How can we reduce the impacts of severe weather?

Country experiences with role-playing exercises for weather and climate-ready nations (WCRN).

KATHY-ANN CAESAR
Caribbean Institute for Meteorology and Hydrology
Husbands, St. James, Barbados

WMO VLab & NOAA Train the Trainers Workshop
6 August 2022, Madison, Wisconsin, USA
We must be ready responsive resilient to extreme weather and climate events.
What does it mean to be weather and climate ready?

WCRNs:

- Evolve their weather forecasting to stress potential impacts
- Communicate impacts clearly to help people make smart decisions
- Engage community partners to spread the word
What steps were taken by Barbados?

- BMS and CIMH integrated new science and technology into National Weather Service operations to improve forecasts
- BMS and DEM improved their operations
- CIMH worked with DEM to improve the programming systems
- Forecasts now stress potential impacts to better support decision-making
- Primary hazards, their impacts, and appropriate responses have been summarized in risk, impact, and response matrices
- The Common Alerting Protocol was implemented to allow consistent alert messaging simultaneously across a variety of media
New risk, impact and response matrices

Created for Barbados’ primary hazards:
High winds, severe convection, heavy rain events, tropical cyclones, tsunamis, high temperatures, drought, and volcanic ash

Risk Matrix

Likelihood
- High
- Medium
- Low
- Very Low

Potential Impacts
- Minimal
- Minor
- Significant
- Severe

Risk Level
- High
- Medium
- Low
- Very Low

Response
- Take Action
- Be Prepared
- Be Aware
- No Action

Response Matrix

Very Low Risk
Low Risk
Medium Risk
High Risk

Message/response
Message/response
Message/response
Message/response

WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services, WMO- No. 1150
# Heavy Rainfall Impact Matrix

<table>
<thead>
<tr>
<th>Category</th>
<th>Minimal Impacts</th>
<th>Moderate Impacts</th>
<th>Significant Impacts</th>
<th>Severe Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transportation</strong></td>
<td>Wet roads and higher likelihood of accidents&lt;br&gt;Localized disruption to traffic&lt;br&gt;Limited impact to traffic signals</td>
<td>Localized pooling and flooding of roads&lt;br&gt;Occasional accidents and associated disruptions; increased travel times&lt;br&gt;Occasional traffic signal outage/flashing and traffic congestion&lt;br&gt;Minor public transportation disruptions</td>
<td>Localized flooding and damage of roads with significant delays and disruption to traffic&lt;br&gt;Accidents and associated Disruptions; increased travel times&lt;br&gt;Frequent traffic signal outage/flashing; significant traffic congestion&lt;br&gt;Significant disruptions to public transportations</td>
<td>Widespread flooding and damage of roads with dangerous driving conditions&lt;br&gt;Multiple accidents and associated disruptions; increased travel times&lt;br&gt;Most traffic signal outage/flashing – major traffic delays, accidents at intersections&lt;br&gt;Most publication transportation delayed or not operational</td>
</tr>
<tr>
<td><strong>Schools</strong></td>
<td>Minor disruption of school activities</td>
<td>Localized disruption of school activities</td>
<td>Regional closure of schools</td>
<td>All schools closed</td>
</tr>
<tr>
<td><strong>Landslides</strong></td>
<td>Isolated land slippage</td>
<td>Localized land slippage – limited debris flow on roads</td>
<td>Localized land slippage resulting in road closures and property damage – significant debris flow (rocks and trees)</td>
<td>Land slippage resulting in road closures and property damage and communities cut off</td>
</tr>
</tbody>
</table>
### Event preparation example: Response matrix

#### Heavy Rainfall

<table>
<thead>
<tr>
<th>Very Low Risk: No Action</th>
<th>Low Risk: Be Aware</th>
<th>Medium Risk: Be Prepared</th>
<th>High Risk: Take Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor for changing weather conditions</td>
<td>Stay out of flood waters</td>
<td>Stay out of flood waters</td>
<td>Stay out of flood waters</td>
</tr>
<tr>
<td>Evaluate inventory of emergency supplies (food, water, medical supplies); prepare to restock supplies at the beginning of season</td>
<td>Evaluate inventory of emergency supplies (food, water, medical supplies); prepare to restock supplies at the beginning of season</td>
<td>Check emergency supplies, purchase additional supplies if needed, fill gas tanks, etc.</td>
<td>Prepare to use emergency supplies, acquire additional supplies if possible, fill gas tanks, preposition food and emergency supplies for post Event</td>
</tr>
<tr>
<td>Be aware of localized flooding of roads and properties in [...locations...]. Impacts include occasional accidents, associated disruptions, increased travel times, land slippages could block roads.</td>
<td>Be aware of localized flooding of roads and properties in [...locations...]. Impacts include occasional accidents, associated disruptions, increased travel times, land slippages could block roads.</td>
<td>Be prepared for localized flooding of roads and properties in [...locations...]. Impacts include accidents, associated disruptions, increased travel times, land slippages could block roads.</td>
<td>Avoid walking or driving through moving water</td>
</tr>
<tr>
<td>Be aware for possible traffic delays due to signal outages</td>
<td>Be aware for possible traffic delays due to signal outages</td>
<td>Prepare for traffic delays due to signal outages</td>
<td>Seek safer/higher ground if in [...locations...].</td>
</tr>
<tr>
<td>Be aware for possible delays in public transportation</td>
<td>Be aware for possible delays in public transportation</td>
<td>Prepare for possible delays or cancellation of public transportation routes</td>
<td>Monitor for changing weather conditions</td>
</tr>
<tr>
<td>Be aware for possible localized flooding water course over flood prone areas</td>
<td>Be aware for possible localized flooding water course over flood prone areas</td>
<td>Prepare for localized flooding in low-lying, flood prone areas</td>
<td>Call emergency services if Impacted.</td>
</tr>
<tr>
<td>Be aware for prepare for possible school closures</td>
<td>Be aware for prepare for possible school closures</td>
<td>Prepare for localized land slippage, debris flow and possible road closures</td>
<td>Stay off roads especially in flood prone areas, streets with traffic signals, or areas with frequent land slippage/landslides</td>
</tr>
<tr>
<td>Ensure drains are cleared.</td>
<td>Ensure drains are cleared.</td>
<td>Ensure drains are cleared.</td>
<td>Ensure drains are cleared.</td>
</tr>
</tbody>
</table>
## DEM Example of combined Heavy Rainfall: Impact, Hazard and Response Matrix developed by forecasters, hydrologists, and disaster managers

<table>
<thead>
<tr>
<th>Minimal</th>
<th>Minor</th>
<th>Significant</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Business as Usual</strong></td>
<td>Localized = Single District Municipality affected Business as usual</td>
<td>Localized = Single District Municipality affected Short term strain on emergency personnel</td>
<td>Widespread = Multiple Districts affected Prolonged strain on emergency personnel</td>
</tr>
<tr>
<td>▪ Some pooling of water on roads or in informal settlements</td>
<td>▪ Localized flooding of susceptible informal settlements or roads, low lying areas and bridges</td>
<td>▪ Flooding of roads and settlements (formal and informal)</td>
<td>▪ Widespread flooding of roads and settlements</td>
</tr>
<tr>
<td>▪ Day to day activities not disturbed</td>
<td>▪ Localized and short-term disruption to municipal services (water, electricity, etc)</td>
<td>▪ Disruption to municipal services (water, electricity, etc)</td>
<td>▪ Widespread, prolonged disruption to municipal services (water, electricity, etc)</td>
</tr>
<tr>
<td>▪ Wet roads</td>
<td>▪ Major roads affected but can be used, increased travel times</td>
<td>▪ Major disruption of traffic flow due to major roads being flooded or closed</td>
<td>▪ Widespread transport routes and travel services severely affected</td>
</tr>
<tr>
<td>▪ Minimal traffic congestion</td>
<td>▪ Minor motor vehicle accidents due to slippery roads</td>
<td>▪ Possible damage to roads and bridges</td>
<td>▪ Major roads and bridges damaged or washed away</td>
</tr>
<tr>
<td>▪ Isolated mudslides and rock falls</td>
<td>▪ Closure of roads crossing low water bridges</td>
<td>▪ Danger to life (fast flowing streams / deep water)</td>
<td>▪ Danger to life (fast flowing streams / deep water)</td>
</tr>
<tr>
<td></td>
<td>▪ Localized mudslides and rock falls</td>
<td>▪ Some communities temporarily not accessible/ cut-off for a prolonged period</td>
<td>▪ Large communities not accessible/ cut-off for a prolonged period</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Displacement of affected communities</td>
<td>▪ Widespread displacement of affected communities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Damage to property, infrastructure and loss of livelihood</td>
<td>▪ Widespread damage to property, buildings and loss of livelihoods</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Mudslides and rock falls</td>
<td>▪ Widespread mudslides and rock falls</td>
</tr>
</tbody>
</table>
Barbados Meteorological Service Alert

Different warnings are separated into separate matrices...  [https://barbadosweather.org/](https://barbadosweather.org/)

Currently, polygon-specific information is broken down by hazards, with standard risk matrices for each of the 6 hazards

There is messaging as to:
*What to expect?*
*What should you do?*
CIMH Dewetra
Upgrades to Support WCRNs

Upgrading the DEWETRA software to generate WCRNs advisory and warning graphics.

- Utilizing GIS polygons to delineate expected impact zones
- Auto message generation techniques to produce impact forecast for WCRN stakeholders
- Multiple hazards can be included
We can’t do it alone.

We need **YOU** as a partner!

- Large businesses
- Small businesses
- Non-profits
- Non-governmental organizations
- Schools / universities
- Other???
Ideas for promoting the WCRN effort

Here’s what others have done in the past. Get more ideas at: https://www.weather.gov/wrn/success-stories

- Created a video on flood safety
- Posted specific storm safety tips on the company website
- Held workshops promoting hydrologic warning best practices
- Donated emergency crank weather radios
- Posted preparedness links on company blogs
- Gotten constituents signed up on the county weather alert system
- Conducted storm spotter training sessions
- Evaluated schools’ weather preparedness and made improvements
UCAR COMET worked with BMS and CIMH to produce a YouTube video to introduce IBFW to the public.

Using a heavy rain situation in Barbados, this video will demonstrate the use of Multi-hazard, Impacts-based Forecasts, and Warning Services. The demonstration will show an evolution of the forecast in the 3-, 2-, and 1-day lead time periods. The rainfall case is based loosely on 2018's Tropical Storm Kirk, although the name and specific details of the storm are not used.

The BMS also employs the Barbados Weather App; and Social Media such as Facebook, Instagram, Twitter, and Youtube.

https://www.youtube.com/watch?v=UaFFBq1opBU&t
Questions?

KATHY-ANN CAESAR
kacaesar@cimh.edu.bb
Caribbean Institute for Meteorology and Hydrology
Husbands, St. James, Barbados
Weather Briefing

Potential Tropical Storm L91

Compiled by:
Kathy-Ann Caesar, Lawrence Pologne and Shawn Boyce

For
Caribbean Disaster Emergency Management Agency

Friday 08th September, 2017 12:15 UTC
Potential Tropical Storm L91- NHC Outlook

BULLETIN

Potential Tropical Cyclone Nine
Intermediate Advisory Number 1A...Corrected
NWS National Hurricane Center Miami FL       AL092017
200 PM AST Thu Aug 17 2017

CORRECTED DUE TO PARTIAL RE-TRANSMISSION OF OLD ADVISORY...

...HURRICANE HUNTER AIRCRAFT ENROUTE TO INVESTIGATE THE DISTURBANCE...

SUMMARY OF 200 PM AST...1800 UTC...INFORMATION
-----------------------------------------------
LOCATION...13.1N 55.1W
ABOUT 295 MI...475 KM E OF BARBADOS
ABOUT 410 MI...660 KM E OF ST. LUCIA
MAXIMUM SUSTAINED WINDS...35 MPH...55 KM/H
PRESENT MOVEMENT...W OR 270 DEGREES AT 17 MPH...28 KM/H
MINIMUM CENTRAL PRESSURE...1007 MB...29.74 INCHES
WATCHES AND WARNINGS
---------------------

SUMMARY OF WATCHES AND WARNINGS IN EFFECT:

A Tropical Storm Warning is in effect for...
* Martinique
* St. Lucia
* Barbados
* St. Vincent and the Grenadines

A Tropical Storm Watch is in effect for...
* Dominica

A Tropical Storm Warning means that tropical storm conditions are expected somewhere within the warning area, in this case within 24-36 hours.

A Tropical Storm Watch means that tropical storm conditions are possible within the watch area, in this case within 24-36 hours.

WRF Model Loop at 2017/08/16 12:00 UTC – 48 hr OUTLOOK
GFS model suggests INVEST 91L will track towards the Lesser Antilles as a weak disturbance. Model guidance suggest the system could move into Barbados Thursday evening as strong disturbance/ weak Tropical Storm. Note more rapid development is indicated as it crosses Lesser Antilles.
**Expected Impacts – Barbados**

**Tropical Storm – High and Significant**

*Friday August 18th, 2017*

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Potential Impacts</th>
<th>Risk Matrix</th>
<th>Risk Level</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Minimal</td>
<td>X</td>
<td>High</td>
<td>Take Action</td>
</tr>
<tr>
<td>Medium</td>
<td>Minor</td>
<td></td>
<td>Medium</td>
<td>Be Prepared</td>
</tr>
<tr>
<td>High</td>
<td>Significant</td>
<td></td>
<td>Low</td>
<td>Be Aware</td>
</tr>
<tr>
<td>Very Low</td>
<td>Severe</td>
<td></td>
<td>Very Low</td>
<td>No Action</td>
</tr>
</tbody>
</table>

**Suggested likelihood (Tropical Storm Conditions):** Moderate to occasionally strong winds; Strong thunderstorms with lightning and heavy rains

**Suggested potential impact (Tropical Storm Conditions):** Tumbling and rolling of unsecured objects (e.g.: inflatable structures, tents, garbage cans) Injury and danger to life from flying debris
Expected Impacts Flash floods – Barbados

Friday August 18th, 2017

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Potential Impacts</th>
<th>Risk Matrix</th>
<th>Risk Level</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Minimal, Minor, Significant, Severe</td>
<td>X</td>
<td>High</td>
<td>Take Action</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td></td>
<td>Medium</td>
<td>Be Prepared</td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td>Low</td>
<td>Be Aware</td>
</tr>
<tr>
<td>Very Low</td>
<td></td>
<td></td>
<td>Very Low</td>
<td>No Action</td>
</tr>
</tbody>
</table>

Suggested likelihood (Flooding and Landslides): **Flash Floods, Heavy to Severe**

Suggested potential impact (Flooding and Landslides): **Localized flooding and damage of roads**
Weather Outlook Barbados for Friday August 18th, 2017

- **Thursday into Friday**

- The Tropical disturbance is developing expect a significant rain event with moderate winds

- Expect increasing tropical storm conditions tonight into tomorrow.

- Heavy Storm conditions will domination much of east, central and southern Barbados districts.

- Flash foods will follow heavy rain events
RAINFALL: Effects of the INVEST 91L is now surging ahead and it is expected that heavy showers and thundershowers will begin affecting Barbados this evening into tonight and St. Vincent north to Martinique within the next 6 - 12 hours. Rainfall amounts of 125 - 135 mm are likely with higher totals at elevated locations.

FLOOD/LANDSLIDE: The likelihood of swollen rivers, localised flooding and landslides in areas prone has increased due to antecedent soil conditions and projected rainfall.

WIND: Winds likely to approach tropical storm force with stronger gusts in areas of thunderstorms.

WAVES: Waves heights likely to approach 3.5 to 4 metres mainly in the area around Barbados north to Martinique. Near shore and marine operators should exercise caution.

In summary: Disturbance INVEST 91L has continued to become more organized and thunderstorm activity has increased and extended ahead of the system. NHC may upgrade to a storm this evening as it approaches the islands.

The effects will be beginning to be felt in Barbados this evening into Friday morning. The system is expected to slow considerably over the islands. This could produce large rainfall accumulation over the islands of Barbados, and St. Vincent north to Martinique. It is expected to further develop as it moves in the Caribbean Sea.
ALERT FROM DEM

• Residents in Barbados should continue to monitor the system and take all necessary precautions against heavy rainfall resulting in flash flooding and storm-force winds which may result in fallen trees, blocked roads and damage to property.

• There is also the potential for downed power lines and both water and electricity outages, therefore residents should begin to activate their Emergency Contingency Plans – stock-up on the emergency supplies, review emergency check-lists and check on the vulnerable within the community.

• Residents seeking shelter should continue to recognise the COVID-19 (deadly coronavirus) stipulations for the wearing of face masks, social distancing and good hygiene practices (bring sanitizing supplies).

• The following Emergency Shelters will be activated as of ……..hrs on ………..

• The DEM will continue to update the public on this situation.
Disclaimer

CIMH is providing special weather interpretation of the current and forecasted tropical weather affecting the Caribbean region.

CIMH is not an official forecasting agency
End of Briefing

Caribbean Institute for Meteorology and Hydrology
https://cimh.edu.bb/

Tel: 246-425-1362/3/5, 246-538-0032 and 246-538-1360/1
Fax: 246-424-4733