abstract

[47] https://ehp.niehs.nih.gov/doi/abs/10.1289/EHP12158

[48] https://www.cambridge.org/core/journals/disaster-medicine-and-public-health-preparedness/article/highamplitude-atlantic-hurricanes-produce-disparate-mortality-in-small-lowincome-countries/37FA47621386D47D8141727C6D61A716

[49] https://journals.ametsoc.org/view/journals/mwre/128/5/1520-0493_2000_128_1366_eoawof_2.0.co_2.xml?tab_body=pdf

[50] https://static.physoc.org/app/uploads/2024/06/10095138/Heat-mental-health-workshop-web-version.pdf

[51] https://www.thelancet.com/journals/lanpsy/article/PIIS2215-0366(19)30277-9/fulltext

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