Weather and Climate Ready Nations Implementation – IBFWS and CAP

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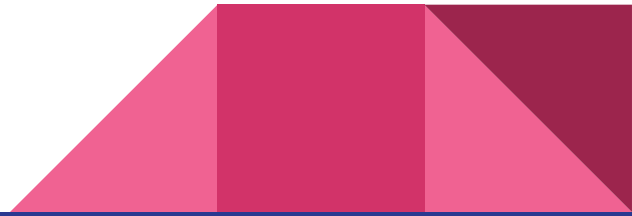
Caribbean Institute for Meteorology and Hydrology

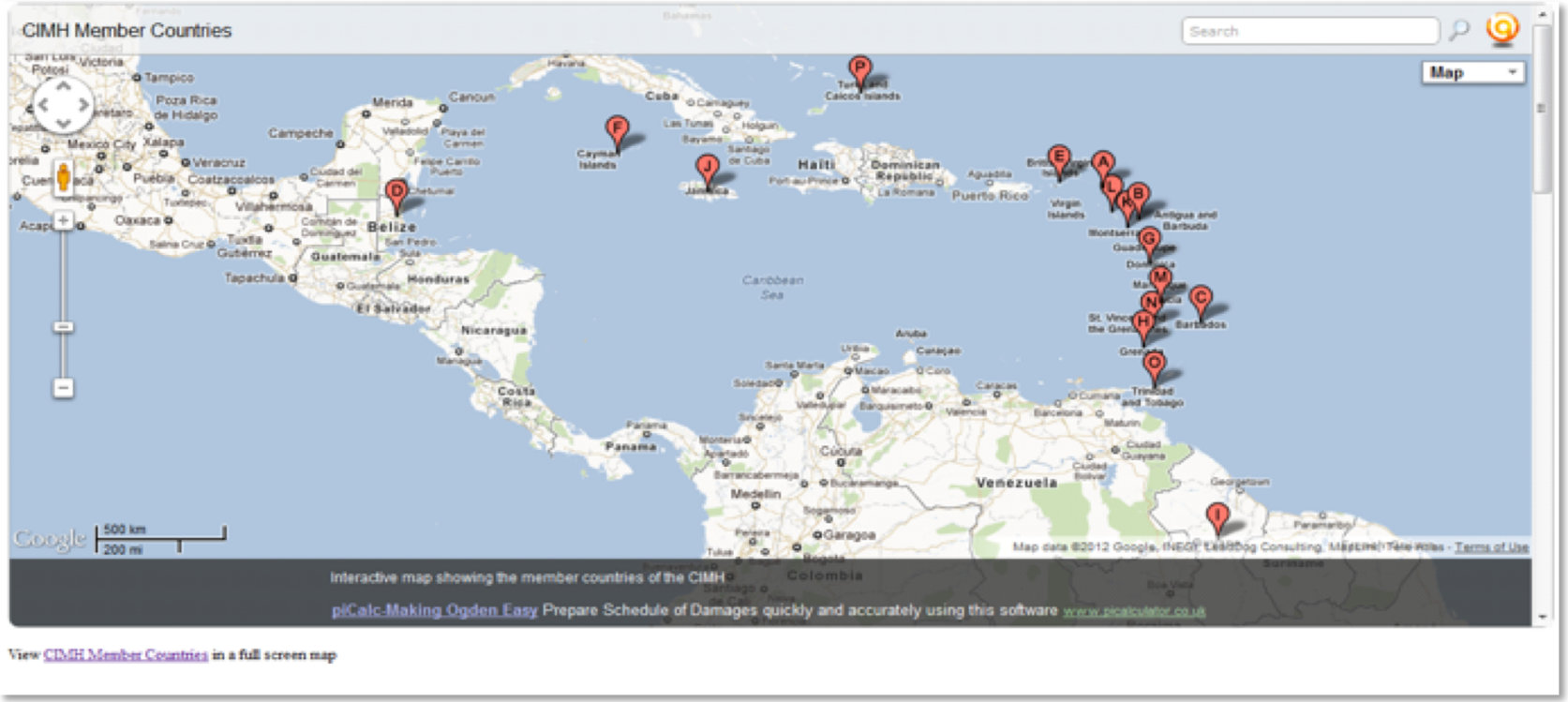
2019 CAP Implementation Workshop
Mexico City, Mexico
October 17 – 18, 2019

Presentation Overview

- Background
- Impact-based Forecasting
- Communication and Public Dissemination
- Integrating CAP Messaging
- Key Takeaways



Background



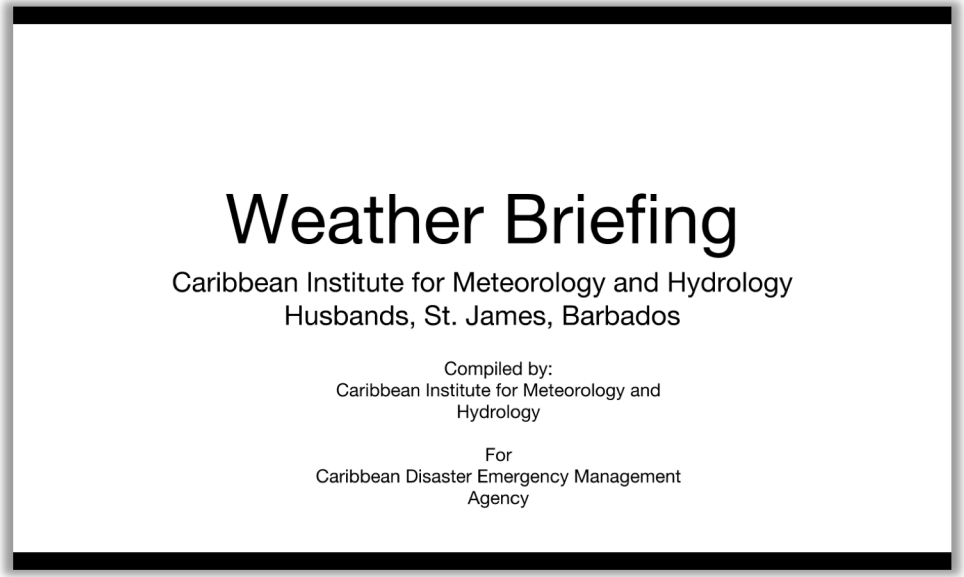
View CIMH Member Countries in a full screen map

"… to assist in improving and developing the Meteorological and Hydrological Services as well as providing the awareness of the benefits of Meteorology and Hydrology for the economic well-being of the CIMH member states. This is achieved through ***training, research, investigations and the provision of related specialized services and advice***".

Background...cont'd

- WMO Regional Training Centre
- Centre for Research and Development in Meteorology, Hydrology and Climatology
- Regional Data Centre
- Regional Instruments Centre
- WMO Regional Centre of Excellence in Satellite Meteorology
- WMO Regional Climate Centre
- Caribbean Centre for Climate and Environmental Simulations
- WMO Pan American Centre for Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)
- Advisor to regional governments

Background...cont'd



Weather Briefing @ CDEMA CU
CDP and other resources

Scenario Planning @ CDEMA CU
Mobilisation, pre-positioning, alerting, etc

Background...cont'd

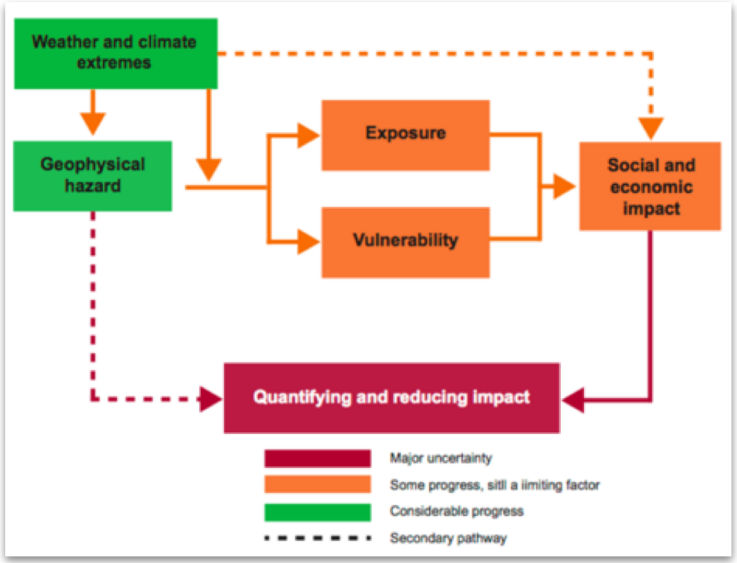
The Weather and Climate Ready Nations (WCRN) is based on the very successful Weather Ready Nations (WRN) programme and partnership implemented in the US which has transformed the utilization and delivery of early warning information to emergency managers, first responders, government officials, businesses and the public.

Project: Impact-based Forecasting and Warning Services: Barbados

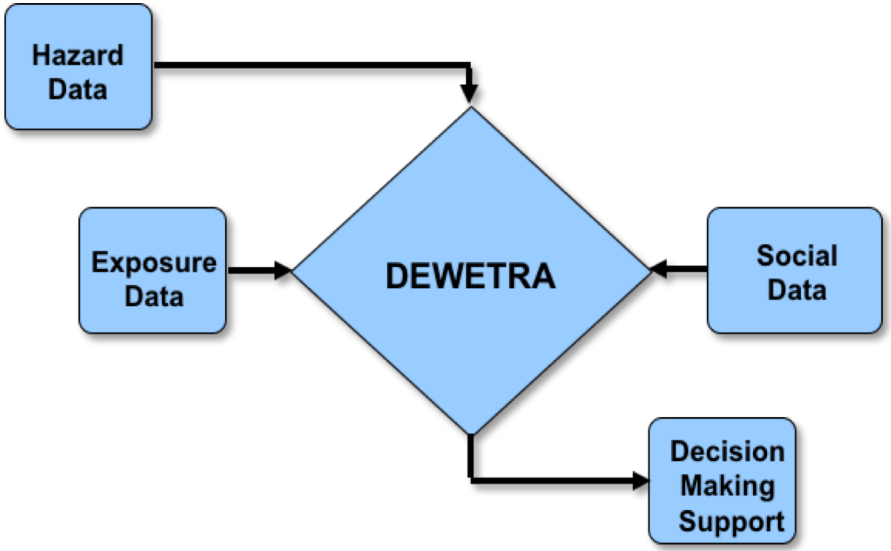
Start date: February, 2017
Funding: United States Agency for International Development
Implementation Agencies: US National Weather Service, United Corporation for Atmospheric Research – COMET, CIMH
Beneficiary Agencies: Barbados Meteorological Service, Barbados Department of Emergency Management, national agencies

Outcome: Strengthening of the hydro-meteorological and climate early warning systems on the island through the establishment of an operational impact-based forecasting workflow and the strengthening of the relationship between BMS and DEM

Impact-based Forecasting

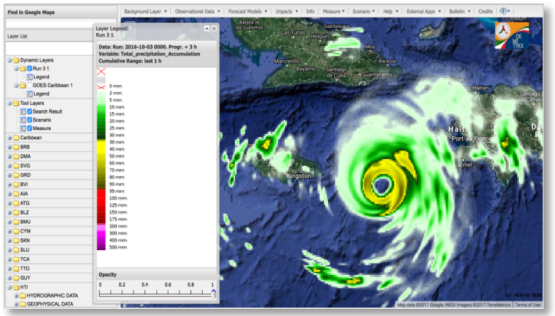


Impact-based Forecasting System
(source: WMO 2105)

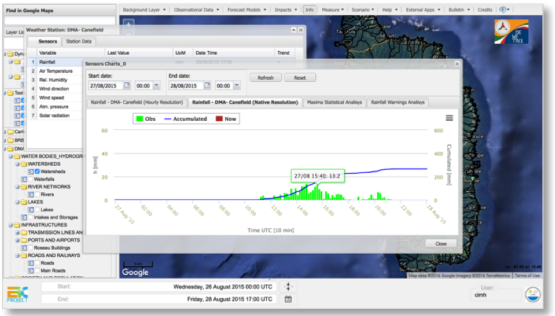


Caribbean Dewetra Application
(established 2013)

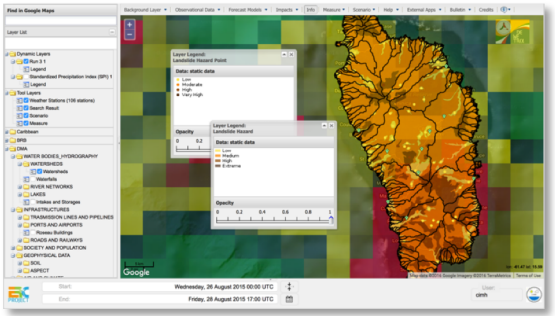
Impact-based Forecasting...cont'd



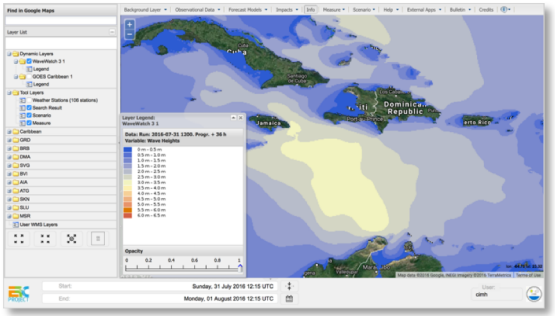
Numerical Weather Prediction



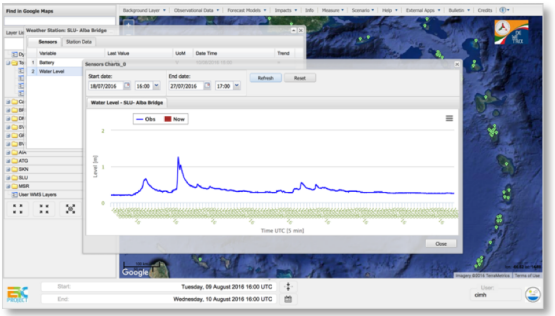
Automatic Weather Station



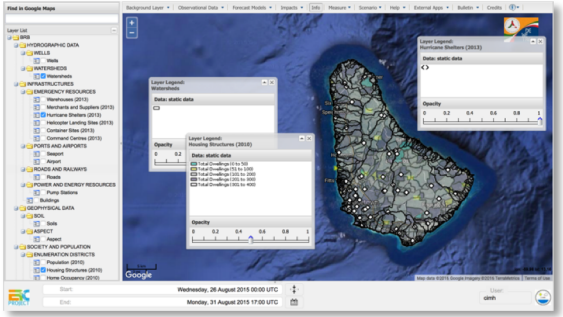
Hazard/Risk Exposure



Wave Height Prediction



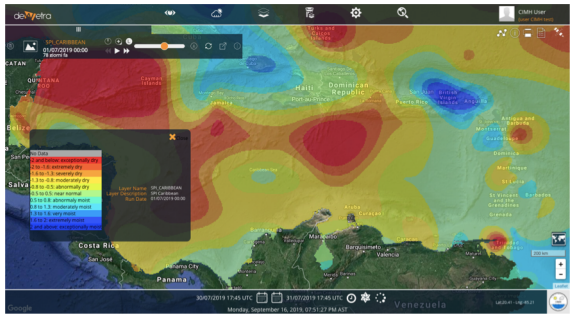
Automatic Water Level Station



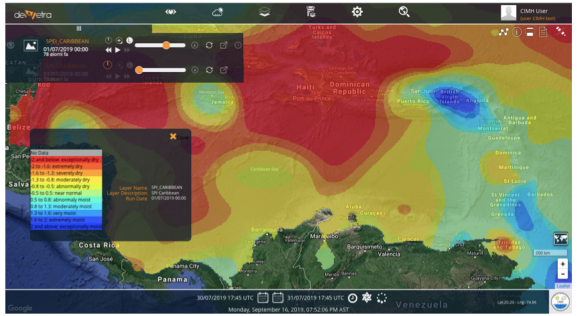
Population Vulnerability

Risk = Exposure x Vulnerability x Hazard

Impact-based Forecasting...cont'd



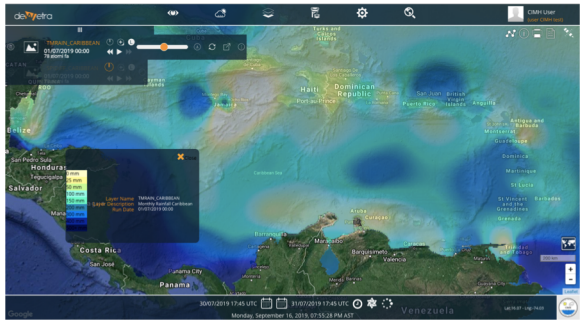
SPI



SPEI

SPI Difference

Temperature Anomaly



Monthly Precipitation

SPEI Difference

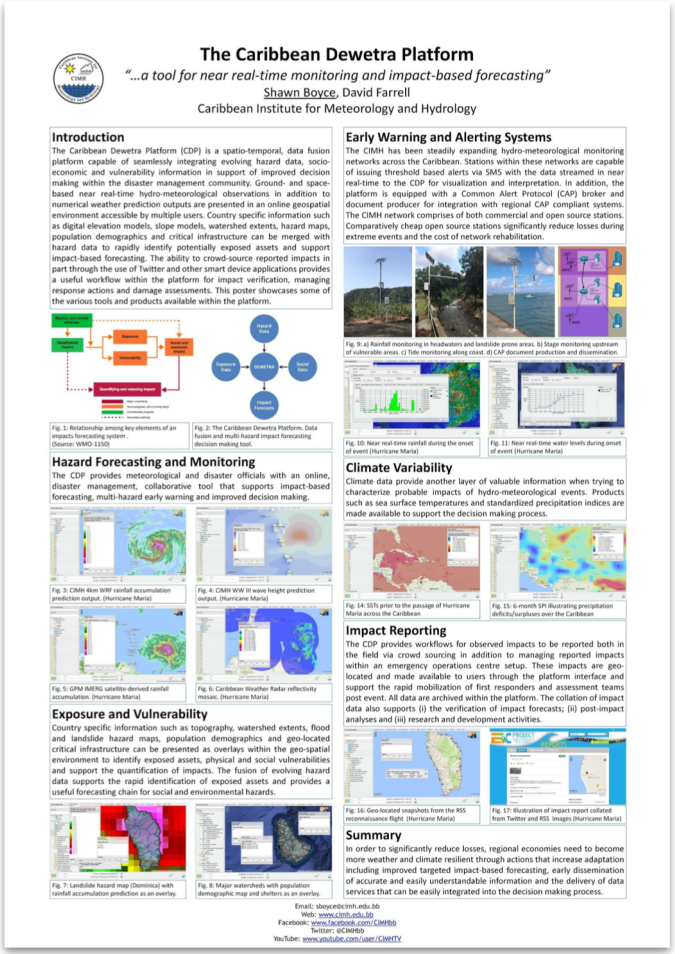
Climate Monitoring

Impact-based Forecasting...cont'd

Caribbean Dewetra Application

- Online spatio-temporal data fusion decision making platform hosted and maintained by CIMH
- Support impact-based forecasting and near real time hydro-meteorological monitoring
- Multiple hazards can be included

- **Auto message generation techniques to support impact forecast were limited**
- **Improvements were required for communication and dissemination of message**
- **Facilitated through the Weather (and Climate) Ready Nations Programme**



The Caribbean Dewetra Platform

"...a tool for near real-time monitoring and impact-based forecasting"

Shawn Boyce, David Farrell
Caribbean Institute for Meteorology and Hydrology

Introduction

The Caribbean Dewetra Platform (CDP) is a spatio-temporal, data fusion platform capable of seamlessly integrating evolving hazard data, socio-economic and vulnerability information in support of improved decision making within the disaster management community. Ground- and space-based near real-time hydro-meteorological observations in addition to numerical weather prediction outputs are presented in an online geospatial environment accessible by multiple users. Country specific information such as digital elevation models, slope models, watershed extents, hazard maps, population demographics and critical infrastructure can be merged with hazard data to rapidly identify potentially exposed assets and support impact-based forecasting. The ability to crowd-source reported impacts in part through the use of Twitter and other smart device applications provides a useful workflow within the platform for impact verification, managing response actions and damage assessments. This poster showcases some of the various tools and products available within the platform.

Fig. 1: Relationship among key elements of an impacts forecasting system . (Source: WMO-1150)

Fig. 2: The Caribbean Dewetra Platform. Data fusion and multi-hazard impact forecasting decision making tool.

Hazard Forecasting and Monitoring

The CDP provides meteorological and disaster officials with an online, disaster management, collaborative tool that supports impact-based forecasting, multi-hazard early warning and improved decision making.

Fig. 3: CIMH 4km WRF rainfall accumulation prediction output. (Hurricane Maria)

Fig. 4: CIMH WW III wave height prediction output. (Hurricane Maria)

Fig. 5: GPM IMERG satellite-derived rainfall accumulation. (Hurricane Maria)

Fig. 6: Caribbean Weather Radar reflectivity mosaic. (Hurricane Maria)

Exposure and Vulnerability

Country specific information such as topography, watershed extents, flood and landslide hazard maps, population demographics and geo-located critical infrastructure can be presented as overlays within the geo-spatial environment to identify exposed assets, physical and social vulnerabilities and support the quantification of impacts. The fusion of evolving hazard data supports the rapid identification of exposed assets and provides a useful forecasting chain for social and environmental hazards.

Fig. 7: Landslide hazard map (Dominica) with rainfall accumulation prediction as an overlay.

Fig. 8: Major watersheds with population demographic map and shelters as an overlay.

Early Warning and Alerting Systems

The CIMH has been steadily expanding hydro-meteorological monitoring networks across the Caribbean. Stations within these networks are capable of issuing threshold based alerts via SMS with the data streamed in near real-time to the CDP for visualization and interpretation. In addition, the platform is equipped with a Common Alert Protocol (CAP) broker and document producer for integration with regional CAP compliant systems. The CIMH network comprises of both commercial and open source stations. Comparatively cheap open source stations significantly reduce losses during extreme events and the cost of network rehabilitation.

Fig. 9: a) Rainfall monitoring in headwaters and landslide prone areas. b) Stage monitoring upstream of vulnerable areas. c) Tide monitoring along coast. d) CAP document production and dissemination.

Fig. 10: Near real-time rainfall during the onset of event (Hurricane Maria)

Fig. 11: Near real-time water levels during onset of event (Hurricane Maria)

Climate Variability

Climate data provide another layer of valuable information when trying to characterize probable impacts of hydro-meteorological events. Products such as sea surface temperatures and standardized precipitation indices are made available to support the decision making process.

Fig. 14: SSTs prior to the passage of Hurricane Maria across the Caribbean

Fig. 15: 6-month SPI illustrating precipitation deficits/surpluses over the Caribbean

Impact Reporting

The CDP provides workflows for observed impacts to be reported both in the field via crowd sourcing in addition to managing reported impacts within an emergency operations centre setup. These impacts are geo-located and made available to users through the platform interface and support the rapid mobilization of first responders and assessment teams post event. All data are archived within the platform. The collation of impact data also supports (i) the verification of impact forecasts; (ii) post-impact analyses and (iii) research and development activities.

Fig. 16: Geo-located snapshots from the RSS reconnaissance flight (Hurricane Maria)

Fig. 17: Illustration of impact report collated from Twitter and RSS images (Hurricane Maria)

Summary

In order to significantly reduce losses, regional economies need to become more weather and climate resilient through actions that increase adaptation including improved targeted impact-based forecasting, early dissemination of accurate and easily understandable information and the delivery of data services that can be easily integrated into the decision making process.

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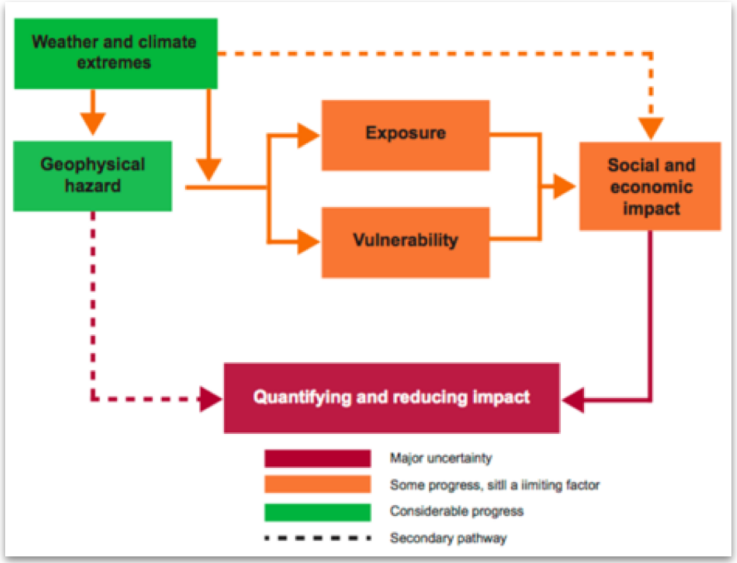
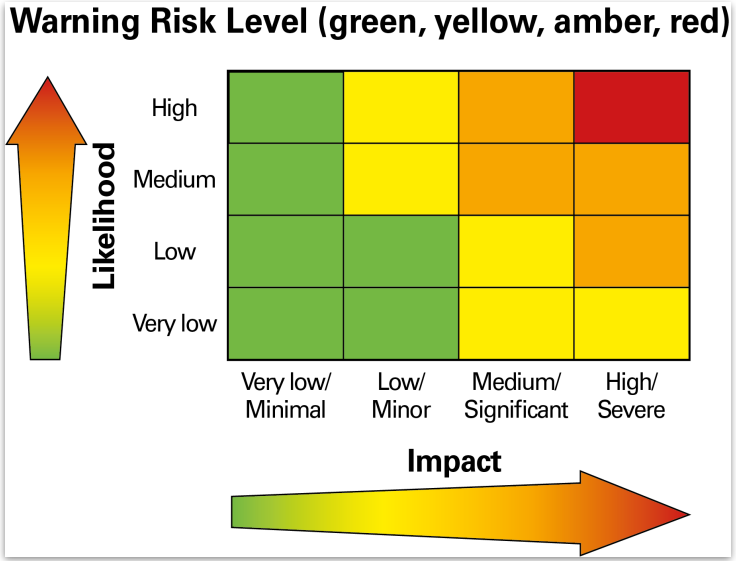
Twitter: @CIMHbb
YouTube: www.youtube.com/user/CIMHTV

Impact-based Forecasting…cont'd



Impact-based Forecasting System
(source: WMO 2105)



Warning Matrix
(source: Weather Ready Nations)

Impact-based Forecasting…cont'd

Risk Matrix					
Likelihood	HIgh				
	Medium				
	Low				
	Very Low				
		Minimal	Minor	Significant	Severe
		Potential Impacts			

Risk Level
High
Medium
Low
Very Low

Response
Take Action
Be Prepared
Be Aware
No Action

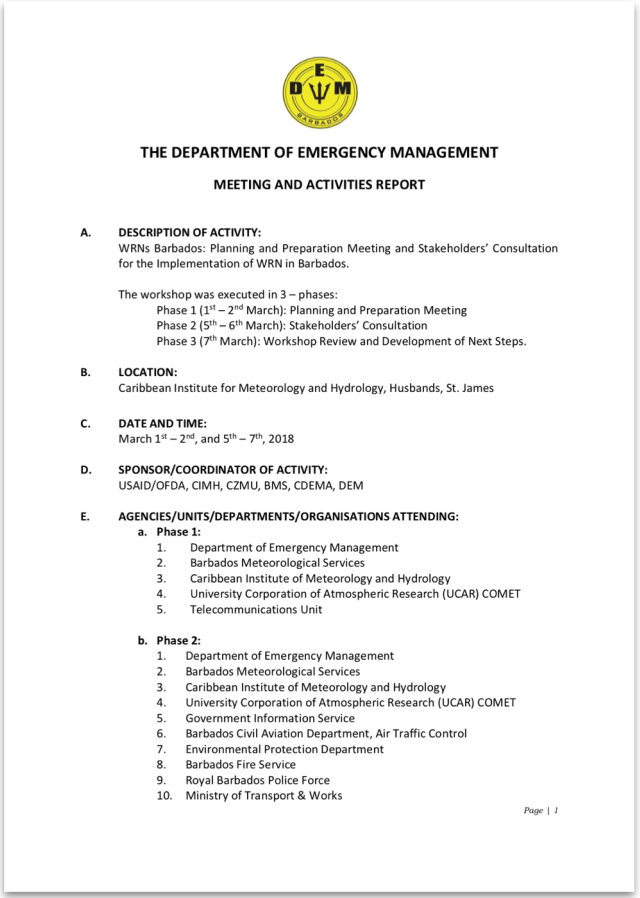
Warning and Response Matrices

Communication and Public Dissemination…cont'd

Conducted a Stakeholders Communication Modes and Methods workshop in March 2018 (Barbados demonstration)

Meeting Objectives:

- Review and refine the ideal impact, risk, and response matrices with local stakeholders
- Review and refine Standard Operating Procedures
- Review resource needs and action items for WCRNs Demonstration
- Introduce Common Alerting Protocol
- Development of Ambassador Program for Barbados



THE DEPARTMENT OF EMERGENCY MANAGEMENT

MEETING AND ACTIVITIES REPORT

A. DESCRIPTION OF ACTIVITY:
WRNs Barbados: Planning and Preparation Meeting and Stakeholders' Consultation for the Implementation of WRN in Barbados.

The workshop was executed in 3 – phases:
Phase 1 (1st – 2nd March): Planning and Preparation Meeting
Phase 2 (5th – 6th March): Stakeholders' Consultation
Phase 3 (7th March): Workshop Review and Development of Next Steps.

B. LOCATION:
Caribbean Institute for Meteorology and Hydrology, Husbands, St. James

C. DATE AND TIME:
March 1st – 2nd, and 5th – 7th, 2018

D. SPONSOR/COORDINATOR OF ACTIVITY:
USAID/OFDA, CIMH, CZMU, BMS, CDEMA, DEM

E. AGENCIES/UNITS/DEPARTMENTS/ORGANISATIONS ATTENDING:

a. Phase 1:
1. Department of Emergency Management
2. Barbados Meteorological Services
3. Caribbean Institute of Meteorology and Hydrology
4. University Corporation of Atmospheric Research (UCAR) COMET
5. Telecommunications Unit

b. Phase 2:
1. Department of Emergency Management
2. Barbados Meteorological Services
3. Caribbean Institute of Meteorology and Hydrology
4. University Corporation of Atmospheric Research (UCAR) COMET
5. Government Information Service
6. Barbados Civil Aviation Department, Air Traffic Control
7. Environmental Protection Department
8. Barbados Fire Service
9. Royal Barbados Police Force
10. Ministry of Transport & Works

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Communication and Public Dissemination…cont'd

Impact Matrices Developed for Several Hazards

- Rainfall
- Wind
- Severe Convection
- Flood

Impact Matrix for emergency management: Rainfall			
Minimal Impact	**Minor Impacts**	**Significant Impacts**	**Severe Impacts**
Transportation Wet roads and higher likelihood of accidents Localized disruption to traffic	Localized pooling and flooding of roads Occasional accidents and associated disruptions and increased travel times Minor public transportation disruptions	Localized flooding and damage of roads with significant delays and disruption to traffic Accidents and associated disruptions and increased travel times Significant disruptions to public transportations	Widespread flooding and damage of roads with dangerous driving conditions Multiple accidents and associated disruptions and increased travel times Most public transportation significantly delayed
Land slippage/landslides Isolated land slippage	Localized land slippage – limited debris flow on roads	Localized land slippage resulting in road closures and property damage – significant debris flow (rocks and trees)	Land slippage resulting in road closures and property damage and communities cut off
Stream/water course flooding Minor ponding on low lying areas	Localized flooding and/or ponding in low-lying flood prone areas	Possible life threatening flash flooding of vulnerable areas	Life threatening, extensive flash flooding of vulnerable areas

Communication and Public Dissemination…cont'd

Risk and Response Matrices Developed for Several Hazards

- Rainfall
- Wind
- Severe Convection
- Flood

Risk and Response Matrix: Rainfall

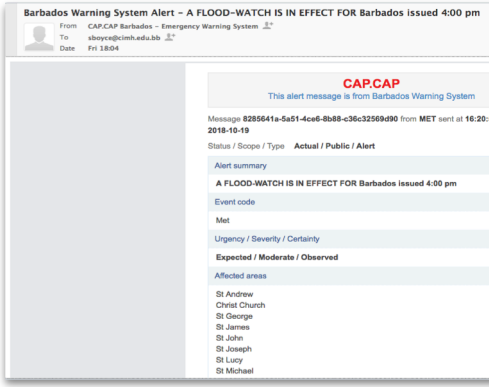
Risk Matrix						Risk Level	Response
Likelihood	HIgh						
	Medium					High	Take Action
	Low					Medium	Be Prepared
	Very Low					Low	Be Aware
		Minimal	Minor	Significant	Severe	Very Low	No Action
		Potential Impacts					

Response Matrix: Rainfall			
Very Low - Business as usual	**Low - Be Aware**	**Medium - Be Prepared**	**High - Take Action**
Monitor for changing weather conditions.	Be aware and stay out of flood waters. Evaluate inventory of emergency supplies (food, water, medical supplies), restock supplies as needed. Monitor roads and properties for localized flooding and possible traffic and public transportation disruptions.	Stay out of flood waters and check emergency supplies, purchase additional supplies if needed, fill gas tanks, etc. Be prepared for localized flooding of roads and properties in […locations…],and land slippages that could block roads. Prepare for possible delays or cancellation of public transportation routes	Stay out of flood waters and prepare to use emergency supplies. Avoid walking or driving through moving water and seek safer/higher ground if in […locations…]. Don't drive and stay off roads in flood prone areas or areas with frequent land slippage/land slides. Plan to shelter in place in non-flood areas.

Communication and Public Dissemination…cont'd

Upgrading the Caribbean MyDewetra platfrom to generate WCRNs advisory and warning graphics.

- Impact-based forecast and response information bulletin produced
- Authorized messages can be passed via the CAP protocol to local stakeholders, Barbados CAP Server or otherwise
- DEM can review impact/response information
- Workflows to support both BMS and DEM responsibilities and integration with the Barbados CAP Server

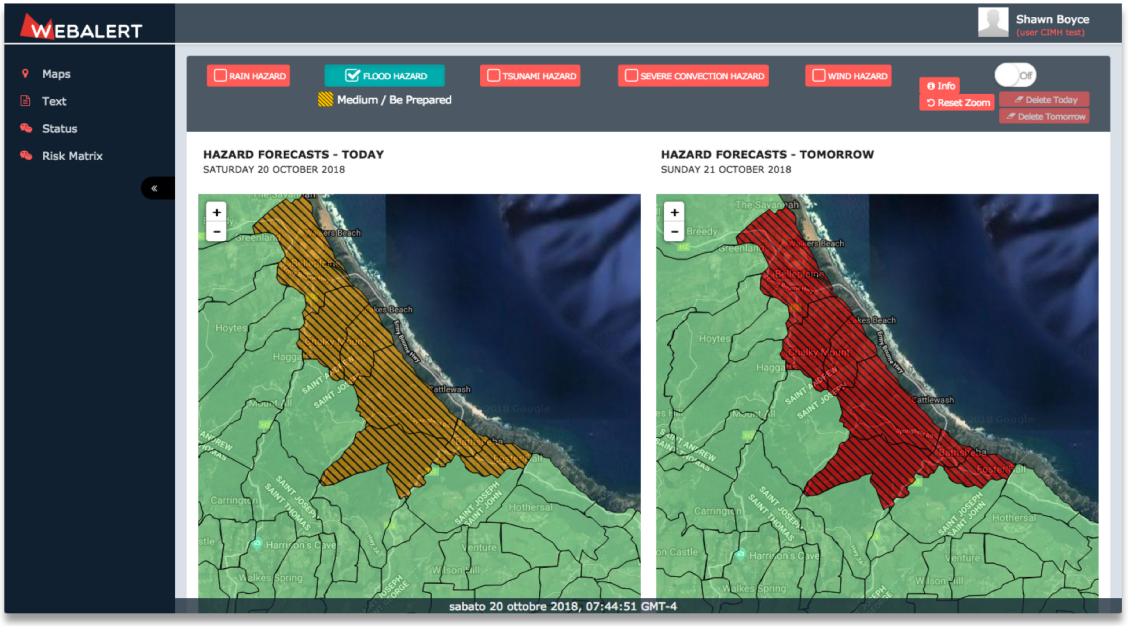


Barbados CAP Server

Integrating CAP Messaging

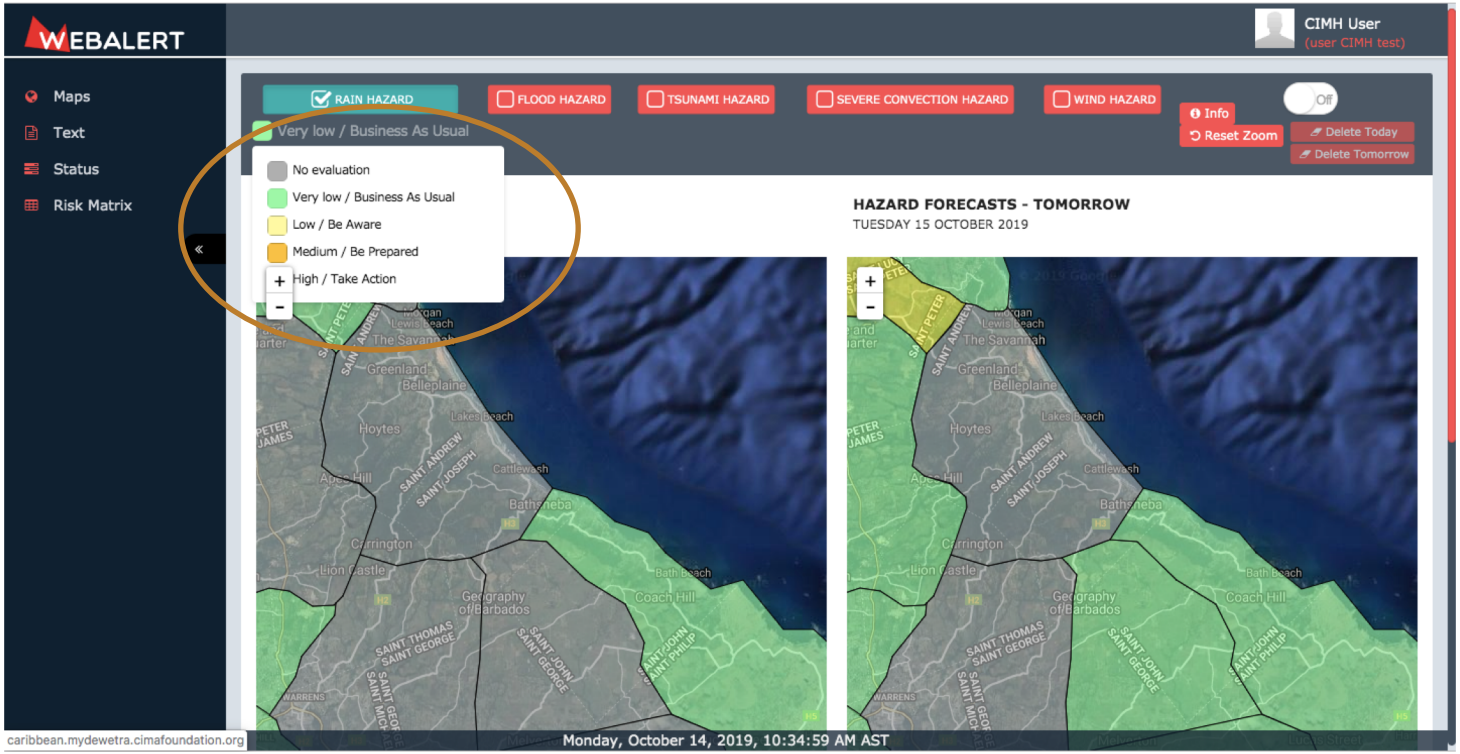
Implementing the WebAlert application to generate alert and warning graphics.

- Utilizing GIS polygons to delineate expected impact zones
- Auto message generation techniques to produce impact forecast for stakeholders
- Multiple hazards can be included
- CAP compliant



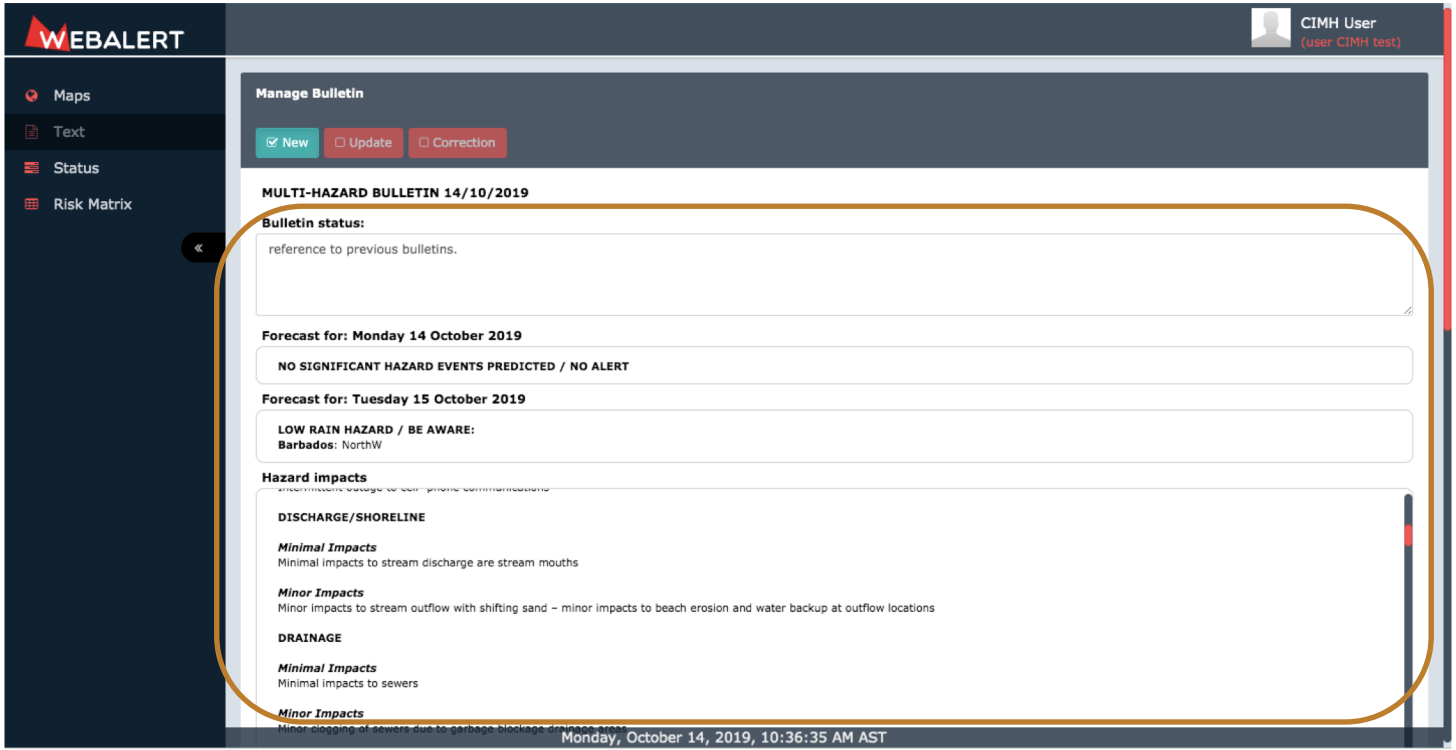
Caribbean MyDewetra Platform
WebAlert 2.0 Application

Integrating CAP Messaging…cont'd



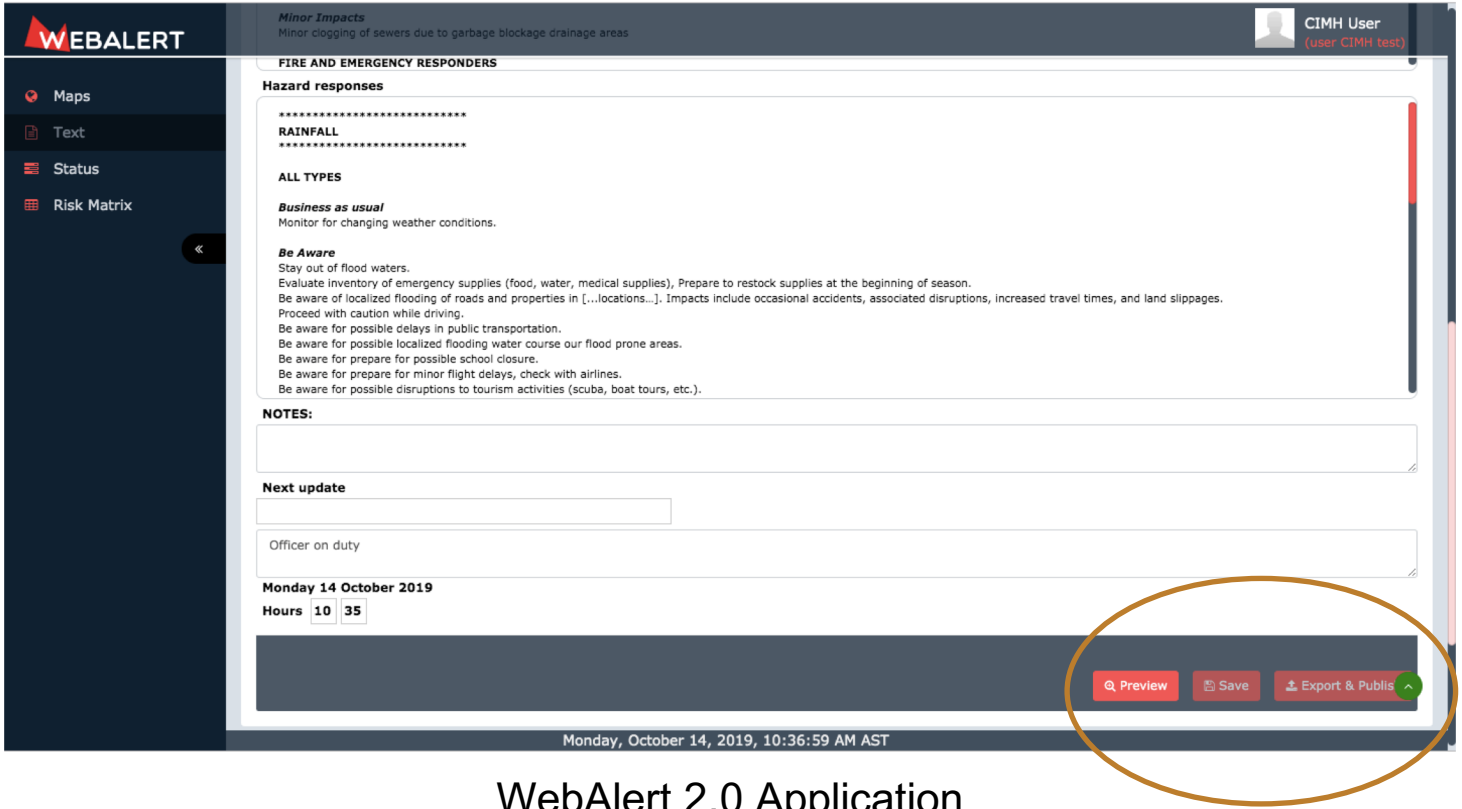
WebAlert 2.0 Application

Integrating CAP Messaging…cont'd



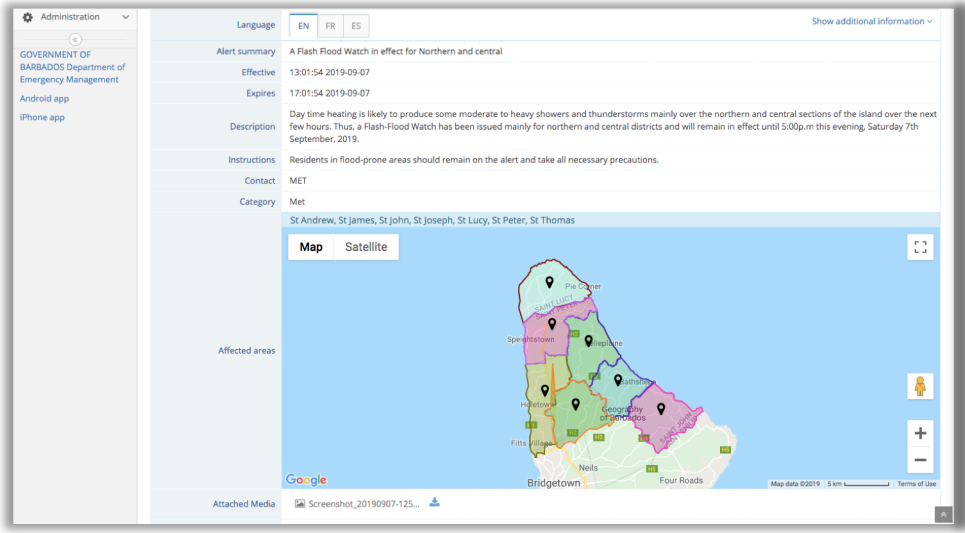
WebAlert 2.0 Application

Integrating CAP Messaging…cont'd

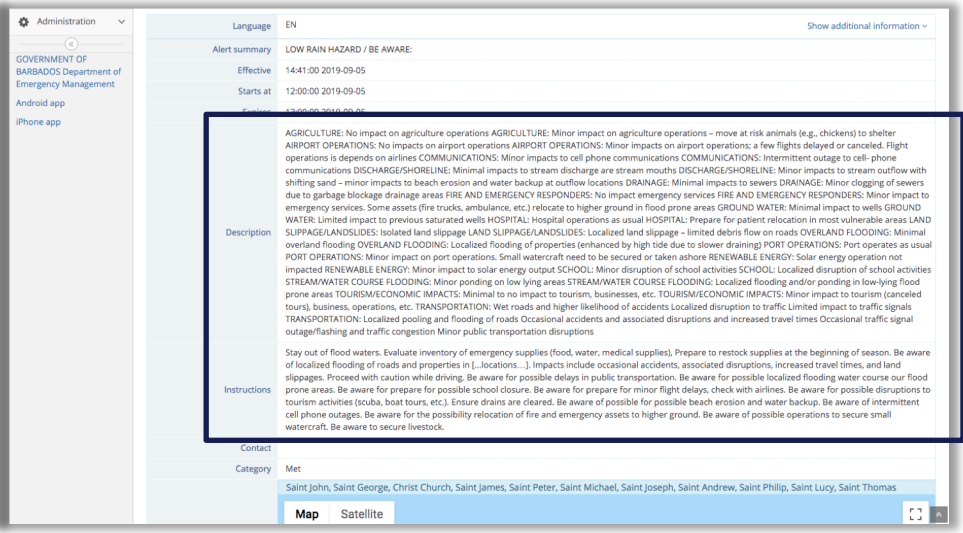


WebAlert 2.0 Application

Integrating CAP Messaging…cont'd

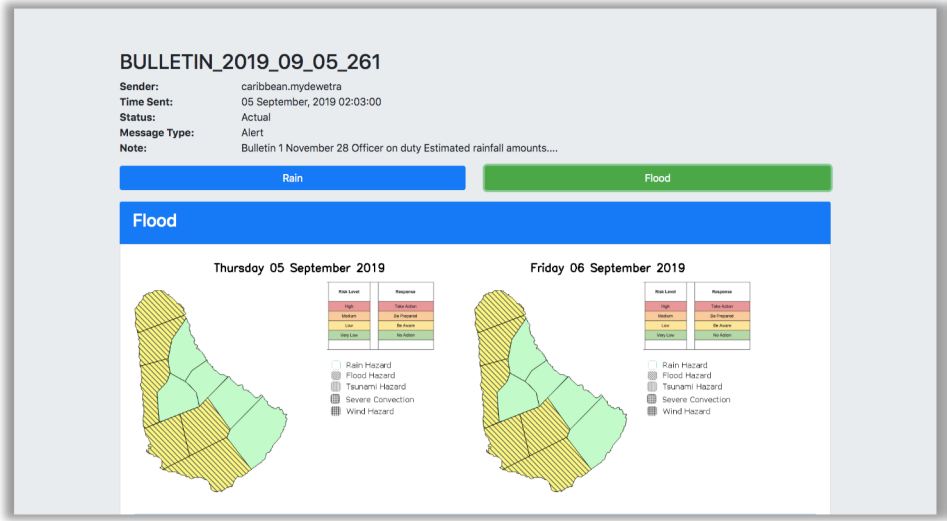


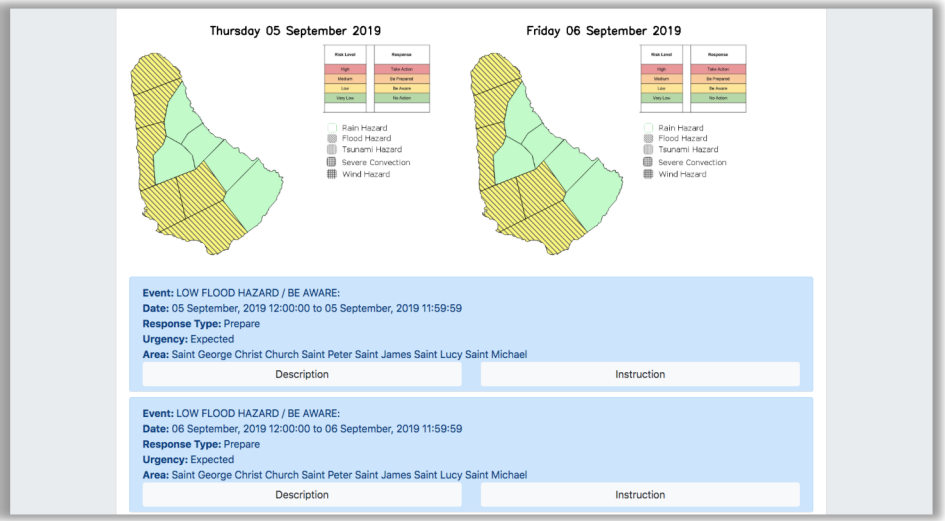
CAP Messaging - Current



CAP Messaging – IBFWS. How do we improve the messaging?

Integrating CAP Messaging…cont'd



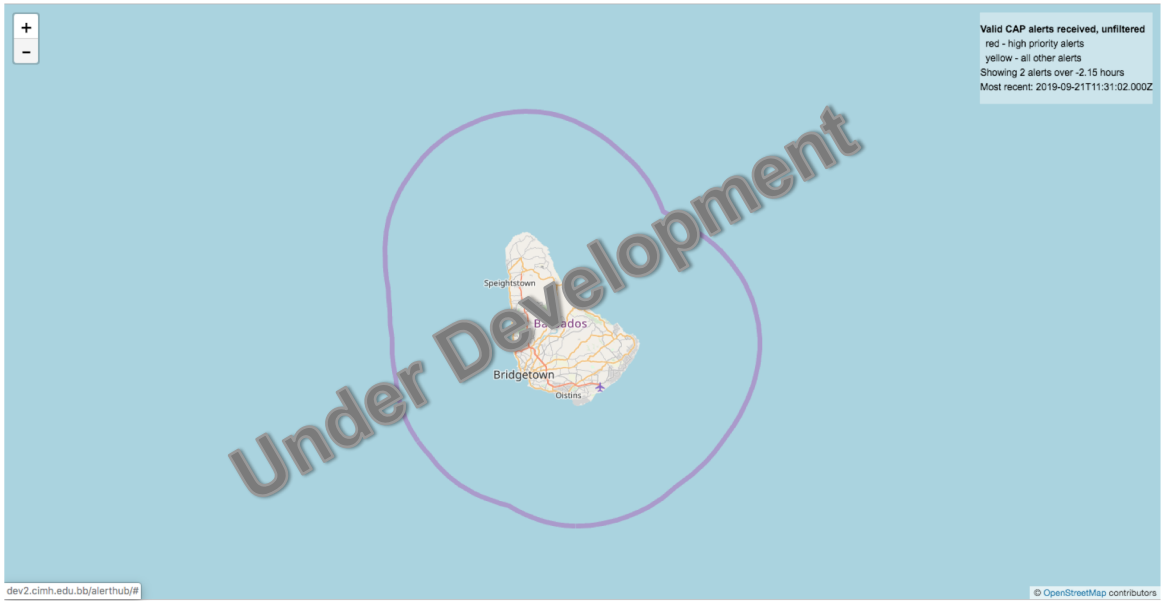


CAP Messaging – Website Integration

Integrating CAP Messaging…cont'd

Lessons learned can guide criteria for future implementations

- Strong relationship among NMHSs and NDMAs
  - Enhances communication
  - Improve existing SOPs
- Data management and data sharing
  - Access to hazard, exposure and vulnerability data to support IBF
  - Dynamic web page with regional CAP alerts



Dynamic web page

Key Takeaways

- IBFWS being implemented in the Caribbean through WCRN Programme Barbados demonstration
- What the weather will be vs. what the weather will do
- Caribbean MyDewetra Platform provided tools to support IBFWS and CAP
- Tools improved through WCRN Programme
- Integration of IBFWS and CAP messaging has its challenges but doable

Thank you!