

Hurricanes, Health Systems, and Human Survival: Strengthening Resilience in a Warming Caribbean

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Objectives

- Overview of hurricane trends in the Atlantic basin
- Role of climate change in intensifying hurricane frequency and severity
- Health risks associated with hurricanes: direct trauma, infectious disease, mental health, and NCD disruption
- Examine health system vulnerabilities to hurricanes
- Highlight case studies from the Caribbean
- Propose disaster medicine strategies in the face of climate change



The Caribbean's Worsening Storms

2004: Hurricane Ivan becomes the costliest storm to hit Grenada, causing more than \$26 billion in damages. It continues on course to Cuba, Jamaica, and the southern United States.

2008: The Atlantic hurricane season devastates Haiti. Four consecutive tropical cyclones kill nearly 800 people and cause about \$1 billion in damage.

2015: Hurricane Joaquin brings 130 mph winds, destroying more than 830 homes in the Bahamas.

2016: Hurricane Matthew becomes the first category 5 Atlantic storm since 2007, causing tremendous damage across the Bahamas, Cuba, and Haiti.

2019: Hurricane Dorian becomes the worst natural disaster in Bahamas history, bringing maximum winds of 185mph. It kills at least 70 people and leaves more than 29,000 without homes or jobs.

2005

2007: Hurricane Dean causes widespread damage to Dominica's agriculture and infrastructure.

2010

2012: Hurricane Sandy, the largest hurricane on record as measured by diameter, causes damage in several countries, including Cuba, the Dominican Republic, and Jamaica.

2015

2015: Tropical Storm Erika unleashes torrential downpours on Dominica, with damages amounting to \$483 million, or 90 percent of the island's GDP.

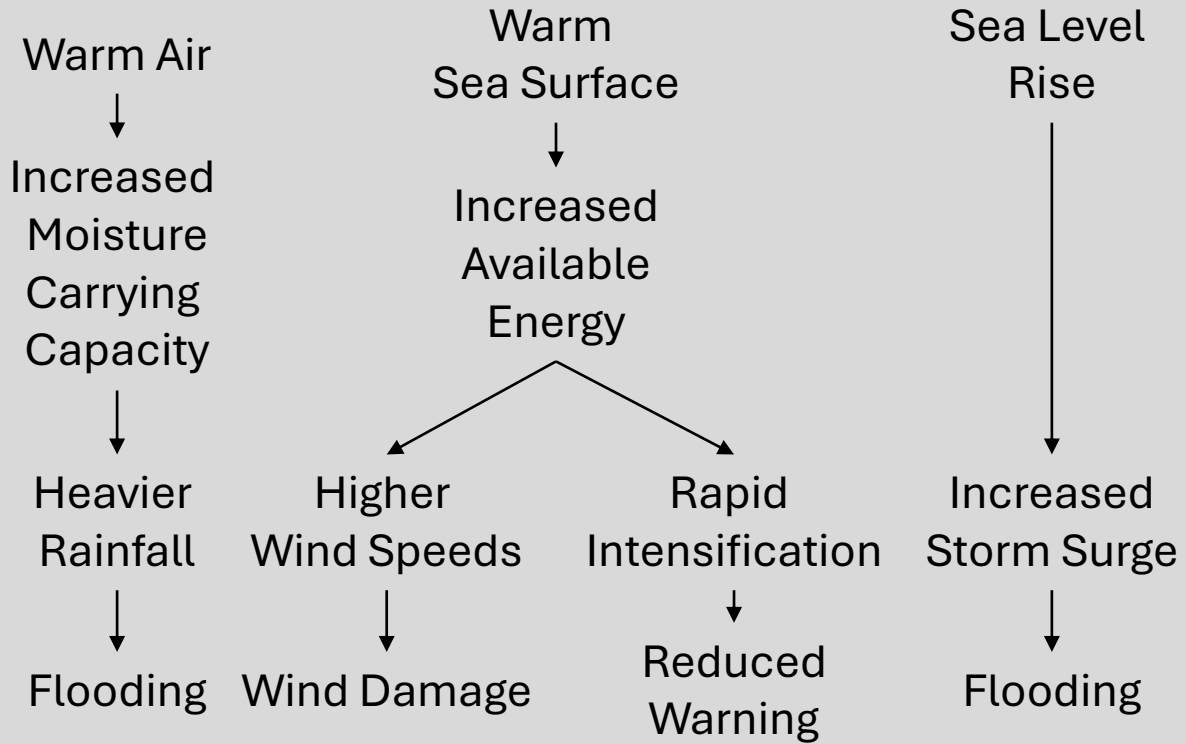
2017: Hurricanes Harvey, Irma, Maria, and Nate make landfall across the region in the span of a few months.

2020

2019: A rare tornado hits Havana, Cuba, bringing winds that reach 186 mph.

Source: CFR research; UN Office for the Coordination of Humanitarian Affairs.

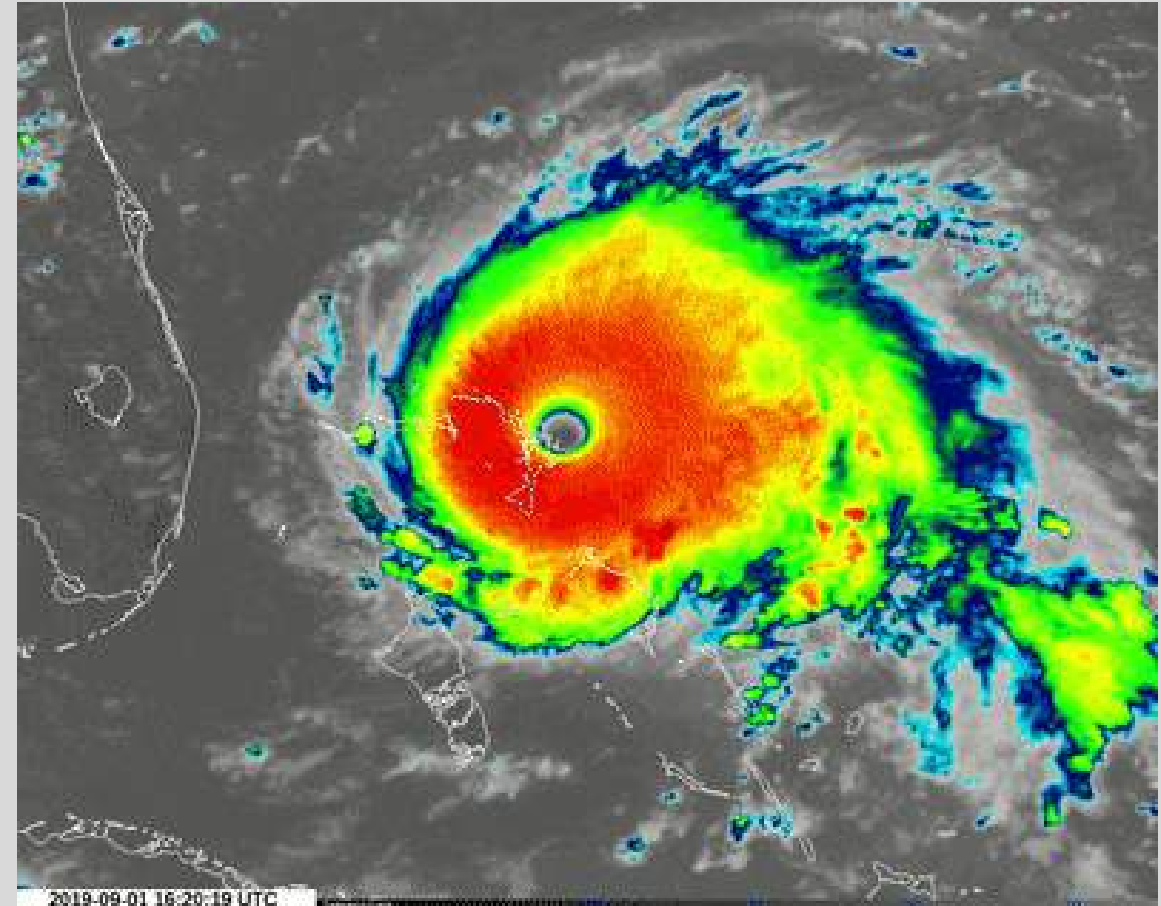
Tropical Cyclone (Hurricanes)



Also:

- Lower translocation speeds
- Risk of stalling
- Poleward shift

Image: The CDC



Hurricane Alley vs Hurricane Belt



The Hurricane Risk in Latin America and the Caribbean

Tropical Cyclone Exposure Index for the region in 2022 (10=highest exposure)



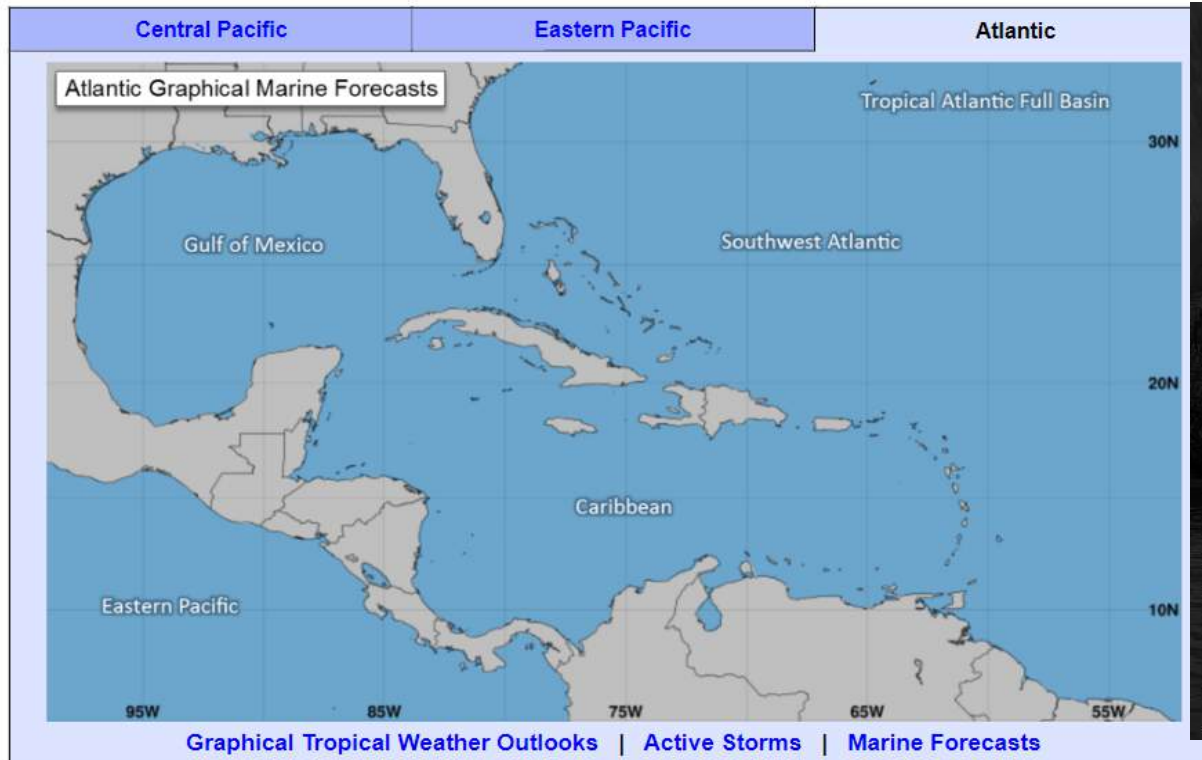
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- **Marine warnings are in effect for the Gulf of Mexico, Caribbean/SW Atlantic and Eastern Pacific**
- National Hurricane Center's New Tropical Atlantic Marine Weather Briefing
- Story Map Showing the New Proposed TAFB Eastern Pacific Offshore Zones
- Damaging 2022 Atlantic hurricane season draws to a close
- The Tropical Cyclone Track Forecast Cone: A conversation with Jamie Rhome, acting director of the National Hurricane Center



Atlantic - Caribbean Sea - Gulf of Mexico
Tropical Weather Outlook
Issuance will resume on May 15th or as necessary.

[Tropical Weather Discussion](#)
1805 UTC Wed Feb 1 2023

**There are no tropical cyclones in the Atlantic at this time.
The Atlantic hurricane season runs from June 1st through November 30th.**

Hurricane Season

Hurricane Preparedness

weather.gov/hurricane

Prepare Before Hurricane Season

- Develop an evacuation plan
- Assemble disaster supplies: food, water, batteries, charger, radio, cash
- Get an insurance checkup and document your possessions
- Create a communication plan with a hand-written list of contacts
- Strengthen your home

NOAA



Significant Hurricane since 2000

Storm	Year	Category
Jeanne	2004	3
Frances	2004	4
Irene	2011	3
Sandy	2012	3
Joaquin	2015	4
Matthew	2016	5
Irma	2017	5
Dorian	2019	5
Nicole	2022	1
Ian	2022*	5
Milton	2024*	5

Explore >

Saffir - Simpson hurricane scale

The infographic illustrates the Saffir-Simpson hurricane scale with five categories. Each category is represented by an illustration of a house and a tree showing the extent of damage. Category 1 shows a house with one window broken and a tree with some leaves falling. Category 2 shows a house with two windows broken and a tree with many leaves falling. Category 3 shows a house with three windows broken and a tree with many leaves falling. Category 4 shows a house with four windows broken and a tree with many leaves falling. Category 5 shows a house with five windows broken and a tree with many leaves falling.

- Category 1**
 - Winds 74-95 mph (119-153 km/h)
 - Some damage and power cuts
- Category 2**
 - Winds 96-110 mph (154-177 km/h)
 - Extensive damage
- Category 3**
 - Winds 111-129 mph (178-208 km/h)
 - Well-built homes suffer major damage
- Category 4**
 - Winds 130-156 mph (209-251 km/h)
 - Severe damage to well-built homes, trees blown over
- Category 5**
 - Winds 157+ mph (252+ km/h)
 - Many buildings destroyed, major roads cut off

Disaster Health Impact Timeline



Impact Phase



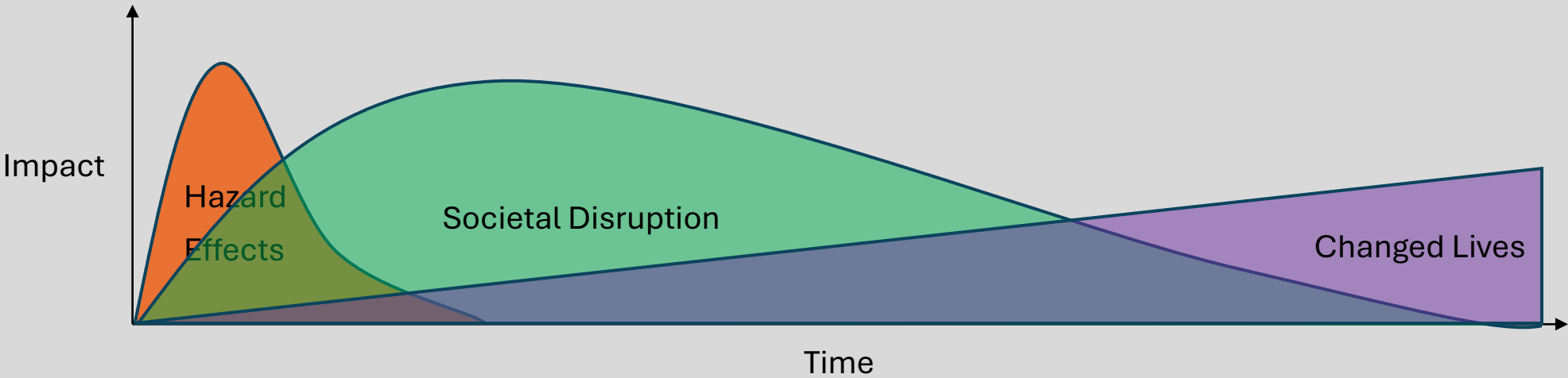
Aftermath (days to weeks)



Recovery



Long-term



Hurricane Health Impact Timeline



Impact Phase

- Trauma
- Drowning
- Exacerbations of chronic conditions
- Lack of access to healthcare



Aftermath (days to weeks)

- Healthcare interruptions (chemotherapy, dialysis, etc.)
- Impacts on electricity-dependent medical equipment
- Problems obtaining prescription medications
- Short-term displacement
- Stress / emotional trauma
- Risk of interpersonal violence



Recovery

- Reconstruction-related electrocutions and other injuries
- Difficulty following up with existing healthcare team
- Financial stress
- Food insecurity
- Mental health impacts
- Toxic exposures



Long-term

- Permanent displacement or migration
- Altered healthcare landscape; permanent demise of some institutions
- Loss of livelihoods
- PTSD, anxiety, depression
- Chronic health impacts

Mental Health and Psychosocial Support

High Burden of Trauma

- Natural disasters lead to PTSD, depression and anxiety among survivors.

Studies estimate **15-20%**

Systemic Gaps

- The Caribbean has a limited mental health workforce and strong stigma around seeking help.



Integrated Response

- Disaster preparedness plans must explicitly include mental health.
- Training responders
- Mobile counseling teams
- Community outreach

Surge Capacity – Concept and Challenges



What Is Surge Capacity? The ability of a health service to expand clinical care during a disaster



Workforce Shortfalls Low number of health workers per population means few reserves in crises



Regional Alliances Cooperation agreements for deploying doctors/nurses from neighboring islands



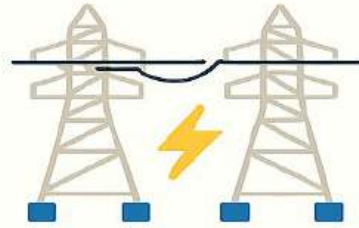
Training & Drills Mass-casualty and field response exercises build a “surge-ready” culture

Hurricanes Maria & Irma (2017) Case Study



Storm Impacts

In September 2017, Irma and Maria struck the Caribbean within two weeks, causing flooding, landslides and widespread



Infrastructure Failure

Maria caused an 11-month blackout in Puerto Rico. Power, telecoms, and water systems were severely disrupted



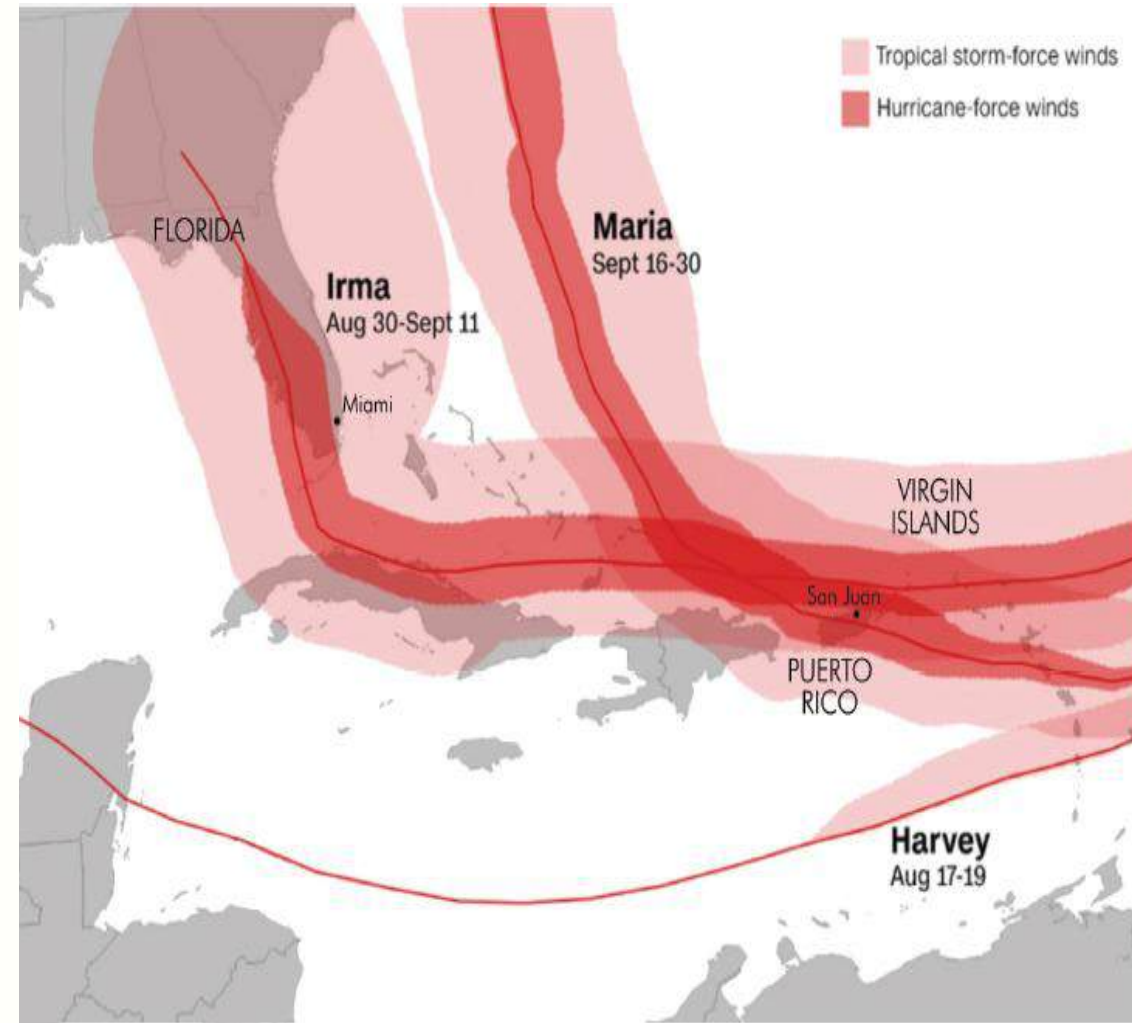
Health System Collapse

An estimated 3,000 excess deaths from delayed care, Hospitals were without electricity and clinics were overwhelmed



Lessons Learned

Importance of backup power and water supply, pre-positioning medical resources, and robust emergency planning



SOURCE: National Weather Service / U.S. Census Bureau

Hurricane Dorian (2019) Case Study



Event Summary

Category 5 hurricane with 185 mph winds made landfall in the Bahamas, unleashing extreme winds and storm surge



Human Impact

>70 confirmed deaths, ~70,000 people left homeless
More difficult for vulnerable groups to access aid



Health Consequences

Widespread injuries (e.g., fractures), illnesses from contaminated water, disruption of care for chronic conditions



Response Actions

Field clinics, international emergency teams deployed
Grants and supplies provided, cleanup initiated

Hurricane Fiona (2022) Case Study



Event Summary

Category 1 hurricane hitting Puerto Rico caused record rainfall (15.8 in.), severe flooding, and landslides



Human Impact

16 deaths and tens of thousands left without water or power, Particularly hard on vulnerable communities



Health Consequences

Floodwaters led to large outbreak of leptospirosis, increased threats to chronic care (e.g. dialysis)



Response Actions

Emergency declarations and quick assistance by health authorities helped speed initial recovery

MARIA & FIONA - ALMOST EXACTLY 5 YEARS APART



HURRICANE MARIA
9/20/2017 LANDFALL
CATEGORY 4

HURRICANE FIONA
9/18/2022 LANDFALL
CATEGORY 1



Beryl intensifies into a Category 5 storm

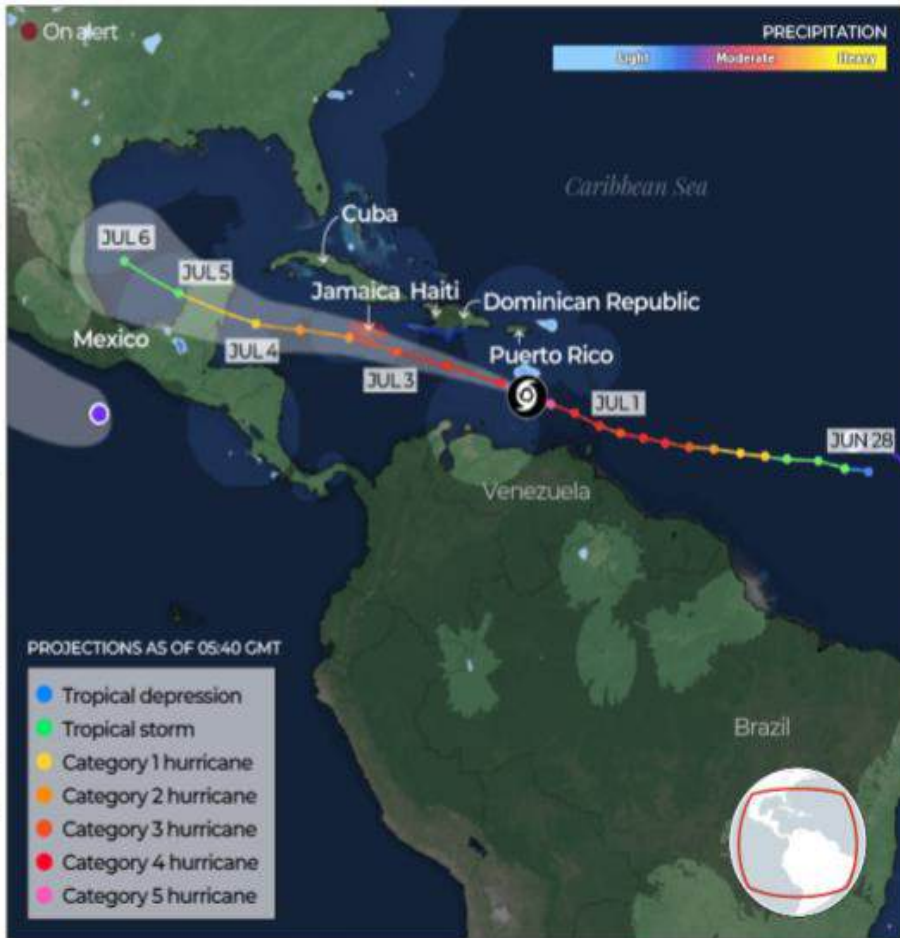
Hurricane Beryl has intensified into a "potentially catastrophic" Category 5 storm as it heads towards Jamaica after bringing down power lines, damaging houses and flooding streets on other southeastern Caribbean islands.



Fishermen pull a boat back to the dock in Barbados, July 1 [Ricardo Mazalan/AP Photo]



A woman runs as water floods a street in the parish of Saint James, Barbados, on July 1 [Chandan Khanna/AFP]



Hurricane Beryl (2024) Case Study



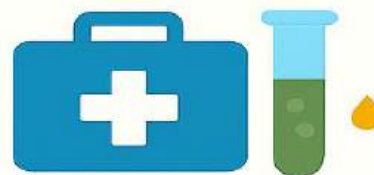
Event Summary

Category 5 hurricane striking eastern Caribbean peaked at ~ 165 mph, intense winds and heavy rains



Human Impact

Widespread damage and displacement: hardest hit on tiny Carriacou, Grenadines. Remote communities isolated



Health Consequences

Nearly all health clinics disrupted, emergency care heightened concern waterborne diseases



Response Actions

Pre-positioning supplies, field clinics, Red Cross aid, airlifts and appeals launched



Lessons Learned and Preparedness



Include NCD patients in preparedness plans: Ensure emergency medical records, personal medication kits, home backup power for critical devices.



Use Mobile Outreach: Deploy clinics and volunteer teams to bridge care gaps if static facilities are closed.



Provide Mental Health Support: Integrate trauma counseling into disaster response alongside medical care.



Strengthen Primary Care & Supplies: Improve stock distribution systems and train staff on NCD emergency kit use.



Water, Sanitation and Disease Prevention



Clinic WASH Safety

Ensure hospitals and clinics have emergency water supplies (backup pumps) and functional toilets.



Vector Control



After flooding, initiate mosquito control at health facilities and communities to prevent dengue, Zika, malaria



Safe Water & Food

Provide safe drinking water kits to shelters.
Protect medical stockpiles from contamination.



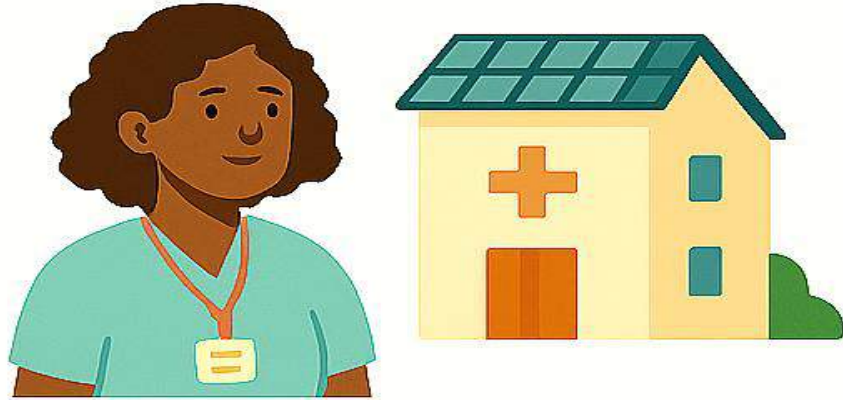
Surveillance & Vaccination

Ramp up surveillance for waterborne diseases
Ensure vaccinations to prevent secondary crises

THE IMPACT HURRICANES HAVE ON ACCESS TO CLEAN WATER.



Health Sector Recovery Frameworks



Reactivating Services

Restoring health facilities and outpatient/emergency services



Whole-System Resilience

Integrating disaster risk management into health system



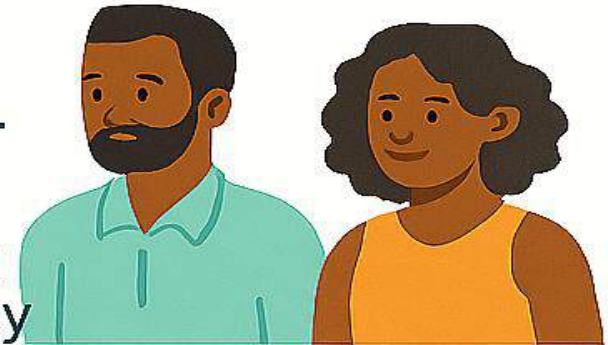
Frameworks & Guidelines

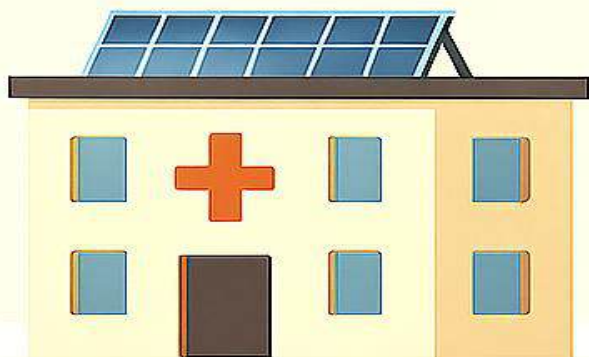
Applying WHO planning to rebuilding



Local Involvement

Involving community





Climate-Adapted Health Facilities and Emergency Care

Case Example

Jamaican health centres sustained minor damage despite Hurricane Beryl

Design Recommendations

Water collection and storage



Smart/Resilient Hospitals

Upgrade facilities with structural safety and green technology



Widespread Need

77% of hospitals in hazard-prone areas still use outdated building codes



Design Recommendations

New facilities should include backup power, improved ventilation, and siting above flood lines

Policy and Planning Frameworks



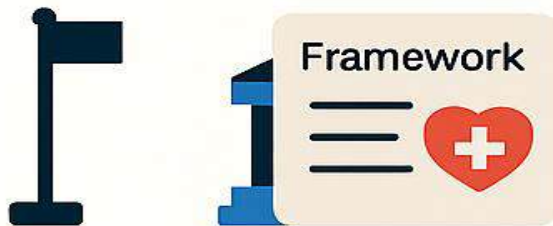
International Guidelines

Align with the UN Sendai Framework for Disaster Risk Reduction for International Health [▶](#)



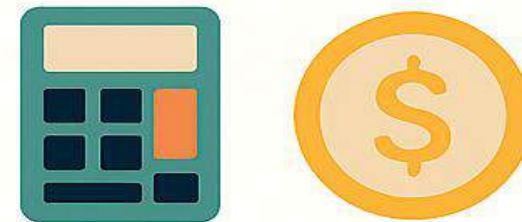
Regional Strategies

The PAHO Caribbean Health & Climate Action Plan and consultations 2025 plan



National EOCs and Laws

Embed disaster roles into Health Ministry mandates and budgets



Integration & Financing

Include health in national disaster laws and allocate adequate pre-disaster funding

Equity and Vulnerable Populations



At-Risk Populations

Identify low-income, rural and coastal areas impacted most by storms



Disadvantaged Groups

Address unique needs based on gender, disability, age, and more



Equity Strategies

Ensure disaster plans explicitly support vulnerable groups



Inclusive Recovery

Prioritize resources to aid underserved households and locations

Emergency Training & Coordination



Emergency Medical Teams (EMTs)

Registry of trained response doctors, nurses, and logisticians for rapid deployment



Mass Casualty Protocols

Standardized triage and regular hospital drills



Communication Readiness

Sat. phones and radios for coordination during blackouts



Risk Communication and Community Engagement



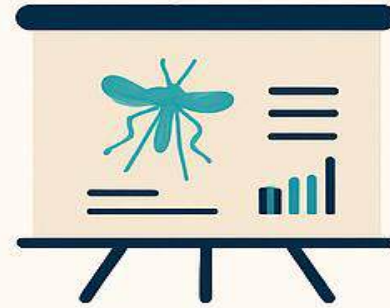
Public Alerts

Integrate health messages into hurricane warnings, Use multiple channels (radio, SMS, social media) for warnings and advisories.



Trusted Messengers

Work with community and faith leaders to disseminate information (e.g., hygiene and safety)



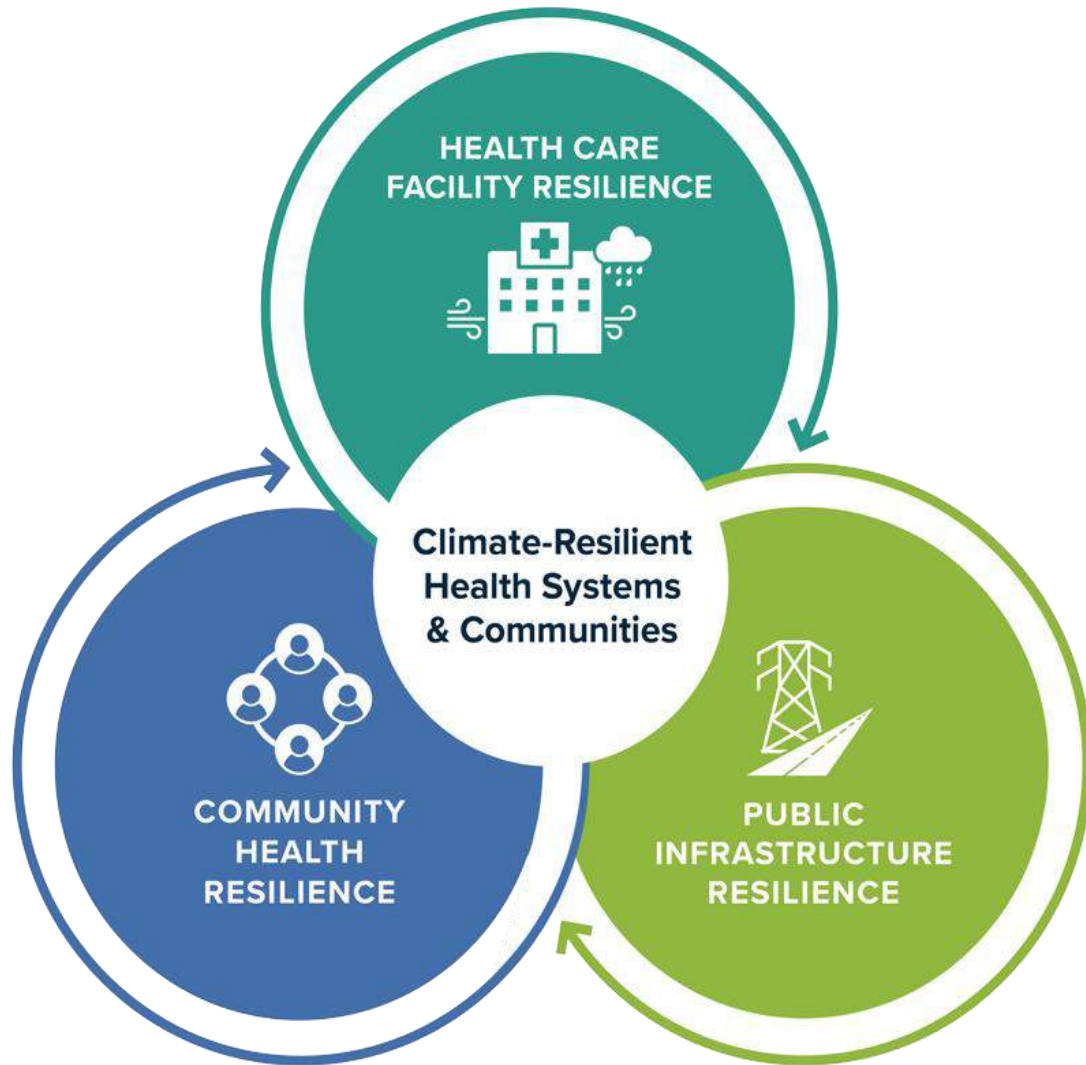
Health Education

Pre-hurricane, educate communities about storm-related health risks. Post-hurricane, inform about disease symptoms and where to seek care.



Feedback Mechanisms

Establish hotlines or community health committees that relay local needs back to health authorities.



Healthcare Without Harm

Intersectoral Partnerships and Community Resilience



Whole-of-Society Approach

Health cannot act in isolation. Work closely with water, energy, transportation and housing agencies to ensure infrastructure resilience.

Private Sector Engagement

Engage pharmacies, clinics, and private labs in emergency networks (e.g. agreeing to share stocks or samples).



Regional Collaboration

Leverage CARICOM, CDEMA, CARPHA, etc., for coordinated action and resource-sharing.



Monitoring, Evaluation and Research



Post-Event Assessments

Conduct thorough health sector after-action reviews to identify gaps



Indicators

Track metrics such as number of functioning clinics, stockouts, vaccine coverage rates after storms



Operational Research

Encourage local academic/health institutions to study disaster impacts and publish



Adaptive Management

Build a feedback loop where lessons learned inform updated plans

Summary of Key Recommendations



Invest in Infrastructure

Upgrade hospitals and clinics for wind and flood resistance; include solar power and water storage.



Strengthen Workforce

Maintain surge plans (EMTs, diaspora volunteers), and integrate mental health into disaster response.



Plan & Coordinate

Use robust health emergency frameworks (EOCs, legal



Secure Financing

Ensure CCRIF or other insurance covers and access climate adaptation funds to guarantee immediate relief.



Focus on Equity

Target the most vulnerable populations in all phases – from preparedness to recovery.



Research Needs

Encourage ongoing studies (e.g. modeling climate impacts on regional health) and data collection to refine strategies.

A vibrant tropical beach scene. In the foreground, a large, mature palm tree with lush green fronds leans diagonally from the right side towards the center. The ground is a mix of light-colored sand and dark shadows cast by the tree. The middle ground features a wide, sandy beach that meets the turquoise ocean. The water is crystal clear, showing a gradient from light green near the shore to deep blue further out. The horizon is a straight line separating the sea from a bright blue sky filled with scattered, fluffy white clouds. The overall atmosphere is peaceful and idyllic.

Thank you

Questions



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